Smart Grid Deployment and Climate Change Response: Evaluating Climate Change Integration in Ontario's Smart Grid Deployment Regime

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Smart grid (SG) is modern electricity infrastructure that has the capacity to facilitate mitigation and adaptation to climate change through technological, institutional, and behavioral interventions. However, despite the capacity to respond to climate change, development and deployment of SG technology also has the potential to facilitate increased GHG emissions or result in the development of a maladaptive grid. By formally integrating climate change considerations into SG deployment regimes, electricity stakeholders can mitigate the risk of contributing to GHG emissions or implementing a maladaptive grid as well as ensure that SG deployment facilitates a comprehensive and efficient response to climate change.

The purpose of this research was to explore the SG deployment regime in Ontario between 2004 and 2013 within the context of climate change. Specifically, this thesis aimed to evaluate evidence of climate change integration within Ontario's SG deployment regime and identify gaps in climate change integration. Ultimately, the objective was to identify areas of SG deployment where climate change integration could be strengthened to assist stakeholders in implementing a SG that results in a positive and comprehensive response to climate change.

Through a content analysis of publically available documents published by electricity stakeholders, it was found that several SG initiatives inadvertently demonstrated climate change integration or an inadvertent response to climate change. There was no evidence that electricity stakeholders explicitly considered climate change in SG deployment activities. In particular, gaps were identified in components of climate change integration related to climate change impact assessments, project evaluations, long-term planning, and consumer education and public awareness. Overall, it is recommended that electricity stakeholders take measures to explicitly consider climate change in future SG deployment activities. As Ontario is a global leader in SG deployment, climate change integration in Ontario's electricity sector could set a precedent and inspire other jurisdictions pursuing SG technology to do the same, both across Canada and globally.

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AMI- Advanced Metering Infrastructure
CCA- Climate Change Adaptation
CCM- Climate Change Mitigation
CCS- Carbon Capture and Storage
CCIEF- Climate Change Integration Evaluative Framework
CDM- Conservation and Demand Management
DMS- Distribution Management Systems
DSM- Demand-Side Management
DTCR- Dynamic Thermal Circuit Rating
EPI- Environmental Policy Integration
EPRI- Electric Power Research Institute
EV- Electric Vehicle
FDIR- Fault Detection Isolation Restoration
FIT- Feed in Tariff
GEGEA- Green Energy and Green Economy Act
GHG- Greenhouse Gas
GIS- Geographic Information Systems
IESO- Independent Electricity System Operator
INDC- Intended Nationally Determined Contributions
IPCC- Intergovernmental Panel on Climate Change
IUT- Intelligent Universal Transformer
LDC- Local Distribution Company
LTEP- Long Term Energy Plan
Mt- Megatonnes
NERC- North American Electric Reliability Corporation
NRCan- Natural Resources Canada
OCP- Official Community Plans
OEB- Ontario Energy Board
OME- Ontario Ministry of Energy
OMECC- Ontario Ministry of Environment and Climate Change
OMS- Outage Management System
OPA- Ontario Power Authority
OPG- Ontario Power Generation
SCADA- Supervisory Control and Data Acquisition
SCC- Standards Council of Canada
SG- Smart Grid
SGWG- Smart Grid Working Group
THESL- Toronto Hydro Electric System Ltd.
TOU- Time of Use
TWh- Terawatt Hours
UNFCCC- United Nations Framework Convention on Climate Change

Chapter 1: Introduction

Section 1.1: Climate Change and Electricity Systems

For most households and businesses, a steady and reliable electricity supply is an invisible, taken-for-granted amenity. However, the infrastructure necessary to generate and deliver energy to homes and businesses is "indispensable to modern society" (Bompard, Napoli and Xue, 2009, p. 5). As the impacts of climate change become increasingly evident, it is clear that climate change poses both a challenge and an opportunity for energy and electricity sectors.

In their 2014 report, the Intergovernmental Panel on Climate Change (IPCC) stated that the energy supply sector is the largest contributor to greenhouse gas (GHG) emissions globally. Specifically, the IPCC notes that in "2010, approximately 35% of total anthropogenic GHG emissions" were attributed to activities involving "energy extraction, conversion, storage, transmission, and distribution" (IPCC, 2014, p. 518, p. 516). Additionally, electricity generation, transmission and distribution in Canada contributed to 12% of Canada's total GHG emissions in 2012 (Environment Canada, 2013a). It is recognized that electricity sectors have a significant role to play in implementing measures to mitigate climate change. Climate change mitigation (CCM) refers to " a human intervention to reduce the sources or enhance the sinks of greenhouse gases" (IPCC, 2012a, p. 561). The IPCC (2014) highlights three fundamental components of CCM specifically for electricity sectors. First, CCM may involve the decarbonizing of power generation through the integration of renewable sources. Second, CCM can involve substituting low-carbon electricity "for direct use of fossil fuels in buildings and industry" as well as for transportation fuels (p. 560). Finally, CCM in the electricity sector involves reducing energy demand using technology and other practices.

Ironically, while the electricity industry contributes to the GHG emissions that cause climate change, electricity infrastructure is vulnerable to disruption and damage as a consequence of a changing climate. Therefore, it is necessary for the electricity sector to introduce climate change adaptation (CCA) measures in addition to mitigation initiatives. For the purpose of this research, climate change adaptation (CCA) is defined in response to the specific risks that climate change poses to electricity infrastructure. CCA refers to measures intended to limit susceptibility of electricity infrastructure to damage, reduce or eliminate the risk of outage, or manage electricity loads.

Climate change increases the vulnerability of electricity infrastructure in three primary ways. First, climate change is predicted to cause a change in electricity demand. Specifically, increased electricity demand for heating and cooling during instances of extreme temperatures may exceed generation and transmission system capacity, resulting in less efficient power delivery or loss of service (i.e., a "power outage") (Bedsworth and Hanak, 2010; Ward, 2013; IPCC, 2014). Moreover, periods of high temperatures can cause transmission infrastructure to work less efficiently due to additional resistance and ultimately result in "breakdown of equipment and service disruption" (Nierop, 2014, p. 79).

Second, climate change is predicted to cause an increase in the frequency and severity of extreme weather events (IPCC, 2007b). Ward (2013) notes that because a large portion of electricity infrastructure, such as overhead lines and outdoor substations, are exposed to weather, they are vulnerable to damage. Nierop (2014) draws particular attention to the risk that flooding poses to substations and electricity infrastructure that is located underground as well as the risk that violent storms pose on overhead power lines.

Third, changes in the availability of renewable energy sources associated with climate change could make electricity supply more vulnerable to shortages. Climate change is predicted to cause changes in wind speeds, changes in cloud cover as well as alter precipitation patterns, temperature and seasonal and total runoff (Nierop, 2014, p. 79). While the availability of renewable energy sources will depend on "regional circumstances," such changes in climate conditions could make it more challenging for electricity providers to ensure a secure supply of electricity from renewable sources (Nierop, 2014, p. 79).

Not only is loss of service disruptive to those who rely on electricity, but the interconnected nature of our modern infrastructure systems means that large-scale outages can result in "cascading" infrastructure failures. A cascading failure refers to a situation when failure in one infrastructure system results in "failure across multiple systems (Kelly, 2015, p. 2). Ultimately, a cascading failure associated with loss of electricity service can threaten the function of vital societal services including sanitation facilities, hospitals, transportation, and communication (Graham, 2010; Hellstrom, 2007). Furthermore, power outages can result in significant economic loss. For instance, the 2003 blackout in Eastern Canada and the Northeastern United States cost the Ontario economy 18.9 million lost work hours and reduced the national GDP in Canada by 0.7% in August (Natural Resources Canada and U.S. Department of Energy, 2006). Furthermore, it is estimated that storm related power outages between 2003 and 2012 cost the US economy US$18 billion to US$33 billion per year (Executive Office of the President, 2013).

Section 1.2: Smart Grid Deployment in Ontario

The smart grid (SG) is modern electricity infrastructure that has the capacity to facilitate mitigation and adaptation to climate change (Stephens, Wilson, Peterson & Meadowcroft, 2013)**.** The Ontario Ministry of Energy (OME) (2009) defines SG as "the advanced information exchange systems and equipment that when utilized together improve the flexibility, security, reliability, efficiency, and safety of the integrated power system and distribution system" (p. 13). The specific technologies associated with SG and their roles in CCM and CCA are discussed in more detail in Chapter 2.

Electricity stakeholders in Ontario have made significant progress updating conventional electricity infrastructure with SG technology. In 2009, the OME adopted the *Green Energy and Green Economy Act* (GEGEA) that specifically mandates SG development in Ontario (Ontario Smart Grid Forum, 2011). Specifically, in the *GEGEA*, the OME states that the SG development and deployment is intended for the following purposes:

> For… enabling the increased use of renewable energy sources and technology, including generation facilities connected to the distribution system; expanding opportunities to provide demand response, price information and load control to electricity consumers; accommodating the use of emerging, innovating and energy-saving technologies and system control applications. (Ontario Ministry of Energy, 2009, p. 13)

Through directives, incentives and funding, the OME has encouraged a wide range of investment in SG development and innovation. Most notably, Ontario is the first jurisdiction in North America to install in each house and small business a "smart meter" which is a device that facilitates bi-directional communication between electricity consumers and utility companies (Briones and Blasé, 2012; Gellings, 2011). This component of SG technology effectively enables utility companies to adopt *Time of Use* (TOU) pricing models. TOU seeks to shift electricity demand away from peak-use times by higher pricing at these times as a means of reducing the peak demand that electricity generation and delivery infrastructure must be sized to meet. Lower peak demand can mitigate climate change as it reduces the demand on generation facilities. Lowering peak demand is especially effective for CCM if the energy supply is replaced with a lower carbon electricity source. As previously mentioned, Chapter 2 provides more detail on the specific SG technologies that facilitate CCA and CCM.

In conjunction with the deployment of SG technology in Ontario, the *GEGEA* also provides a policy framework to promote an increase in the production of renewable energy as well as encourage a "culture of conservation" in households and businesses in the province. Complimenting the goals of the *GEGEA*, Ontario's *Long Term Energy Plan* (LTEP) (Ontario Ministry of Energy, 2013a) commits the province to having 20,000 MW of renewable energy "online" by 2025, reflecting approximately half of Ontario's installed capacity (p. 6). Additionally, the OME set an ambitious long-term conservation target of 30 terawatt-hours (TWh) by 2032 (p. 5). As of 2013, the province-wide conservation initiative resulted in 8.716 TWh of energy savings, achieving 29% of the 2032 target (Environmental Commissioner of Ontario, 2014, p. 89).

The objectives outlined in the *GEGEA* and the *LTEP* require the involvement of stakeholders operating throughout Ontario's electricity sector. In particular, all licensed Local Distribution Companies (LDCs) in Ontario have been required to roll out smart meters to all homes and businesses, and to develop and implement a Conservation and Demand Management (CDM) strategy. As the *GEGEA* and the *LTEP* are implemented, LDCs are required to utilize smart meter technology and CDM programs together as a means to promote efficient energy use and encourage consumers to adopt electricity-conserving practices. Given that the success of these programs is contingent on consumer uptake and behavior change, education and awareness building activities are critical components of all CDM initiatives.

Section 1.3: Climate Change Integration and Smart Grid Deployment

While SG refers to a diverse range of modern electricity delivery technologies, it is important to understand that the SG deployment process requires a behavioral, social and institutional paradigm shift in order to ensure an effective technological transition (Stephens et al., 2013). With regards to climate change, SG is capable of facilitating CCM and CCA from both a technological standpoint (i.e., the integration of renewable energy sources), as well as from a behavioral and institutional perspective (energy conservation and demand management). This is discussed in more detail in Chapter 2.

Stephens et al. (2013) note that it is incorrect to assume that the SG will inherently contribute to CCM and CCA efforts. Because SG deployment is a continually evolving process and involves the implementation of a diverse number of technologies, it is very possible that SG technology can be deployed in a manner that does not contribute to CCA and CCM. For instance, Stephens et al. (2013) go so far to argue that if climate is not a consideration during SG deployment, there is a risk that the SG could actually lead to an increase in electricity consumption and generation, perpetuate GHG emissions and facilitate maladaptive practices. For example, consumers who have not been educated on SG, conservation and climate change may increase electricity consumption by adopting "novel electric devices" such as smart appliances, thinking them more efficient; the electrification of transportation without any demand management or conservation considerations elsewhere in the sector could increase peak demand (p. 203). Furthermore, without considering climate impacts on electricity infrastructure, SG deployment may result in an electricity system that is unable to cope with future climate extremes (Stephens, et al, 2013, p. 203).

Stephens et al. (2013) recommend that electricity stakeholders integrate climate change into the formal electricity system decision-making structures to ensure that SG deployment results in positive progress towards climate objectives. This recommendation is consistent with the vast body of literature highlighting the importance of integrating or "mainstreaming" climate change policy to ensure that all stakeholders in a given sector are considering climate change as part of their operations (see Chapter 2). The benefits of this are twofold. First, by integrating climate change considerations into SG planning and deployment, electricity stakeholders can ensure that the implemented SG technology does not contribute to GHG emissions, is not maladaptive, and does not result in a grid that is vulnerable to climate change-related damage. Second, in the case of Ontario, the Province has invested a substantial amount of money to both implement SG and respond to climate change. Integrating climate change considerations into SG deployment is an effective way to ensure that provincial funding is being allocated efficiently given that integration can also ensure that the behavioral, social, and institutional paradigm shift towards SG complements the policy, technical and behavioral objectives necessary to respond to climate change.

Section 1.4: The Research

The purpose of my research is to explore the SG deployment regime in Ontario within the context of climate change. Specifically, I explore SG deployment between 2004 and 2013 through a climate change lens as a means to evaluate evidence of climate change integration within Ontario's SG deployment regime. The overall objective is to highlight components of SG deployment that demonstrate evidence that electricity stakeholders considered not only possible contributions to climate change response and climate change impacts, but also to identify potential shortcomings or gaps where integration could be strengthened. Through this research I consider both the process and outcome of SG deployment. Specifically, the former was explored through consideration of policy, program objectives and SG planning, while the latter examined the specific technology that was deployed between 2004 and 2013.

The following questions guided my research inquiry:

Research Question #1: *Given the conceptualization of climate change integration in SG deployment articulated by Stephens et al. (2013) and content found in publically available documents published by electricity stakeholders, what evidence indicates that climate change considerations have been integrated into the SG deployment regime in Ontario?*

Research Question #2: *In which components of SG deployment in Ontario could there be a more targeted effort to integrate climate change considerations into smart grid deployment and ensure that SG technology facilitates a comprehensive response to climate change?*

To answer my research questions I conducted a content analysis of publically available documents published between 2004 and 2013 by stakeholders involved in SG deployment in Ontario. Documents include OME policy and directives, Ontario Energy Board (OEB) regulations and technical reports, Ontario Smart Grid Forum reports as well as annual reports, CDM strategies and reports, and business plans available from the LDCs operating throughout the province. The document selection process is outlined in more detail in Chapter 4.

The data collection and analysis process took place over several phases and involved using both manifest and latent content analysis techniques. Manifest content analysis refers to a technique that involves analyzing the frequency of "words, phrases or concepts in text" (Silverman and Patterson, 2015, p. 99) and is useful for assessing the nature of discourse in a given text. For this research I developed and applied an evaluative framework that utilizes manifest content analysis techniques. Specifically, the

Climate Change Integration Evaluative Framework (CCIEF) was used to rank and evaluate selected keywords indicative of SG deployment activities that are relevant to climate change integration.

In contrast to manifest content analysis, latent content analysis is a non-numerical approach to content analysis and involves using open coding techniques to identify "underlying meanings and patterns in data being analyzed" (Silverman and Patterson, 2015, p. 101). I used latent content analysis to further explore and contextualize manifest content analysis findings.

Together the manifest and latent content analysis were used to evaluate evidence of climate change integration in various components of SG deployment and identify areas of SG deployment that could be strengthened to integrate climate change considerations. The methodology and methods employed for this research will be discussed in detail in Chapter 4.

Section 1.5: Contribution

With regards to SG literature, this research examines Ontario's SG deployment program within the context of climate change. Not only is this perspective distinct from existing SG research in Ontario, it is also a relatively new field of study in the broader context of SG literature. Broad SG literature primarily focuses on technological applications as well as the political and social dimensions of deployment. Although there has been discussion on the role of SG deployment in responding to climate change, it has been less extensive and discussion on climate change integration in SG deployment has been relatively limited. This research expands on the work of Stephens et al. (2013) by using the general recommendations for climate change integration outlined in their paper to inform a quantitative and qualitative evaluation of integration within the SG deployment regime in Ontario.

In addition to its contribution to SG literature, this research is also a unique contribution to climate change literature. Existing literature published on the subject of climate change policy implementation highlights the importance of policy integration or "mainstreaming," yet there are minimal attempts to assess or evaluate such integration in a large multi-stakeholder sector. Although the use of the

Climate Change Integration Evaluative Framework (CCIEF) was developed specifically to assess climate change integration in the SG deployment process (see Chapter 4), this method of content analysis could be adapted to include sector-specific indicators and applied to assess climate change integration in other sectors such as land use planning and development. .

Finally, this research is an important contribution to both SG and climate change policy development and implementation because it will provide a comprehensive view of SG deployment activities and climate change objectives and initiatives underway throughout the electricity sector between 2004-2013, as well as the factors that drive such activities. Furthermore, this holistic perspective will allow me to provide context-specific recommendations for electricity stakeholders in Ontario to strengthen climate change integration in the SG deployment regime. Such recommendations, while context-specific to SG implementation in Ontario, are relevant to other jurisdictions seeking to deploy SG technology as a means of responding to climate change. I argue that SG deployment not only offers electricity stakeholders the opportunity to integrate climate change response activities, but also that climate change integration is necessary for electricity stakeholders to ensure that infrastructure serves to both mitigate and adapt to climate change in a cost-efficient, comprehensive, consistent and continuous manner.

Section 1.6: Thesis Structure

This thesis consists of seven chapters including the introductory chapter. In the following chapter (Chapter 2: Literature Review), I outline previous literature and research in the fields of climate change, SG and policy integration. Chapter 3 provides relevant contextual information on the electricity sector in Ontario, the SG deployment regime and the broad climate change initiatives underway in the sector between 2004 and 2013. Chapter 4 discusses the research methodology and research method employed for this research as well as describes the data collection and analysis process. In Chapter 5 I present my research findings and answer my research questions while in Chapter 6 I consider the research findings in the context of broader literature. Finally, in Chapter 7, I conclude the thesis and provide recommendations for practice and for future research.

Chapter 2: Literature Review

This chapter is divided into five major sections. In Section 2.1 I discuss CCM and CCA as climate change response measures with a focus on literature pertaining to CCM and CCA initiatives identified in energy and electricity sectors. In Section 2.2 I discuss existing research on SG technology and SG deployment. Specifically, I outline the technological capacity that SG technology and applications have for climate change response. In Section 2.3 I discuss existing literature on policy integration and mainstreaming. Section 2.4 focuses on the methods employed in this field of research and Section 2.5 highlights the literature gaps and the contributions this thesis makes to the SG, climate change and policy integration fields of research.

Section 2.1: Managing Climate Change Risk

Climate change did not emerge as a public issue on scientific and political agendas until the late 1970s despite the fact that scientists have been aware of climate change since the 1820s (Harding, 2007; Gupta, 2010). Climate change is defined as “a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties, and that persists for an extended period, typically decades or longer” (IPCC, 2007a, p. 943). While the IPCC notes that their definition of climate change does not inherently attribute climate change to human activities, in their Fourth Assessment Report (2007b), they concluded, “there is a very high confidence that the net effect of human activities since 1750 has been one of warming” (p. 5). Specifically, industrial activities have increased the emission of GHGs, which contribute to the greenhouse effect or the “trapping” of heat caused both by their reflection of the planet’s thermal infrared radiation and atmospheric radiation within the earth’s troposphere (IPCC, 2007b).

There are two primary strategies to manage climate change risks: mitigation and adaptation (Ayers and Huq, 2009). As discussed in Chapter 1, climate change mitigation (CCM) is defined as “a human intervention to reduce the sources or enhance the sinks of greenhouse gases" (IPCC, 2012a, p. 561). Climate change adaptation (CCA) refers to "an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2012b, p. 5; also cited in Bulkeley and Tuts, 2013; Tompkins et al., 2010). Essentially, both strategies are intended to "reduce the undesirable impacts of climate change" (Ayers and Huq, 2009, p. 753). However, the strategies differ in that CCM is largely an attempt to "avoid the unmanageable" while CCA is a strategy to "manage the unavoidable" (Laukkonen, et al., 2009, p. 288).

Adaptation to climate change is a relatively recent addition to the climate policy agenda. Historically, policies intended to address climate change focused primarily on mitigation and were largely "synonymous with energy policy" (Klein, Schipper and Dessai, 2005, p. 583). Initially, climate change was framed as an environmental program and mitigation, as a technological response, was emphasized in both research and policy (Swart and Raes, 2007; Preston, Westaway and Yuen, 2011). Furthermore, mitigation received more political and academic attention than adaptation because mitigation practices have global implications, while most adaptation strategies are more impactful at the local level (Swart and Raes, 2007; Fussel and Klein, 2006).

It is now acknowledged that climate change is not only an environmental issue, but is also relevant in discussions pertaining to social and public policy, resource law, and the economy (Dovers and Hezri, 2010). This, in combination with "increasing evidence of climate change impacts" has resulted in a surge of adaptation research, policies and projects (Biesbroek et al., 2010, p. 440). There is now a growing recognition in the literature that both CCM and CCA are necessary responses to climate change as we must both limit future contribution to climate change as well as prepare for the consequences of past behavior and consumption patterns (Laukkonen, et al., 2009; IPCC, 2012b; Klein, et al., 2005).

Section 2.1.1: Climate Change Mitigation

CCM approaches to reduce GHG emissions typically result in "emissions trading schemes, carbon emissions capping, and the hope of achieving GHG reduction targets 'in time' to prevent worst case scenarios of global warming" (Ayers and Huq, 2009, p. 755). As previously mentioned, much of the international negotiations and global collaboration aimed at responding to climate change has been focused on mitigation. Of particular significance is the Kyoto Protocol, a large multi-state agreement that was adopted in 1997 and came into force in 2005 (Gupta, 2010). The Kyoto Protocol called for a 5.2% emissions reduction of six GHGs (carbon dioxide, methane, nitrous oxide, HFC, SF_6 and PFCs) in developed countries (Gupta, 2010). While Canada originally ratified the Kyoto Protocol, it withdrew in 2011 after a change in Federal leadership. In 2009 Canada committed to reducing GHG emissions 17% from 2005 levels by 2020 under the Copenhagen Accord (Environment Canada, 2013b), an international agreement that in contrast to Kyoto, was not legally binding (Kypreos, 2012). Additionally, in Canada's 2015 Intended Nationally Determined Contribution (INDC) submission to the United Nations Framework Convention on Climate Change (UNFCCC), Canada committed to reducing GHG emissions by 30% below 2005 levels by 2030 (UNFCCC, 2015).

In their Fifth Assessment Report, the IPCC (2014) discusses possible mitigation strategies for a number of specific sectors: energy systems, transport, buildings, industry, agriculture, forestry and other land uses as well as human settlements, infrastructure and spatial planning. While there are mitigation strategies specific to each sector, I will focus my discussion of CCM to strategies within the energy sector.

CCM Strategies for Energy Supply

In their Fifth Assessment Report, the IPCC (2014) reported that in 2010 the energy supply sector was responsible for 35% of total anthropogenic GHG emissions making the sector the "largest contributor to global greenhouse gas emissions" (p. 518). According to the IPCC, the energy supply sector comprises "all energy extraction, conversion, storage, transmission and distribution processes with the exception of those that use final energy to provide energy services in the end-use sectors" (IPCC, 2014, p. 518). In the Fifth Assessment Report, the IPCC (2014) goes on to note that 75% of GHG emissions over the last decade can be attributed to electricity and heat generation, 16% of emissions were caused by fuel production and transmission while petroleum refining contributed to 8% of total GHG emissions for the sector.

In their 2014 report the IPCC notes that there are three "generic components" of CCM in the energy sector: decarbonizing power generation, substituting electricity use for fossil fuels, and reducing energy demand (p. 560). Specific strategies outlined by the IPCC for the energy supply sector include: improving energy efficiency, reducing "fugitive non-CO_2 GHG emissions," fuel switching (i.e., from coal to natural gas), integrating renewable energy or nuclear energy sources as well as using carbon capture and storage technologies (CCS) (p. 569). The IPCC emphasizes that no one mitigation option will result in the reduction of GHG emissions required to "hold the increase in global average temperature change below 2°C" (p. 569). Furthermore, the IPCC (2014) states that "climate change can only be mitigated and global temperature be stabilized when the total amount of CO_2 emitted is limited and emissions eventually approach zero" (p. 527).

Implementation

Generally, to achieve the desired GHG reduction it is necessary for federal, regional and local policy makers to introduce sector-specific policy measures and instruments to achieve broader national and global goals and objectives. In the case of Canada, while the federal government has established "legislative instruments to address climate change," the provinces and territories have statutory authority over matters pertaining to natural resources, energy, and the environment (Canada Submission to UNFCCC, 2015). Consequently, in addition to the GHG regulations mandated by the Federal government, each Canadian province maintains its own legal framework and policies to reduce GHG emissions (Environment Canada, 2014).

Blechinger and Shah (2011) highlight a number of policy measures and policy instruments used to reduce GHG emissions in the power generation sector (see Figure 1).

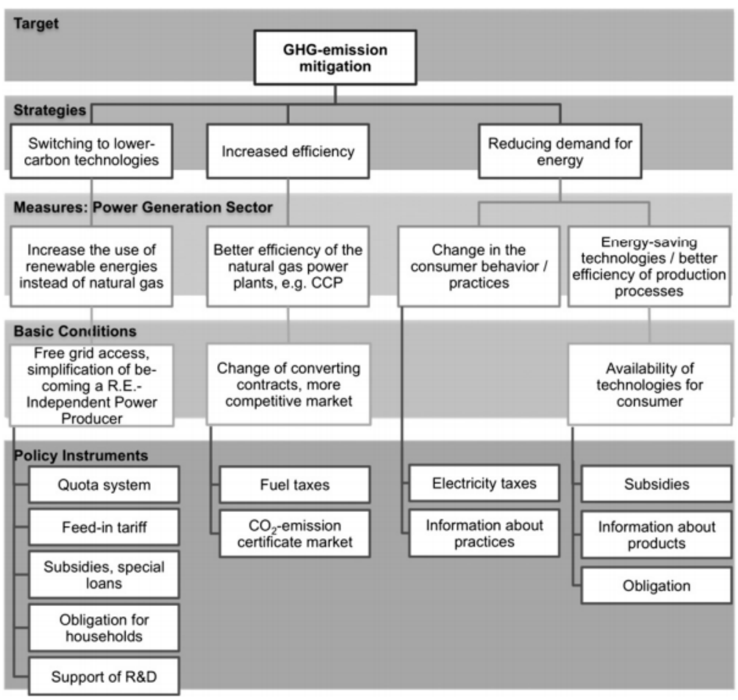


Figure 1: GHG Emission Reduction Policy Measures and Instruments
Source: Blechinger and Shah, 2011, p. 6335.

As shown in Figure 1, policy measures include objectives such as increasing the use of renewable energy sources to replace natural gas, enhancing efficiency in power plants, changing electricity consumer habits and adopting technology to facilitate energy savings and efficiency. To achieve these goals, Blechinger and Shah (2011) suggest the use of policy instruments such as taxes, quotas, subsidies and consumer education.

Section 2.1.2: Climate Change Adaptation

What is CCA?

The IPCC (2012a) defines CCA both in terms of human and natural systems. In human systems CCA refers to "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities" (p. 556). In natural systems the IPCC (2012b) defines CCA as "the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate" (p. 556). Despite the fact that the IPCC definition for CCA is widely accepted in literature, in contrast to CCM, adaptation to climate change is a relatively ambiguous concept. Based on my review of the literature on CCA, it is possible that such ambiguity can be attributed to the fact that in comparison to CCM, CCA is a recent concept and is largely dependent on local circumstances. Consequently, there is no agreed-upon standard for CCA. Examples of CCA measures can include relocating human settlements, building sea walls, diversifying crops, decentralizing energy generation and changing land use patterns. It is worth noting that CCA can occur either as a reaction or in anticipation to climatic trends or weather events (Smit, Burton, Klein and Wandel, 2000).

In contrast to CCM, CCA is extremely context specific and locally focused. An intervention that is overwhelmingly effective in one community may not be appropriate in another due to the diverse nature of climate change threats and the varying characteristics that make a system (a population, a community, or an infrastructure system) vulnerable to climate change. As a result of the diverse practical applications of CCA interventions, Klein et al. (2005) note that the benefits of adaptation are "difficult to express in a single metric" (p. 581).

In the literature, the concepts of vulnerability, resilience and adaptive capacity are key themes associated with the overall conceptualization of CCA. While vulnerability refers to "the potential for loss" or the "propensity or predisposition to be adversely affected" (Cutter, 1996, p. 529; IPCC, 2012a, p. 564), resilience can be defined as the ability of a system to "survive and function under extreme stress" and “recover quickly after a shock” (Godschalk, 2003, p. 137; Bruneau et al., 2003, p. 736). Essentially, the overall goal of CCA is to minimize the vulnerability of a given system to climate change-related risk, while also enhancing resilience (Kelly and Adger, 2000; McEvoy, Funfeld, and Bosomworth, 2013). It is worth noting that the concept of resilience maintains multiple definitions. The term has its origins in the field of ecology (Holling, 1973) but has been adopted by a number of other disciplines including materials science, psychology, economics, sociology, and engineering (Molyneaux, 2012; Bruneau et al., 2003). In the context of ecology, Holling defined resilience as “a measure of the persistence of systems and of their ability to absorb change and disturbances and still maintain the same relationships between populations or state variables” (p. 14). In the context of my research, I use the term resilience in the context of engineering or hazards recovery (see definition above). In contrast to ecological conceptualizations of resilience, engineering or hazards recovery-related definitions of resilience emphasize the ability of a system to maintain function under extreme stress and recover after a shock (Steen and Aven, 2011; Bruneau et al., 2003; McDaniels, et al., 2008; Goldschalk, 2003).

Given that my research is partially premised on the necessity for resilient infrastructure to mitigate the risk of cascading infrastructure failures, it is also important to acknowledge the role of systems theory in this context. Systems theory “approaches a complex system such as an organization, city or region… as an integrated system of which all component parts have an impact or are impacted by all others” (Kaiser and Smallwood, 2014, p. 95). An understanding of systems theory and the interconnected nature of systems can assist individuals working on initiatives related to enhancing resilience and adapting to climate change. Essentially, recognition of systems theory in this context can mitigate the risk that an initiative to enhance the resilience of one system increases the vulnerability of another.

Adaptive capacity refers to the ability of a system to adapt to climate change (Huq and Reid, 2004, p. 16). Nelson, Adger, and Brown (2007) highlight three primary features that determine the adaptive capacity necessary for a community to implement successful CCA measures: ability to cope "while retaining structure and function," the ability to "self organize," and the capacity for learning (p. 65). Adaptive capacity is determined by socio-economic characteristics such as demographics, the economic environment, the political atmosphere, governance structures, dominant natural resource management practices, and the nature of civil society (Brenkert and Malone, 2005).

Implementation

Effective CCA implementation requires policy interventions, institutional changes, and a societal paradigm shift to "[alter] the behaviors of individuals, households, communities, firms, and governments" (Dovers and Hezri, 2010, p. 221; Bulkeley and Tuts, 2013; Pelling, 2011). Not only can CCA be both proactive and reactive, but also adaptation can occur in an informal, autonomous or "serendipitous" manner (Bulkeley and Tuts, 2013; McGray, Hammill and Bradley, 2007; Smit et al., 2000), as well as in more formal or planned capacities. Not surprisingly, there is minimal literature published on informal adaptation initiatives, while there has been more research on the subject of implementing formal CCA plans for communities or municipalities.

Notably, Bowron and Davison (2011) identify six steps necessary for a municipality to implement a formal CCA program (summarized in Table 1).

Table 1: CCA Policy-Making Process

Step 1: Get Started	Raise awareness of the risks of climate change and the necessity for adaptation amongst the public, politicians and other relevant stakeholders.
Step 2: Analyze how local climate will change	Accumulate relevant data and build climate scenarios
Step 3: Scope potential impacts	Identify the expected impacts of climate change within the policy area.
Step 4: Assess Risks and Opportunities	Note the area-specific risks and opportunities associated with CCA impacts, evaluate the adaptive capacity of the community and develop priorities.
Step 5: Prepare Adaptation Plan	Draft an adaptation plan that not only identifies goals and objectives but also highlights specific policies and projects and the responsibilities of various stakeholders.
Step 6: Adopt, Implement, Monitor and Review Adaptation Plan	Formally adopt the policy and develop an implementation strategy as well as make appropriate budgetary considerations and establish indicators and milestones

(Note: Adapted from Bowron and Davidson, 2011)

CCA implementation can involve policy, legal and behavioral interventions, as well as specific technical solutions (Klein et al., 2005; Bedsworth and Hanak, 2010). Within the electricity sector Bedsworth and Hanak (2010) highlight the use of a specific set of “tools” to facilitate CCA: structural, planning and regulatory, response, and market-based. Structural tools refer primarily to processes intended to make infrastructure more resilient, while planning and regulatory tools are policies aimed at encouraging the use of different zoning procedures and limiting development in vulnerable areas. Response tools refer to programs that further develop emergency procedures and market-based tools refer to programs that financially incentivize adaptive activities.

While it is recognized that CCA benefits are most evident at a local scale, the fact that climate change impacts often supersede the jurisdiction of any one level of government, policy sector or community greatly challenges the implementation of a consistent CCA response (Reinecke and Bernard, 2011). Many argue that local adaptation is not enough and that action is required at all scales: national and subnational governments, policy sectors, municipalities, communities and households (Dovers and Hezri, 2010; Olhoff and Schaer, 2010). Policy integration or "mainstreaming" is an approach that is often advocated as a means to ensure consistent adoption of CCA measures across jurisdictions. Policy integration will be discussed in detail in Section 2.3.

Section 2.1.3: Role of the Public

In addition to the role of technology and policy in facilitating climate change response, it is also important to recognize that there is a role for the public in facilitating a response to climate change. In the literature it is acknowledged that a full response to climate change (both in terms of CCM and CCA) will require a modification in behavior at all scales from "international climate change policy making to individual action" (Tompkins and Adger, 2005, p. 564). There are two key roles for individuals to respond to climate change that have been emphasized in literature.

The first is with regards to individual behavior to mitigate or to adapt to climate change (Rees and Bamberg, 2014; Dowd et al, 2012). Behavior changes specifically relevant to the electricity sector include consumers' adoption of energy efficient devices, conservation, load shifting, as well as involvement in outage preparation strategies in emergency situations (Bedsworth and Hanak, 2010). The second key role for individuals in facilitating climate change response is with regards to public policy development. Specifically, it is acknowledged in the literature that individuals have the ability to "influence support or opposition of" various methods of climate change response or "risk regulation" (Leiserowitz, 2005; cited in Uggla, 2008, p. 718). Wendling et al. (2013) note that public support for climate change action is "related to how individuals perceive the risks from climate change, with higher risk perceptions associated with greater support for immediate action" (p. 5155). Given the necessary role for the public in both individually responding to climate change and in encouraging broader societal and political climate change action, it is recognized in the literature that initiatives to increase public awareness and knowledge about climate change are essential (Uggla, 2008; Dowd, Ashworth, Carr-Cornish and Stenner, 2012; Boyes, Skamp and Stanisstreet, 2009).

However, while there is a consensus in the literature that initiatives to increase public awareness and education with regards to climate change are necessary, there is less of a consensus on the effectiveness of public awareness and education initiatives on facilitating behavior change. Yencken (2000) noted that in a large international study there was a "pronounced relationship" between environmental knowledge and behavior in secondary students, and Zsoka, Marjaine, Szechy and Kocsis (2013) found a correlation between "the intensity of environmental education and the environmental knowledge of students" (p. 126). However, Boyes, Skamp and Stanisstreet (2009) found that although environmental awareness may be a prerequisite for "pro-environment behavior," it might not automatically facilitate behavior change (p. 663). Consequently, Boyes et al. (2009) assert that in isolation, education is not the most effective method of modifying behavior. There are a number of factors that can influence an individual's willingness to change their behavior in response to a given issue. Kollmuss and Agyeman (2002) highlight the following variables associated with pro-environmental behavior: knowledge of the given issue, awareness of "action strategies," "locus of control," "verbal commitment" and "individual sense of responsibility" (p. 247). Moreover, the idea that behavior change tends to occur if the change would "reduce domestic costs," while there was more resistance to adopting pro-environmental behaviors that were inconvenient or "economically costly" (Fortner et al., 2000; Boyes et al., 2009).

Given the various factors that influence the ability for consumers to change their behavior, Boyes et al. (2009) argue that in order for education programs to be effective, they ought to be "complemented by structural changes including regulations and infrastructure" (p. 676). Arbuthnott (2010) further articulates this view by arguing that individual behavior change is difficult without a degree of societal change and "context management" is necessary (p. 14).

The role of the public in responding to climate change both in terms of changing behavior and facilitating social and political change is a theme that I draw on in Chapter 6 to further explore my research findings in the context of literature.

Section 2.2: Smart Grid and Climate Change Response

What is a Smart Grid?

A "smart grid" (SG) refers to a modern electricity delivery system that can be described as "a self healing network equipped with dynamic optimization techniques that use real-time measurements to minimize network losses, maintain voltage levels, increase reliability, and improve asset management" (Momoh, 2012, p. 12). SG is "characterized by a two-way flow of electricity and information to create an automated, widely distributed energy delivery network" (Gellings, 2011, p. 9). This contrasts with a conventional power system, which is a system that maintains unidirectional electricity flow, minimal monitoring technology and manual control functions (Alvial-Palavicino, Garrido-Echeverria, Jimenez-Estevez, Reyes and Palma-Behnke, 2011). Figure 2 provides a comparison of a conventional grid and SG.

Existing grid	Smart grid
Mostly electromechanical	Digital in nature
One-way communication	Two-way communication
Mostly centralized generation	Distributed generation
Sensors are not widely used	Sensors are widely used
Lack of monitoring; only manual	Digital self-monitoring
Failures and blackouts	Adaptive and intelligent
Lack of control	Robust control technology
Less energy-efficient	Energy-efficient
Usually not possible to integrate RE	Possible to integrate large-scale RE
Customers have less scope to modify uses	Customers can check uses and modify

Figure 2: Comparison between conventional grid and smart grid
Source: Shafiullah, Amanullah, Shawkat and Wolfs, 2013, p. 24

The term "smart grid" was coined in the late 1990s and since 2000 there has been widespread deployment and development of various SG technologies for electricity systems worldwide (ENBALA Power Networks, 2011). In 2000, Italy became the first jurisdiction to implement a functioning SG (ENBALA Power Networks, 2011). Specifically, this SG system included smart meters, concentrators, modems and a central system (Rogai, 2007, p. 11). Boulder, Colorado is credited with operating the first functional SG system in the United States. The initiative commenced in 2007 and included the installation of "digital capabilities" across the grid including two-way communication, grid automation, and continuous monitoring as well as the deployment of 23,000 smart meters in Boulder (Jaffe, 2012; Xcel Energy, 2015). Ontario, Canada is the first jurisdiction in North America to initiate a smart meter roll out (ENBALA Power Networks, 2011; Briones and Blasé, 2012).

SG deployment is driven by a variety of factors "ranging from financial pressures to environmental requirements" (Gellings, 2011, p. 35). The gradual transition towards a SG is reflective of change in the electricity sector more broadly. Not only is SG deployment an opportunity to modernize aging infrastructure, SG provides electricity stakeholders with an opportunity to respond to new demands. For instance, there have been increasing policy pressures to increase renewable energy supply portfolios and implement demand side management (DSM) strategies (Stephens, 2013). Given that SG technology enables the integration of renewables and the operation of DSM programs, many policy objectives are contingent on the availability of a functioning SG. In fact, Gellings (2011) notes that without a SG many of the benefits of new electricity technology may not be realized. Consequently, policymakers may mandate the development of a SG as a means to achieve other environmental, economic and social objectives related to the electricity sector (Stephens et al., 2013, Gellings, 2011). Additionally, the desire of technology companies to develop innovative products and the associated demand for those products are other drivers of SG deployment. Gellings (2011) notes that SG technology is perceived as the "market equivalent of the internet" and many companies and consumers are eager to participate in one of the "most attractive business opportunities of the future" (p. 43). Finally the desire for utilities to prevent outages and ensure a reliable supply of power is another key driver of SG deployment (Gellings, 2011, Stephens, et al., 2013).

Despite the fact that the term "smart grid" is often used when referring to it as a single entity, a SG system actually consists of a variety of infrastructure components that together facilitate the generation, transmission, distribution, regulation and consumption of electricity. In literature, policy, and publicly available documents, the term "smart grid" can refer solely to the hard technology and infrastructure itself, or it can mean the infrastructure and all of the associated operational, regulatory and consumption components associated with grid modernization (for instance, TOU pricing) (Stephens et al., 2013). For the purposes of this research, I use the latter conceptualization of SG in my discussion.

In addition to the specific technology associated with SG deployment, it is also important to note that SG reflects a paradigm shift in the manner that electricity is produced, distributed, consumed and regulated. There are a number of economic, social and environmental benefits that can be attributed to the technological, institutional and social evolution associated with SG deployment (see Stephens et al., 2013; Gellings, 2011; Momoh, 2012). For the purpose of this research, the benefits of SG will be discussed in the context of CCM and CCA. Broadly, SG enables climate change response by facilitating demand side management and conservation initiatives, allowing the replacement of fossil fuels with electricity (electrification), enabling the integration of renewable energy sources onto the electricity grid, as well as by enhancing grid reliability, flexibility, and resilience.

The following section highlights the technological components of SG and its applications that have the capacity to contribute to both CCM and CCA efforts. However, it is important to note that SG deployment does not automatically facilitate a response to climate change. As mentioned in Chapter 1, Stephens et al. (2013) argue that in order to ensure that SG investments do not result in increased GHG emissions due to the rebound effect or maladaptive infrastructure, it is necessary for stakeholders to consider climate change throughout the deployment process. Stephens et al. (2013) outline eight general strategies for electricity stakeholders to integrate climate change considerations into SG deployment (pp. 211-212).

1. "All SG investments should be assessed for potential contributions to climate change mitigation and adaptation in the short and long term;"
2. "SG initiatives that contribute to energy efficiency and electricity conservation should be a priority;"
3. "SG initiatives that facilitate the incorporation of low-carbon generation should be encouraged;"
4. "SG measures that support the emergence of local microgrids and enhance local community-based energy systems are generally positive;"
5. "Particular attention should be paid to ways in which SG can enhance system flexibility and redundancy;"
6. "SG initiatives that promote further societal electrification also have potential;"
7. "SG proponents need to make a clear case for the specific economic, social and environmental benefits particular investments will secure" as a means of "maintaining public trust and support;"

8. “The regulatory focus on developing electricity markets must be tempered by the need for greater coordination and longer term planning than private actors typically provide.”

These “common leverage points across diverse contexts” (Stephens et al., 2013, p. 211) will be discussed extensively in Chapters 4 and 5, because they provide the basis for my evaluation.

Section 2.2.1: Smart Grid and Climate Change Mitigation

The Electric Power Research Institute (EPRI) estimates that relative to 2005 emission rates, the SG and SG-enabled technologies (such as renewable energy generation) have the potential to reduce 58% of carbon dioxide emissions from the electricity sector by 2030 (Gellings, 2011).

SG and Demand Side Management

SG technology enables electricity stakeholders (governments, regulators and utility companies) to implement DSM strategies. DSM refers to “actions, policies, or programs that aim to alter end users’ electricity consumption habits, either via a reduction or a change in the patterns of electricity use” (Carley, 2012, p. 7). There are three components of DSM for electricity systems. The first, efficiency, is typically achieved at the “end user” level through the installation of energy efficient appliances and building materials. The second DSM component is conservation, referring to “changes in human consumption and lifestyle behaviors” (Carley, 2012, p. 7). The third component of DSM is load management or “demand response” which is intended “to alter end user electricity consumption patterns through the use of price signals and information sharing” (Carley, 2012, p. 7). In the context of CCM, DSM strategies are often adopted as “low-hanging fruit” interventions to facilitate the creation of decarbonized electricity sectors (Carley, 2012, p. 6). Essentially, efficient energy use and demand response serve to conserve electricity and reduce peak demand thereby reducing demand on electricity generation facilities thus reducing GHG emissions (IPCC, 2014).

DSM activities (referred to as conservation and demand management (CDM) activities in Ontario) associated with SG deployment are enabled by Advanced Metering Infrastructure (AMI) or "smart meters." Unlike conventional meters, a smart meter facilitates bi-directional communication between electricity consumers and utility companies (Briones and Blasé, 2012; Gellings, 2011). Specifically, phasor measurement units (PMUs) (or synchrophasors) provide utility companies with "information about the power system's dynamic performance" by taking time-stamped measurements of electrical waves at strategic points in the grid (Gellings, 2011, p. 92). Smart meters provide both utility companies and customers with data pertaining to customer consumption, allowing consumers to change their consumption behavior as well as provide utilities with opportunities to develop peak load management strategies (Moura, Lopez, Moreno and Almeida, 2013, p. 630). Additionally, these data enable utility companies to adopt TOU pricing models. TOU pricing allows utilities to make electricity more expensive during peak times, serving to both encourage consumers to conserve electricity, as well as to use electricity during off-peak periods. Demand response shifts demand from peak times and ultimately makes electricity delivery more efficient (IESO, 2015b).

While the smart meter is a critical technological component of SG that can enable the reduction of GHG emissions through DSM, it is also important to note the role of electricity stakeholders and consumers in the implementation of such programs and ultimately, in the achievement of CCM objectives. The IPCC (2014) notes that the behavior of energy consumers is both a driver of GHG emissions as well as an "important potential agent for change in emissions" (p. 387). In fact, Knuth (2010) contends that a lifestyle shift towards energy conservation and "other GHG reducing behaviors" ought to be a primary component of long-term CCM strategies (p. 519). Notably, some research has indicated that providing electricity customers with consumption data does facilitate behavior change towards conservation. For instance, a 2012 study examining "real-time feedback pilots" in the U.S., U.K. and Ireland found that energy consumption was reduced by 0-19.5% per household with energy savings of up to 25% for some consumer groups (Foster and Mazur-Stommen, 2012; cited in Moura et al., 2013, p. 636). Moreover, the study also found that a peak demand reduction of up to 11.3% was possible through the use of dynamic pricing mechanisms.

SG and Electrification

In addition to facilitating demand response and conservation, the SG also enables the use of electricity to replace fossil fuels. The electric vehicle (EV) is an excellent example of this type of initiative within the transportation sector. There has been a significant amount of research pertaining to the potential for EVs to reduce GHG emissions (Mwasilu, 2014; Sugiyama, 2012; Brady and O'Mahony, 2011). For instance, Brady and O'Mahony (2011) found that EV use in the Greater Dublin Area could reduce carbon dioxide emissions by up to 3% (assuming a 10% market penetration scenario). Moreover, Tulpule, Marano, Yurkovich and Rizzoni (2013) suggest that one EV could eliminate up to 0.6 tons of carbon dioxide emissions per year if the driver utilized solar charging at the workplace.

However, while there are many CCM benefits associated with the deployment of EVs, there are also many challenges associated with recharging EV batteries without increasing peak demand (Mwasilu et al., 2014). Studies have found that the amount of electricity required to recharge a current EV battery is "almost the same as a single household in Europe or the United States per day" (Mwasilu, et al., 2014). Furthermore, Boulanger, Chu, Maxx and Waltz (2011) found that charging a battery on a conventional grid increases the electricity demand of a single household by 17 to 25% (cited in Mwasilu, et al., 2014, p. 504). The concept of increasing demand as a result of a novel technology or "an increased use of energy services following an increase in the efficiency of that service" is sometimes referred to as a "rebound effect" (Ghosh and Blackhurst, 2014, p. 55). The SG is a critical component for minimizing the occurrence of the rebound effect for EV development and deployment. In particular, smart meter technology can be used to implement EV management systems in order to facilitate "real time energy measurement, communication and control based on the impact of the EV charging" (Mwasilu, 2014, p. 506). Additionally, smart meters and EV management systems encourage "smart charging schemes" which serve to optimize the available grid capacity and ultimately limit increases to peak demand (Mwasilu, et al., 2013, p. 508).

In addition to the electrification of transport, SG-enabled EVs also have the capacity to integrate renewable energy onto electricity grids. Specifically, EVs can "absorb surplus power" produced by renewable energy sources. EV batteries have the capacity to address the unpredictable and intermittent nature of renewable energy systems. By absorbing this electricity, an EV can utilize this energy either for charging, to supply power to the grid, or to level the grid operations (Mwasilu, 2014, p. 509).

SG and Renewable Energy

Finally, the SG serves to enable decarbonization of electricity generation as it enables the integration of renewable energy sources onto the electricity grid. Renewable energy is "any form of energy from solar, geophysical or biophysical sources that is replenished by natural processes at a rate that equals or exceeds its rate of use" (IPCC, 2011, p. 44). Renewable energy resources include geothermal heat, hydropower, tidal energy, solar, wind, and (possibly) biomass energy (IPCC, 2011). In contrast to fossil fuels, renewable energy sources have the potential to sustainably meet energy demand with minimal GHG emissions (Sims, Rogner, and Gregory, 2003). With regards to CCM, the expansion of renewable energy generation essentially reduces the necessity to generate energy from less efficient resources in order to meet demand (Gellings, 2011). In fact, in their 2003 study, Sims et al. found that compared to "business as usual," the use of alternative energy sources (such as nuclear power and renewable energy sources) could result in a reduction in carbon emissions of 8.7 to 18.7% by 2020 (p. 1325).

However, the challenge with relying on renewable energy to meet electricity demand is that the availability of such resources is variable and uncontrolled by grid operators (Sims et al., 2003; Momoh, 2012). SG can be adopted to ensure effective integration of renewable energy sources onto the electricity grid, specifically by mitigating the variable availability of renewable energy and enhancing the reliability of the electricity supply (Gellings, 2011). The SG integrates "variable power flows from renewable energy systems while allowing grid operators to monitor short term forecasts for renewable energy production" (Gellings, 2011). This monitoring provides grid operators with the data necessary to mitigate any variable supply to ensure that energy consumers are provided with stable and reliable electric service. Additionally, intelligent universal transformer (IUT) technology can serve as a "Renewable Grid Interface" that integrates "widespread renewable energy technologies… while also providing an architecture that allows the operation of reliable local energy networks" (Gellings, 2011, p. 119). Renewable Grid Interface also integrates renewable energy with storage and EV technology. These technologies have the potential to be energy management resources for utilities and consumers (Gellings, 2011; Shafiullah et al., 2013).

Section 2.2.2: Smart Grid and Climate Change Adaptation

SG has the technological capacity to enhance the flexibility and resilience of conventional electricity infrastructure. Specifically, the self-healing capability, automatic monitoring equipment, distributed generation, and storage enabling technology are SG features and applications that have significant potential to make electricity delivery systems more resilient to extreme weather events and climate change.

Self-Healing Technology and Monitoring

With regards to the self-healing capabilities, SG "independently identifies and reacts to system disturbances and performs mitigation efforts to correct them" (Gellings, 2011, p. 18). Armin and Wollenbert (2005) discuss the self-healing potential as being executed through the use of software agents. Agents can be applied to a variety of technologies in a number of disciplines and can be used for “artificial intelligence, robotics and information retrieval” (p. 39). Agents can be either passive or active; while passive agents “respond to environmental changes without changing the environment,” an active agent is able to exert “some influence on its environment to improve its ability to adapt” (Armin and Wollenbert, 2005, p. 39). In the context of the SG, active agents would operate in local subsystems throughout the grid and would “perform preprogrammed self-healing actions that require an immediate response” (Armin and Wollenbert, 2005, p. 39). Eventually the use of such agents could be applied to have them “reconfigure the grid” in response to “material failures, threats or other destabilizers” (Armin and Wollenbert, 2005, p. 40). For instance, in the event that electricity infrastructure is damaged, a self-healing SG could reconfigure itself to isolate the fault and reroute power to ensure a minimal disruption of service for consumers (Amin, 2013).

In addition to self-healing technology, SG also has automatic monitoring capabilities. Specifically, it has built in “sensors, cameras, automated switches and intelligence… to observe, react and alert when threats are recognized within the system” (Gellings, 2011, p. 24). Such intelligence includes Dynamic Thermal Circuit Rating (DTCR), which monitors a continuous flow of real time data pertaining to “line sag, tension… wind speed, [and] conductor temperature” (Gellings, 2011, p. 54). Such information allows system operators to respond rapidly to any faults or damages to power lines, as well as to detect any problematic tendencies or patterns (Gellings, 2011).

Distributed Generation, Micro-grids and Storage

SG-enabled distributed generation, micro-grids and energy storage are additional technologies that enhance grid resilience (Shafiullah et al., 2013; Gellings, 2011). Decentralized generation refers to the use of energy produced from local sources (such as wind turbines, photovoltaic systems and fuel cells) “to supply active power to distribution systems connected close to the consumer’s load” (Hidayatullah, Stojcevski and Kalam, 2011, p. 218). In literature, it is widely recognized that decentralized generation has many advantages to conventional transmissions systems because generation occurs closer to demand (Coll-Mayor, Picos and Morena, 2004, p. 66). Although there are many benefits associated with decentralized generation, with regards to resilience, decentralized generation increases grid security as it has the potential to add supply redundancy that reduces perturbations and outages, limits power losses and minimizes the prospect of blackouts in distribution systems (Coll-Mayor et al., 2004; Hidayatullah et al., 2011).

Moreover, decentralized generation technology also enables the use of micro-grids. A micro-grid system is an isolated electricity system that comprises "small power generating sources, loads consuming electricity, batteries for electricity storage, a controller, and a coupling point connected to the national grid" (Alvial-Palavicino, et al., 2011; Kwok, Yu, Karimi and Lee, 2013, p. 142). In combination with decentralized generation technology, a micro-grid enhances grid resilience because in the event of a disturbance "the generation and corresponding loads can separate from the [central] distribution system to isolate the micro-grid's load from the disturbance without harming the transmission grid's integrity" (Gujar, Datta and Mohanty, 2013, p. 1).

With regards to storage of electricity, the SG, in comparison to a conventional grid provides more opportunities for electricity storage. On the conventional grid electricity storage is not necessary given that demand equals supply and electricity can only flow unilaterally. This is referred to as "just in time" electricity delivery (Gellings, 2011, p. 88). In instances when storage is necessary because the electricity supply exceeds the demand (such as at night), most current electricity storage reserves take the form of pumped hydro storage (Moslehi and Kuman, 2010). However, in response to threats of climate change and resource depletion, many jurisdictions are moving towards the use of renewable sources for electricity. Given that SG aids integration of alternative energy sources onto the electricity grid, storage technology is necessary to "counter growing net demand variability" as well as the supply inconsistencies discussed in the previous section (Moslehi and Kuman, 2010, p. 59). The SG will enable a multiplicity of storage options of different sizes and at different locations throughout the grid (Moslehi and Kuman, 2010). Storage facilities can range from "end-use customer premises to major substations and central power stations" (Moslehi and Kuman, 2010, p. 59). In the event that electricity generation infrastructure is damaged, stored electricity will ensure an uninterrupted supply of power for a period of time so that critical services and infrastructure can continue to function until the necessary repairs are made (Gellings, 2011).

In comparison to the conventional grid, SG is more resilient in terms of detecting and resisting damage as well as reducing the severity of power outages. In the event of a disaster, a community with the aforementioned technology could operate electricity infrastructure to maintain function of essential services such as hospitals, police departments, transportation systems, telecommunication services and even grocery stores, notwithstanding other flooding or wind conditions that could disrupt such operations (U.S. Department of Energy, n.d.; Gellings, 2011). This technology clearly reduces the vulnerability of infrastructure systems, increases resilience and essentially provides infrastructure to facilitate long-term CCA within the electricity sector.

Section 2.3: Policy Integration

What is Policy Integration?

In CCM and CCA literature, discussions surrounding policy integration and mainstreaming are dominant themes. As previously mentioned, many members of the academic community and policy experts strongly advocate the use of policy integration or mainstreaming to facilitate climate response measures. The terms policy integration and policy mainstreaming are synonymous and are used interchangeably in this thesis. Integration is a highly iterative process that involves arranging policies, strategies, and programs to ensure that climate change becomes a standard consideration for stakeholders at all levels of government and in industry (Reinecke and Bernard, 2011; Klein, et al., 2005; UNDP-UNEP, 2011).

Policy integration was first used in the 1960s as an approach to assimilate disabled children into regular classrooms (Elsey, Tolhurst and Theobald, 2005). Typically, integration is used as a response to phenomena that supersede any one level of government, department or political/economic sector. For instance, policy mainstreaming has been used as a strategy to enable widespread attention to and adoption of policies and strategies relating to gender, environment and "greening," disaster risk reduction, poverty and HIV/AIDs (Olhoff and Schaer, 2010). Climate change integration is most frequently compared to the European practice of Environmental Policy Integration (EPI). Many of the principles applied to EPI implementation are similar to the conceptualization of climate mainstreaming as identified by academic and policy experts and are therefore applicable to efforts intended to assess or evaluate the success of climate mainstreaming initiatives (Jordan and Lenschow, 2008; Rauken, Mydske and Winsvold, 2014). Climate change is an issue that does not specifically impact any one level of government, and therefore, many are of the opinion that effective response requires action from governments, communities and individuals (Reinecke and Bernard, 2011). Advocates of policy mainstreaming assert that climate integration ensures that all policy-makers working to respond to climate change collaborate, coordinate to share resources, limit maladaptive practices and work to exploit synergies in an efficient and effective manner (Rauken, Mydske and Winsvold, 2014; Reinecke and Bernard, 2011; Klein, Schipper and Dessai, 2005). Essentially, policy mainstreaming allows governments, economic, and political sectors and civil societies to share the responsibility of responding to climate change (Schipper and Pelling, 2006). Advocates of policy mainstreaming clearly highlight the idea that climate change responses will be successful if they are undertaken in combination with both new and ongoing strategies and "supported by an integrated, cross-cutting policy approach" (UNDP-UNEP, 2011, p. 3; Huq and Reid, 2004; Smit and Wandel, 2006).

Implementing Policy Integration

Policy integration can occur on multiple scales and involve many different stakeholders. In literature, there are two primary distinctions to be made between different types of mainstreaming. First, there is a distinction between horizontal and vertical policy integration. While horizontal policy integration refers to "coordination across sectors and portfolios within a jurisdiction," vertical policy integration refers to "coordination across political and organizational scales" (Dovers and Hezri, 2010, pp. 225-226). For example, horizontal policy integration could be applied in a municipality, where various departments must coordinate their efforts to ensure climate change is addressed. In contrast, vertical policy integration could involve coordination of climate-related objectives between different levels of government (i.e., national, regional and local).

The second distinction identified in policy integration literature is the difference between institutional and operational mainstreaming. In her discussion regarding gender mainstreaming within HIV/AIDS community organizations, Mannell (2010) identifies institutional mainstreaming as involving the day-to-day operations of a government, organization or a business while operational mainstreaming involves the process and outcome of a specific project.

With regards to implementation, there has not been a significant amount of literature published on *how* to establish an integrated climate change response regime. However, this concept is discussed extensively in other policy areas and is arguably applicable to climate mainstreaming initiatives. In the case of mainstreaming gender policy, Greed (2005) identifies the following basic stages as necessary to establish an effective mainstreaming system (p. 260):

1. Research and analysis
2. Programme preparation
3. Monitoring and evaluation
4. Institutional framework
5. Public participation and consultation

Rittenhofer and Gatrell (2012) build on Greed's work and outline several mechanisms through which gender-mainstreaming strategies have been implemented throughout the EU. The EU enshrined gender in treaties and worked to establish measures to ensure gender is considered in national action plans and matters relating to employment and salaries. Furthermore, the European Commission has worked to "download" the responsibility for establishing sector specific gender frameworks to local and organizational levels of the EU bureaucracy.

In addition to large-scale policy mandates, the concept of an "entry point" is identified in literature as a necessary component for the implementation of a mainstreaming regime. In their paper outlining methods to integrate climate policy into existing policy, the OECD (2009) defines "entry points" as the opportunities within a policy cycle where climate-related considerations can be incorporated. Entry points can exist during the conceptualization, funding and resource allocation phases of the policy cycle, as well as in implementation, and monitoring and evaluation. While new initiatives automatically have the opportunity to consider climate change from the initial stages, the benefit of identifying an entry point in existing policies and projects is that they can be used to revise these initiatives to incorporate climate considerations (OECD, 2009).

In addition to using entry points to facilitate policy integration, the concept of "climate-proofing" or using a "climate lens" is another practice that is cited as necessary for implementing climate mainstreaming programs (OECD, 2009; Urwin and Jordan, 2008). A "climate lens" is a tool used in policy interventions to analyze a policy, strategy, program or project in the context of climate change. Specifically, a climate lens can be applied to determine the extent in which a policy (or strategy, program or project) could be vulnerable to climate change risks as well as consider the extent that a given initiative could contribute to GHG emissions or be maladaptive in nature (OECD, 2009).

The idea that climate change must be integrated or mainstreamed into both horizontal and vertical policy levels, as well as both operational and institutional realms, is a key theme in climate change literature. However, the discussion on climate integration in SG deployment has been relatively limited to date. While Stephens et al. (2013) provide a compelling argument as to why such integration is important, based on my review of SG, climate change, and policy integration literature, to my knowledge there has been no attempt to evaluate or assess climate change integration in a SG deployment regime.

As discussed in Chapter 1, Stephens et al. (2013) contend that it is necessary to integrate climate change considerations into the SG deployment process to ensure that SG technologies and applications are implemented in a manner that facilitates rather than compromises CCM and CCA objectives. Stephens et al. (2013) emphasize the highly complex and contextual nature of both SG deployment and climate change response. Specifically, they state "SG offers multiple potential benefits, yet effective capturing of the climate benefits will be context-specific and dependent on particular socio-political energy system landscapes" (p. 213). Despite this, in their discussion Stephens et al. (2013) provide a general list of SG deployment actions that enable both mitigative and adaptive climate responses and are relevant for SG proponents and electricity stakeholders operating "across diverse contexts" (pp. 211-212). This list, along with several other frameworks identified in climate change, energy and policy integration and mainstreaming literature, have informed my development of the Climate Change Integration Evaluative Framework (CCIEF) (discussed in detail in Chapter 4).

Evaluating Policy Integration

Many argue that evaluating climate policy integration is a very challenging task given that adaptation in particular does not have a clear "theoretical foundation" or an easily identified outcome (Brouwer, Tayner and Huitema, 2013, p. 137). Therefore, much of the research seeking to evaluate climate mainstreaming has been informed by previous efforts to evaluate gender mainstreaming and EPI. I will outline several studies that applied EPI evaluative frameworks to assess climate mainstreaming (Rauken, Mydske and Winsvold, 2014; Brouwer, Tayner and Huitema; Urwin and Jordan, 2008).

The first attempt to measure policy mainstreaming was in 1980 when Underdal published *Integrated Marine Policy: What? Why? How?* Underdal's key contribution to the field of policy integration evaluation was his use of three indicators: *comprehensiveness, aggregation* and *consistency.* These indicators remain extremely influential in studies seeking to evaluate policy integration and mainstreaming regimes. In their 2014 study, Rauken, Mydske and Winsvold applied Underdal's three indicators of policy integration to assess the differing approaches to CCA mainstreaming adopted by five Norwegian municipalities (also see Lafferty and Hovden, 2003).

The overall objective of the study was to explain why the municipalities use different approaches to mainstreaming and to identify how policy is used to drive CCA at the local level in Norway. Rauken et al. (2014) used Underdal's indicators as a framework to analyze interview data. To assess comprehensiveness, Rauken et al. (2014) determined which sectors were aware of CCA, which sectors' awareness is reflected in CCA measures or decision-making practices and whether there have been organizational steps to ensure that CCA is integrated into different policy fields. Rauken et al. (2014) assessed aggregation by examining the level of collaboration between sectors on matters relating to CCA. Finally, Rauken et al. (2014) assessed consistency by examining the extent in which CCA complemented or conflicted with other policy issues and whether steps had been taken to ensure policy fields consistently adopted CCA measures. This research primarily focused on evaluating horizontal policy integration.

Similar to Rauken et al. (2014), Brouwer, Tayner and Huitema (2013) also used three indicators of policy integration to assess mainstreaming CCA. However, in contrast to Rauken et al. (2014), Brouwer et al. (2013) identify *inclusion, contradictions* and *weighting* as the key indicators of mainstreaming. The indicators were used as a framework to organize data from document analysis and key informant interviews. The primary objective of their study was to assess the extent that climate considerations were vertically mainstreamed into the Water Framework Directive in the EU. Additionally, Brouwer et al. (2013) developed a ranking system to evaluate how each case study performed based on each of these indicators. Brouwer et al. (2013) define inclusion as the extent in which climate impacts or climate objectives have been considered in the implementation of a given policy or project. Similar to Rauken et al. (2014), consistency is defined as the extent in which contradictions between policies have been considered or minimized. Weighting is assessed based on the extent in which the relative priorities of climate change policy goals compared with other policy objectives. Figure 3 (below) provides an example of the ranking scheme that was used in this study.

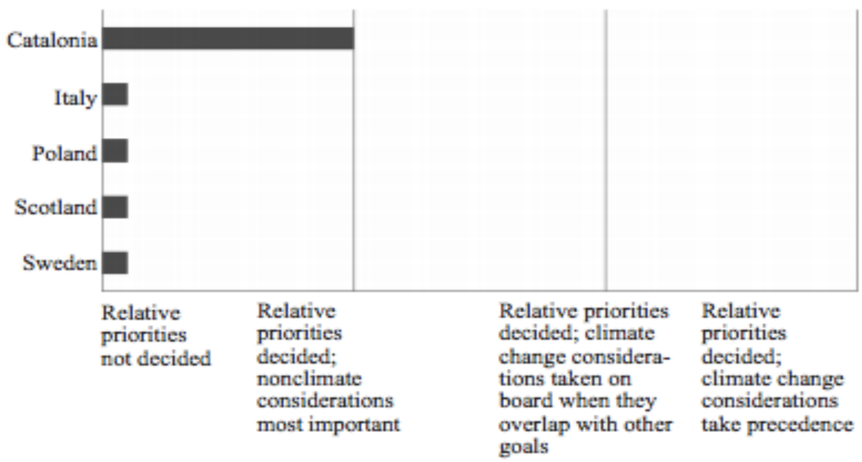


Figure 3: Example of Climate Change Policy Integration Ranking Scheme
Source: Brouwer et al., 2013, p. 145

While mainstreaming indicators are necessary to evaluate policy integration, in the case of vertical policy integration, it is also necessary to consider the interaction of policies at various levels of implementation. Urwin and Jordan (2008) note that one of the key barriers to effective vertical policy integration is that in many cases, high-level policies constrain or limit the adaptation measures at the lower levels of a bureaucracy. Therefore, they argue that an assessment using top-down and bottom-up methodological perspectives is appropriate to evaluate whether high-level policy mainstreaming regimes are having the intended impacts on the ground, or for policy-makers operating at the local or community levels.

Urwin and Jordan (2008) examined UK policy in three different sectors from both a top-down and bottom-up perspective. To assess the sectors from a top down perspective, they used a content analysis of key documents in three different policy sectors, noting the explicit references to CCA and then focusing on the interplay between policy goals and their potential to facilitate or inhibit CCA response.

In contrast, the bottom-up perspective was assessed using key informant interviews with stakeholders operating at the sectoral levels of the bureaucracy. Specifically, Urwin and Jordan (2008) presented interview participants with possible climate change scenarios and asked the key informants their perspectives on the "relative importance of prevailing policies as a constraint on their decision making" (p. 184). Additionally, Urwin and Jordan asked participants to identify specific policies that have an enabling and inhibiting influence on their ability to adapt to climate change.

Overall, Rauken et al. (2014) found that each Norwegian municipality considered for the study was broadly aware of climate change and the need to adapt, yet at the sector level, with the exception of land use planning and water management sectors, "the awareness was either very low or totally absent" (p. 418). Furthermore, Rauken et al. (2014) found that in four out of five municipalities considered in the study, CCA was in conflict with population growth objectives and consequently "development projects therefore seemed to trump climate change adaptation concerns in these municipalities" (p. 418). In response to these findings, Rauken at al. (2014) assert that the size of municipalities and access to resources can also be drivers of CCA. Furthermore, they articulate the view that varying degrees of political attention in the municipalities was a key factor in explaining the varying degrees of CCA mainstreaming.

Similar to the findings articulated by Rauken et al. (2014), Brouwer et al. (2013) found that mainstreaming in the Water Framework Directive was displayed in varying degrees. They conclude that "there is a greater chance of mainstreaming being vigorously pursued when the policy context in the target sector coincides with a climate agenda" and when there is potential for technological intervention that can provide "win-win solutions" (p 148).

Finally, in their top-down, bottom-up evaluation, Urwin and Jordan (2008) found that despite the fact that political leaders had made "high-level commitments" to pursue policy integration for CCA, there were few policies that "explicitly encourage climate change adaptation across the three sectors although some do (indirectly) support or undermine adaptive responses" (p. 189). Urwin and Jordan (2008) go on to note that for effective climate change policy integration it is necessary to "raise the profile of adaptation by identifying and resolving the most obvious antagonisms between existing policies" while ensuring that policy systems are flexible and adaptable rather than inhibitive to accommodate CCA (p. 189).

Section 2.4: Studying Climate Change Integration and Smart Grid Deployment

The use of policy analysis as a method to study both CCA and climate change integration at the national or regional level is a common method employed in this field of research (Urwin and Jordan, 2008, Rauken et al., 2014; Brouwer, 2013; Baynham and Stevens, 2014). In this research, I use content analysis or what Ford et al., (2011) refer to as a "systematic literature review" (p. 328) to evaluate change integration in Ontario's SG deployment regime between 2004 and 2013.

Ford et al. (2011) define a "systematic literature review" as a "summary and assessment of the state of knowledge on a given topic or research question, structured to rigorously summarize existing understanding" (p. 328). Ford et al. (2011) highlight several characteristics of systematic literature reviews that I applied to the content analysis. Specifically, they assert that systematic literature review involves having criteria for the inclusion and exclusion or documents, "reviewing documents according to clearly formulated questions," and using "systematic and explicit methods and criteria to select relevant research" (p. 328). In contrast to Ford et al. (2011), my research focused on documents systematically selected from publically available documents published by key stakeholders in Ontario's SG deployment regime rather than literature. However, similar to Ford et al. (2011), I used a specific time frame as a mechanism not to structure my research for temporal analysis, but to systematically select documents to be included in the content analysis and get a "snapshot of what is going on" during a particular time period (Ford et al., 2011, p. 334). Additionally, documents were reviewed using specific indicators and research criteria. The specific details pertaining to the content analysis will be discussed in Chapter 4.

While content analysis has been used primarily as a means to specifically study CCA and is slightly less widespread in policy integration research in comparison to a policy analysis approach, I am of the opinion that in the context of my research it was more appropriate. Given that the electricity sector in Ontario comprises of a large number of stakeholders with both public and private ownerships (see Chapter 3), a policy analysis would not capture activities of stakeholders not directly involved in policymaking or regulation. While several studies (such as Urwin and Jordan, 2008) opted to employ a combination of policy analysis and interviews to address this, given the large number of stakeholders involved in the electricity industry in Ontario it was more feasible to use a consistent approach to evaluate all of the stakeholders involved in the SG deployment regime.

As discussed briefly above, research on climate change integration in the context of SG to date has been limited. As such, I developed the Climate Change Integration Evaluative Framework (CCIEF) method of evaluation based on the list of SG technology and deployment activities that facilitate climate change response outlined in Stephens et al. (2013) (see Section 2.2). The ranking method developed for the CCIEF was inspired by a similar method used by Brouwer et al. (2013). In their policy analysis of climate change mainstreaming in the Water Framework Directive in the European Union, Brouwer et al. (2013) identified a set of mainstreaming criteria and developed a corresponding qualitative scoring system. The qualitative scores were then displayed visually for comparison between countries (see Figure

3 above). To develop the CCIEF I adapted this method to accommodate the quantitative nature of manifest content analysis. The CCIEF will be discussed in detail in Chapter 4.

Section 2.5: Literature Gap

This literature review has addressed three key themes, all of which are extremely relevant to my research design, methods and analysis. There are several contributions that my research will make to literature in the fields of climate change, SG and policy integration. First, while there is vast literature available on the topics of CCA, CCM, SG technology and policy integration or mainstreaming, with the exception of the work contributed by Stephens et al. (2013), there has been very little research on the relationship between these three themes. My research essentially integrates these themes as I explore SG deployment through a climate change lens with a specific focus on climate change integration in Ontario's SG deployment regime. Not only is this perspective a unique contribution to SG literature, but it also addresses a gap in climate change literature. Figure 4 is a visual representation of the conceptual framework applied to my research. Conceptually, my research is at the intersection of three themes: policy integration, climate change response and SG technology.

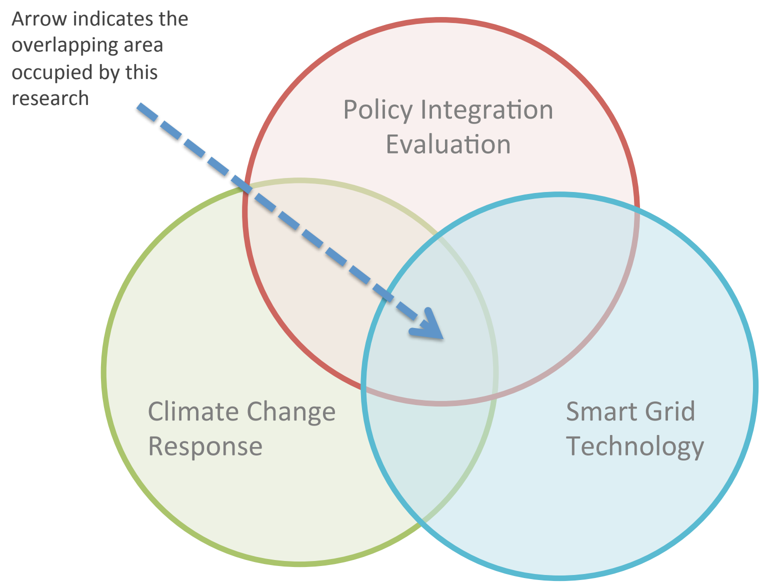


Figure 4: Conceptual Framework

Through my review of the literature I identified several attempts to measure climate change integration (Preston, Westaway and Yuen, 2011; Rauken et al., 2014; Reinecke and Bernard, 2011; Tompkins et al., 2010; Uittenbroek et al., 2013; Brouwer et al., 2013; Urwin and Jordan, 2008). Most of the studies reviewed pertaining to climate change policy integration evaluation explored specific climate change legislation and strategic plans to assess climate change integration or evaluated the bureaucratic components of integration. In addition, despite identifying several attempts to evaluate climate change policy integration in a multi-stakeholder sector, (i.e., Brouwer et al., 2013; Urwin and Jordan, 2008), to my knowledge there has yet to be an attempt to evaluate or assess vertical climate change integration within an electricity sector or SG deployment regime. Finally, most reviewed studies were focused in Europe and involved only governmental stakeholders. My research will not only address the gap in climate change integration literature in North America, it will also address the gap in literature pertaining to climate change integration in an electricity sector or SG deployment regime.

Chapter 3: Study Context

Chapter 3 is divided into four major sections. In Section 3.1, I provide background information on the electricity industry in Canada and in Ontario. Section 3.2 offers an overview of the stakeholders involved in SG deployment in Ontario while in Section 3.3, I discuss the SG deployment regime in Ontario between 2004 and 2013. In Section 3.4, I highlight the climate change initiatives that were underway in the electricity sector between 2004 and 2013. Although there has been progress both in terms of SG innovation and deployment as well as climate change response since 2013, the timeframe selected for this research makes the activities occurring from 2004 to 2013 most relevant for understanding the context of this research.

Section 3.1: Electricity System Background

In Canada, the electricity industry is involved in three primary activities. In addition to generating electricity using "various energy sources and technologies," the electricity industry is also involved in the long-distance transmission of electricity from "power plants to end-use markets" and the distribution of electricity to consumers through "low voltage local distribution power lines" (Natural Resources Canada, 2014).

The Canadian Constitution plays a significant role in shaping the electricity landscape in Ontario. Given that Canada is a multi-jurisdictional democracy and a federation of ten provinces and three territories (Fournier, Hardwike-Brown and Sprun, 2002; Natural Resources Canada, 2015), there is a division of power between the federal government and the provincial governments that is defined in the *Constitution Act, 1867; 1982* (Fournier et al., 2002). Broadly, the federal government has jurisdictions over "matters of national and international importance" (outlined in Section 91 of the *Constitution Act)*, while provincial legislatures maintain authority to make laws pertaining to "matters of local or private nature" (outlined in Section 92 of the *Constitution Act*) (Fournier et al., 2002, p. 69).

With regards to jurisdiction over energy and electricity, Section 92 of the *Constitution Act, 1867* gives provincial governments jurisdiction over “exploration for non-renewable natural resources in the province” as well as “development, conservation and management of non-renewable natural resources and forestry resources in the province” (Natural Resources Canada, 2015). In addition, Canadian provinces also maintain jurisdiction over the generation, transmission and distribution of electricity. However, despite the fact that energy and electricity primarily fall under provincial jurisdiction, the federal government has jurisdiction over “electricity exports and over international and interprovincial power lines” (Natural Resources Canada, 2014). In addition, the federal government supports the provincial electricity sectors by investing in research, innovation and development of technology as well as by exercising constitutional authority over “electricity exports and over international and interprovincial power lines” through the National Energy Board (Natural Resources Canada, 2014).

As mandated in Section 92 of the *Constitution Act, 1867,* the provincial government in Ontario is responsible for establishing policy and regulating the generation, transmission and distribution of electricity. Electricity in Ontario comes from a number of sources including natural gas, nuclear, hydroelectricity and other non-carbon renewable energy sources (see Figure 5; Ontario Energy Board, 2015) and is transported across the Province along approximately 30,000 km of high voltage transmission lines (Ontario Ministry of Energy, 2015b).

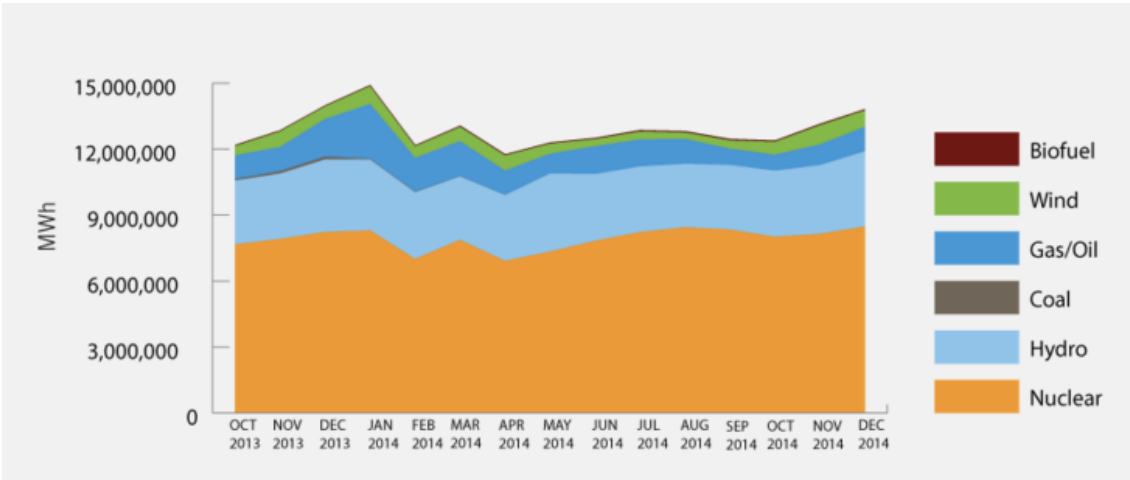


Figure 5: Ontario's Energy Supply Mix, 2014
Source: IESO, 2015c

Stakeholders in Ontario's electricity sector are "owned and operated by public, private and municipal corporations in Ontario" (Enersource Corporation, 2014). Specifically, the OEB, the Independent Electricity System Operator (IESO), the majority of Hydro One and the Ontario Power Generation (OPG) are provincially owned and operated entities. While there is more variation with regards to LDC ownership, the Government of Ontario or municipal governments own most LDCs while a small number are owned by private firms (OME, 2012). For example, FortisOntario, a private utility company, owns Algoma Power, Canadian Niagara Power, and Cornwall Electric, while also holding minority shares in several other LDCs (OME, 2009, p. 9).

Section 3.2: Key Smart Grid Players in Ontario

At a basic level, Ontario's electricity sector is comprised of policy, regulatory and operational stakeholders as well as 76 LDCs and transmission companies. Each stakeholder has been involved in SG deployment in varying extents. While some stakeholders have been working towards further developing and deploying additional SG technology as well as ensuring that appropriate policies, regulations and operations are in place, other stakeholders are involved in SG deployment as a result of policy mandates and regulations. Furthermore, other stakeholders, while not involved in SG deployment, are involved in the application of SG technology (the OPG for example). Figure 6 depicts the legislative and regulatory relationships between the major stakeholders in Ontario's SG deployment regime. I have included the Federal government as well as the North American Electric Reliability Corporation (NERC), the bulk power operator for North America, to demonstrate wider context. However, given that the research focuses on the SG deployment regime in Ontario, my research focuses on the stakeholders operating on behalf of or within Ontario only.

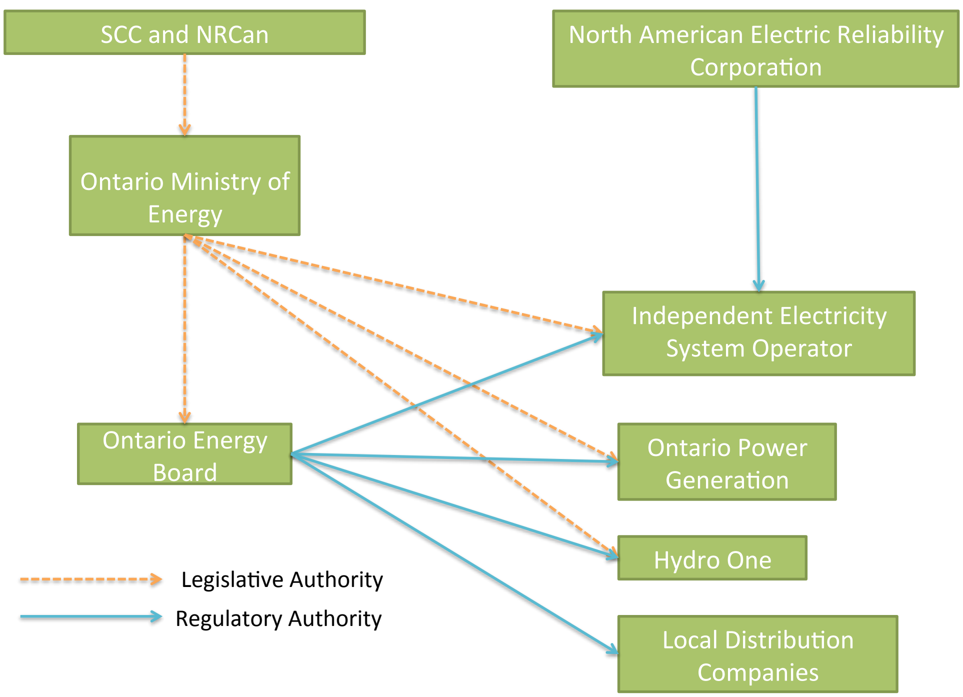


Figure 6: Key SG Players in Ontario's Electricity Sector

The Government of Canada

The Government of Canada's primary role in SG deployment is to assist with SG strategic planning as well as to facilitate "standardization discussions with stakeholders" (CNC/IEC Task Force on Smart Grid Technology and Standards, 2012, p. 5). In 2012 the Standards Council of Canada (SCC) and

Natural Resources Canada (NRCan) engaged electricity stakeholders across the country and created a strategic planning document for the development and deployment of SG technology in Canada. The *Smart Grid Standards Roadmap* provides guidelines for "utilities and manufacturers to participate in the emerging global Smart Grid marketplace" (CNC/IEC Task Force on Smart Grid Technology and Standards, 2012, p. 2). Additionally, the report provides standards for technical distribution and transmission as well as for privacy and security.

Furthermore, the Federal government committed funding for SG innovation and deployment as part of Canada's Economic Development Plan as well as through a Clean Energy Fund and the ecoEnergy Innovation Initiative (CNC/IEC Task Force on Smart Grid Technology and Standards, 2012). As of 2013, the Government of Canada had invested $114 million in SG demonstration projects nationwide (Natural Resources Canada, 2013).

The Ontario Ministry of Energy (OME)

The Ontario Ministry of Energy is the primary policymaker for Ontario's electricity sector. Specifically, the OME works to facilitate SG deployment through legislation, directives, regulation as well as incentives. The OME adopted the *GEGEA,* the policy that specifically mandates SG deployment technology in Ontario, and the *LTEP,* a long-term planning document that emphasizes the use of SG technology to facilitate CDM objectives and renewable energy in the province. Additionally, the OME also operates the Smart Grid Fund, a $50 million fund intended to provide financial assistance to actors working on SG-related projects.

The Ontario Energy Board (OEB)

The OEB is the organization that regulates the electricity and natural gas sectors in Ontario to ensure that consumer interests are protected in terms of electricity pricing as well as the quality and reliability of service (Ontario Energy Board, 2015). Essentially, the OEB is responsible for establishing transmission and distribution rates while also licensing all "market participants" including the IESO (Ontario's system operator), electricity generators, transmitters, distributors, wholesalers and retailers working in the province (Ontario Energy Board, 2015).

With regard to SG deployment, the OEB works under a directive from the OME to provide regulatory guidance to actors in Ontario's electricity sector working to implement SG (directive from November 23, 2010 under the *Ontario Energy Board Act, 1998*). The OEB established a Smart Grid Working Group (SGWG) and a Smart Grid Advisory Committee (the "Advisory Committee") to provide technical support to the OEB as they work to develop and implement a regulatory framework. Specifically, the Smart Grid Working Group (SGWG) was established in 2004 and was intended to provide advice to the OEB on technical matters. The Advisory Committee was established in 2013 and is intended to "provide the Board with ongoing assistance" as SG issues emerge during the SG deployment process (Ontario Energy Board, 2013).

North American Electric Reliability Corporation (NERC)

NERC is the regulatory authority that is primarily responsible for standardizing and evaluating "reliability of the bulk transmission power system in North America" (CNC/IEC, 2012, p. 6). Specifically, NERC develops and imposes reliability standards and assesses compliance while also monitoring the bulk electricity system (CNC/IEC Task Force on Smart Grid Technology and Standards, 2012).

With regards to SG deployment, NERC is responsible for developing reliability standards for SG networks.

Independent Electricity System Operator (IESO)

The IESO is the electricity system operator and reliability coordinator in Ontario. The IESO is responsible for managing Ontario's electricity system to ensure compliance with the reliability standards established by NERC while also forecasting the “demand and supply of electricity” (IESO, 2015a). Furthermore, the IESO operates the wholesale electricity market and works to ensure fair competition using market surveillance techniques (IESO, 2015a).

As of January 1st 2015, the IESO and the Ontario Power Authority (OPA) have merged as a single entity. Prior to the merger, the OPA was primarily responsible for long-term planning in the electricity sector as well as for coordinating conservation efforts and working to ensure service reliability. The IESO now encompasses the roles of both organizations and its mandate is to “oversee the real time operation of Ontario’s electricity system and market, long-term energy planning and procurement, and the promotion of a conservation culture in the province” (Campbell, 2015, p. 1).

With regards to the IESO’s role in SG deployment, the IESO is responsible for ensuring that Ontario’s electricity system remains reliable during the gradual transition from a conventional grid to modern smart grid technology. Furthermore, the IESO also is responsible for “reporting on the progress of projects that impact the power grid” (IESO, 2015a). The IESO also operates the “smart meter data repository” (Campbell, 2015, p. 8). In 2009 the IESO established the Smart Grid Forum, a group with members from organizations throughout Ontario’s electricity sector, public agencies and academia that work together to “develop the smart grid in Ontario and examine the many components it comprises” (IESO, 2013). The Smart Grid Forum has been involved in the smart grid deployment process by providing technical, market and academic input into policy and regulatory initiatives.

Hydro One

Between 2004 and 2013 Hydro One was a provincially owned company. However, following the Ontario government’s sale of 13.6% of its stake in Hydro One, as of November 2015, a portion of the company is now publically traded (Posadzdi, 2015). Hydro One operates the majority of transmission lines in Ontario and plays a supportive role in SG deployment. Specifically, Hydro-One offers technical support to the OEB, sits on the SGWG as well as the Advisory Committee. Additionally, Hydro One is involved in a number of SG initiatives including the establishment of the Hydro One Electricity Discovery Centre, participation in the Green Button Initiative and the development of SG technologies including in-home displays, energy storage, advanced metering infrastructure (AMI or smart meters), conservation voltage reduction, outage management and distribution management systems (OMS/DMS), selective load shedding, DG dispatch, and operational data storage (Bettencourt and Malenfant, 2013).

Ontario Power Generation (OPG)

Ontario Power Generation is primarily involved in the generation and sale of electricity in Ontario. As a generator of electricity, OPG is not currently involved in SG deployment in Ontario, though they are a key stakeholder in the electricity sector and have the potential to implement energy storage options as well as decentralized generation, both of which are CCA measures that require SG technology (See Chapter 2). Furthermore, the OPG is also involved in the generation of non-carbon based energy and is therefore relevant in discussions pertaining to climate change mitigation as well.

Local Distribution Companies (LDCs)

Local Distribution Companies (LDCs) are the businesses that are responsible for delivering electricity to homes, businesses and public institutions in Ontario. Specifically, they transform high voltage electricity from transmission to a low-voltage for distribution. Additionally, LDCs are responsible for maintaining local distribution wires, and implementing conservation programs and connecting Feed In Tariff (FIT) and microFIT projects to local distribution systems (IESO, 2012). At the time of data collection, there were 76 OEB regulated LDCs in Ontario. LDCs are publically and/or privately owned and operate as “regulated monopolies” over electricity delivery infrastructure within a given community or service area (IESO, 2012).

As mandated within the *GEGEA,* LDCs are responsible for developing and implementing Conservation and Demand Management (CDM) strategies within their service areas. Essentially, the purpose of these programs is to introduce programs, technologies and other measures to meet the conservation and demand management targets set by the Province in the *LTEP* (2013) (discussed in Chapter 1). The OEB is the organization responsible for regulating electricity distribution and setting CDM targets for each LDC as mandated in the OME's March 31, 2010 directive to the OEB. The OEB requires that each LDC submit a report detailing their CDM initiatives and their progress towards achieving their mandated targets.

With regards to their role in SG deployment, the LDCs, as the closest entity to consumers, are primarily responsible for rolling out SG initiatives (e.g., smart meters). As discussed in Chapter 2, many CDM initiatives are enabled by SG technology and consequently, CDM efforts and SG deployment efforts are often "dovetailed" to ensure "consistency and efficiency in these efforts" (Erie Thames Powerlines, 2014, p. 18).

The Ontario Smart Grid Forum

As discussed earlier, the Ontario Smart Grid Forum is a group of electricity stakeholders collaborating to develop and implement SG in Ontario. Member organizations include utility stakeholders, industry associations, public agencies and universities (IESO, 2013). Through the publication of several reports on the "smart grid's evolution in the province," The Ontario Smart Grid Forum works to guide SG deployment and innovation in the province and provide recommendations to stakeholders involved.

The Corporate Partners Committee, a committee that represents the interests of over 30 private sector stakeholders "active in the smart grid space" provides support to the Ontario Smart Grid Forum

(IESO, 2013). This includes stakeholders involved in SG applications such as electric cars, energy management, systems integration and equipment manufacturing (IESO, 2013).

Section 3.3: Smart Grid Deployment in Ontario (2004-2013)

As previously mentioned, Ontario was the first jurisdiction in North America to successfully deploy a smart meter roll out. Following this success, the Government of Ontario continued to work towards expanding and deploying additional SG technology throughout the province as well as evolving supportive policy and regulations. Notably, in 2012 Ontario became one of the few jurisdictions that has established a "comprehensive regulatory framework" to guide the SG deployment (Ontario Smart Grid Forum, 2013).

The adoption of the 2009 *Green Energy and Green Economy Act* (*GEGEA*) was a pivotal moment for SG deployment in Ontario. Specifically, the *GEGEA,* in addition to formalizing the definition of SG into legislation, also promoted the deployment of SG in order to integrate renewable energy sources into the electricity grid, provide consumers with the opportunity for demand response, load control, and price information. Furthermore, the *GEGEA* highlights the use of SG to promote the use of conservation and energy saving technologies and to support "other objectives that may be prescribed by regulation" (p. 13). In the *GEGEA,* SG is defined as "the advanced information exchange systems and equipment that when utilized together improve the flexibility, security, reliability, efficiency and safety of the integrated power system and distribution system" (Ontario Ministry of Energy, 2009)

Following the *GEGEA*, additional policy and regulatory developments began to facilitate a rapid SG deployment program in Ontario. The OEB, in collaboration with the Ontario Smart Grid Forum worked to develop Ontario's Smart Grid Objectives, Privacy by Design Principles and the Corporate Partners Committee (Ontario Smart Grid Forum, 2013). Perhaps most notably, in 2011 the OME created the Ontario Smart Grid Fund, a $50 million program intended to sponsor SG projects at "the crucial early stages of development" (Ontario Smart Grid Forum, 2013). Additionally, in 2012, the OEB introduced a

Renewed Regulatory Framework for Electricity. This framework, developed in response to evolving SG technology, represents a fundamental shift in the manner in which the OEB evaluates proposed expenditures (Ontario Smart Grid Forum, 2013).

With regards to the deployment of specific SG technologies, Ontario completed a successful rollout of smart meters to almost 4.8 million retail customers under 50 kW of demand across the province (Ontario Smart Grid Forum, 2013). This initiative, primarily undertaken by LDCs, was in response to a provincial mandate issued by the OME and the OEB in 2004. The mandate stipulated that all LDCs and utilities must install smart meters on all residential and small business properties by 2010 (Ontario Smart Grid Forum, 2013). In 2006 the province formalized the smart metering deployment program and currently almost all of Ontario's 4.8 million household and retail consumers have been equipped with a smart meter and are billed using the time of use pricing model (Ontario Smart Grid Forum, 2013). Between 2005 and 2014 the smart metering initiative cost over $1.9 million (Office of the Auditor General of Ontario, 2014).

In addition to a successful smart meter roll out program, SG initiatives in Ontario from 2004 to 2013 included "ongoing efforts to increase available communications options and promote the creation of a communications spectrum for use by electric utilities; projects to install distribution transformer monitors and related communications equipment and increased installation of automated distribution equipment" (Ontario Smart Grid Forum, 2009, p. 3). Additionally, in 2012 the OME, in collaboration with MaRS, introduced a "Green Button" initiative to help consumers understand their electricity consumption patterns. Specifically, the Green Button initiative uses smart meter data to enable electricity consumers to access and share information pertaining to their use of electricity and the associated cost of energy (Green Button, n.d.). At the local level, many utility companies worked on implementing innovative SG programs including self healing grids, advanced distribution systems, digital fault indicators, transformer and power-line monitoring and community energy storage (Briones and Blasé, 2012).

In 2013 the Smart Grid Forum stated that there is much work to be done for the province to modernize Ontario's electricity system through SG deployment. Notably, the Smart Grid Forum contends that work is required to establish connections "between energy, transportation and environmental policy" (Ontario Smart Grid Forum, 2013). As previously mentioned, while it must be recognized that there has been progress on SG deployment and innovation in Ontario since 2013, these activities are less relevant in the context of my research.

For the purpose of my research, I will use the SG definition provided by the OME in the *GEGEA*. As discussed in Chapter 1 in the *GEGEA*, SG is defined as the "advanced information exchange systems and equipment that when utilized together improve the flexibility, security, reliability, efficiency and safety of the integrated power system and distribution system" (p. 13). I conceptualize SG to encompass all of the technologies and regulatory components associated with the modern electricity infrastructure (see Chapter 2).

In this thesis, I make a distinction between SG technology and applications. SG technology essentially includes any electricity infrastructure or equipment that is involved in electricity delivery and consumption (for example, smart meters, TOU, OMS etc.). A SG application includes any additional equipment that is enabled by SG technology. Examples of SG applications considered in this thesis include renewable energy, distributed generation, micro-grids, storage and electric vehicles (EVs).

Section 3.4: Climate Change Action in Ontario (2004-2013)

As discussed in Chapter 2, Canada originally ratified the Kyoto Protocol in 1997 but withdrew in 2011 following a change in Federal Leadership from the Liberal Party to the Conservative Party. The rationale for withdrawing from the Kyoto Protocol was that the Conservatives felt that the targets were unrealistic and that Canada was not on track to meet its commitment and would therefore be faced with a fine of "$14 billion in international penalties" (Kennedy, 2011).

In 2009, after Canada became a signatory of the Copenhagen Accord, the Government of Canada and the Government of Ontario introduced both legislation and regulations to mitigate and adapt to climate change. Specifically, under the Copenhagen Accord, Canada committed to reduce GHG emissions by 17% from 2005 levels by 2020, with a target of 607 megatonnes (Mt) (Environment Canada, 2012, p. 3). As a result of this agreement, The Government of Canada implemented a GHG regulation regime that operated on a “sector-by-sector basis” (Environment Canada, 2012, p. 3). With regards to GHG-related regulations on electricity sectors, the Federal government implemented an emissions performance standard for coal-fired electricity. This emissions performance standard was applied to new coal-fired electricity plants as well as “units that have reached the end of their useful lives” and establishes a standard of 420 tonnes of CO_2 per gigawatt-hour of electricity produced (Environment Canada, 2013b). Additionally, the Government of Canada announced that they would implement incentives for the use of carbon capture and storage (CCS) technologies (Environment Canada, 2014).

It is important to note that these targets and regulations may be subject to change as a result of a change in Federal Leadership in October 2015. Specifically, Liberal Party Leader and Prime Minister of Canada Justin Trudeau campaigned on a commitment to a more ambitious national climate policy that will include a new carbon pricing system (McDiarmid, 2015; McCarthy, 2015).

Between 2004 and 2013 the Government of Ontario also worked to respond to climate change and was involved in a number of initiatives. Most notably, in 2003 the Province of Ontario made an ambitious commitment to eliminate coal from its generation supply mix (in 2003 coal made up 25% of Ontario’s supply mix) and by 2014 Ontario became the first jurisdiction in North America to completely eliminate coal from its supply mix (Ontario Ministry of Energy, 2015a). This was done through the phase out of coal generation facilities and through investment in alternative sources of energy including natural gas, nuclear energy and renewables (Ontario Ministry Energy, 2015). The OME notes that this initiative is the “single largest climate change initiative in North America to date” and helped Ontario to achieve its "ambitious 2014 emissions reduction target of 6% below 1990 levels" (Ontario Ministry Energy, 2015, p. 3).

With regards to CCA, in *Climate Ready: Ontario's Adaptation Strategy and Action Plan (2011-2014)*, the Ontario Ministry of Environment and Climate Change outlines a series of measures and strategies to reduce vulnerability to climate change and adapt to climate change. Notably, the strategy calls for climate change mainstreaming and the requirement of CCA consideration in policymaking. However, unlike many of the previously outlined CCM activities, CCA initiatives are not legally binding.

Chapter 4: Methodology and Methods

As discussed in Chapter 1, the objective of my research is to use content analysis to evaluate the extent to which climate change considerations have been integrated into SG deployment in Ontario and to identify components of SG deployment in which integration could be strengthened. The overall goal of this research is to provide recommendations that will assist electricity stakeholders in ensuring that SG deployment facilitates a comprehensive response to climate change. In this chapter I will discuss the research methodologies that guided this research (Section 4.1) and the research methods employed for this study (Section 4.2).

Section 4.1: Methodology

Pragmatism and Mixed Methods

This research is informed by a pragmatic worldview, a methodology that "arises out of actions, situations and consequences" (Creswell, 2014, p. 10). In research guided by pragmatism, rather than focusing on methods, "researchers emphasize the research problem and use all approaches available to understand it" (Creswell, 2014, p. 245). Although there is only one method utilized in this research, pragmatism is an appropriate methodology to guide this study because the study is exploratory in nature. I contend that this study is exploratory as there was no hypothesis developed; rather, the research questions seek to *explore* instead of *explain* existing phenomenon.

Pragmatism allows a researcher to "choose the methods, techniques and procedures that meet their needs and purposes" (Creswell, 2014, p. 11). In the case of my research, I felt that the information I was looking for already existed within publically accessible documents, and therefore, in order to answer the research questions it was appropriate to employ content analysis techniques as my primary research method.

In this application of a pragmatic research approach, I used both quantitative and qualitative content analysis techniques to extract data. Specifically, I used a *convergent parallel mixed methods* design, a mixed methods design that involves "converg[ing] or merg[ing] quantitative and qualitative data in order to provide a comprehensive analysis of the research problem" (Creswell, 2014, p. 15). The use of mixed methods is a common feature of research influenced by pragmatism (Onwuegbuzie, Johnson and Collins, 2009; Christ, 2013), as this worldview does not restrict research to a particular method of data collection or analysis based on a theoretical perspective (Creswell, 2014). In the context of my research, the use of mixed methods allows me to explore sector-wide discourse as well as specific excerpts containing smart grid and climate change-related content in a comprehensive manner.

Section 4.2: Methods

As discussed briefly in Chapter 1, I conducted a content analysis of publically available documents published by electricity stakeholders involved in SG deployment in Ontario between 2004 and 2013. Specifically, I used NVivo 10, qualitative research software that assists in managing and analyzing qualitative data (QSR International, 2014) to employ manifest and latent content analysis techniques. Recall from Chapter 1, manifest content analysis relates to word frequencies identified within a data set while latent content analysis pertains to exploring the meaning within identified content.

Figure 7: SG Discourse Node and Sub-Nodes (NVivo)

In the context of my research NVivo was used as a database to save and categorize documents used in the content analysis as well as a tool to explore and analyze the content within the documents. Specifically, I used NVivo queries to compile data pertaining to patterns of word frequencies as well as to search for specific content in the documents. NVivo allowed me to search for keywords relating to a topic relevant to my research (i.e., "smart grid") and "code" them by saving the excerpts in which the keywords are found in a "node." A node refers to a "collection of references about a specific theme, place, person or other area of interest" (QSR International, 2014). Using NVivo, it is possible to create nodes within nodes (sub-nodes) and create a node hierarchy. The nodes developed for this research contained topical content (text content relating to smart grids and climate change) while the sub-nodes were created using analytical coding and served to organize topical content in the primary node into sub-themes. Figure 7 (above) shows the node hierarchy for content relating to smart grid. While the primary node is topical in nature (Discourse- Smart Grid), the nodes that follow were selected using open coding techniques. Open coding refers to the process of "break[ing] down… data into segments in order to interpret them" (Benaquisto, 2008). The content found within the sub-nodes are excerpts related to themes or content identified within the topical content (i.e., challenges and barriers or drivers and enablers). For example, the following excerpt was first categorized into the "Discourse- SG" primary node, and then further categorized into the "complementary initiatives" sub-node because it speaks to the desire that LDCs coordinate CDM and SG initiatives to complement each other and ensure efficiency:

> "Ensure CDM efforts are dovetailed with smart grid planning to ensure consistency and efficiency in these efforts" (Erie Thames Powerlines, 2013 CDM Report, p. 10).

Section 4.2.1: Stakeholder and Document Selection Process

Prior to beginning the content analysis, I identified stakeholders involved in the SG deployment process in Ontario by using OME website content and reports published by the Ontario Smart Grid Forum. In particular, the OEB website provided me with the names of all of the LDCs operating in Ontario as of 2013 (76 total). Additionally, Google searches using the following search items helped me to verify that the Ontario Smart Grid Forum and the OME identified all of the stakeholders relevant to my research:

- "smart grid" AND "Ontario" "
- "smart meter" AND "Ontario,"
- "advanced metering infrastructure" OR "AMI" AND "Ontario"
- "time of use" OR "TOU" AND "Ontario"

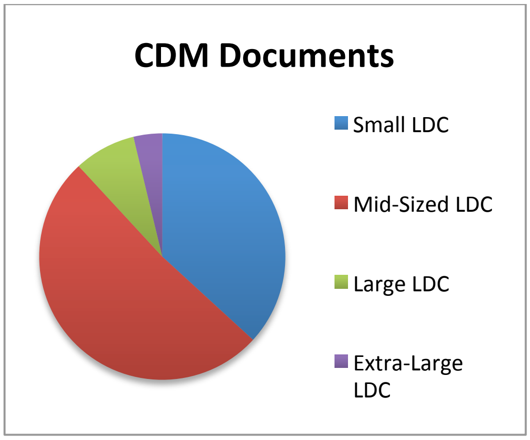
A full list of the stakeholders included in the content analysis can be found in Appendix A.

Following the identification of relevant stakeholders, I compiled documents to be included in the content analysis. Documents published between 2004 and 2013 were the focus of the content analysis because SG deployment was initiated in Ontario in 2004 and 2013 was the date of the most recent publications for most stakeholders at the time of data collection. It is worth noting that similar to the work of Ford et al. (2011), the use of a time frame was specifically for the purpose of systematically acquiring documents. Given that there is no temporal component to my research questions, I did not use temporal analysis on data; rather I considered the time period as a whole.

Documents selected for content analysis were policy, directives, regulations, annual reports and business plans, CDM documents as well as technical or "special" reports (including OEB Reports and Smart Grid Forum Reports). Policy, directives, regulations and technical or special reports were included because they contain the goals and objectives for SG deployment, the regulatory and operational logistics relating to technological development and large-scale deployment, as well as references to specific SG projects and technology. Furthermore, annual reports and business plans include information pertaining to specific SG deployment initiatives and investments undertaken by the individual stakeholders. Finally, CDM strategy documents and reports have also been included in the content analysis because they provide insight into how SG technology is being applied across the province. The following table (Table 2) provides a summary of documents included in the document analysis, while the following figures (Figures 8, 9, 10, 11, 12) display the proportion of CDM documents, annual reports, strategies, business plans and technical or special reports published by each stakeholder group. Notably, I did not include a figure providing a stakeholder breakdown for policy, regulation and directive documents as these were all published by the OME. For a full list of documents included in the content analysis see Appendix B.

Table 2: Content Analysis Document Summary

Type of Document	Total Number Included (576 Total)	% Total Documents
Policy	3	0.52%
Regulation	14	2.43%
Directive	2	0.35%
Strategy	4	0.69%
Business Plan	22	3.82%
Annual Report	171	29.69%
CDM Strategies and Reports	346	60.07%
Technical and Special Reports	14	2.43%



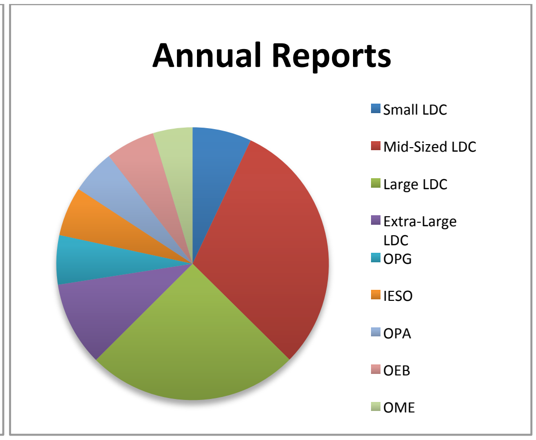
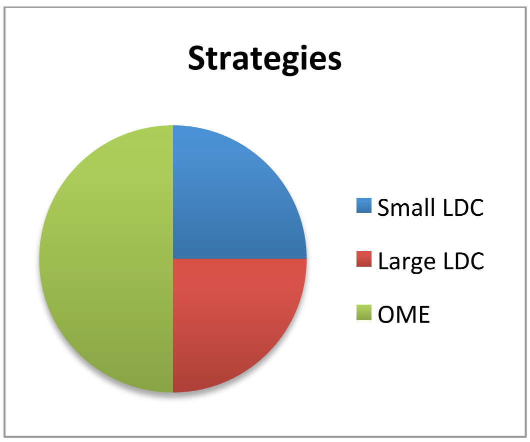


Figure 8: Percentage of Total CDM Reports by Stakeholder Group (n=346 documents)

Figure 9: Percentage of Total Annual Reports by Stakeholder Group (n=171 documents)



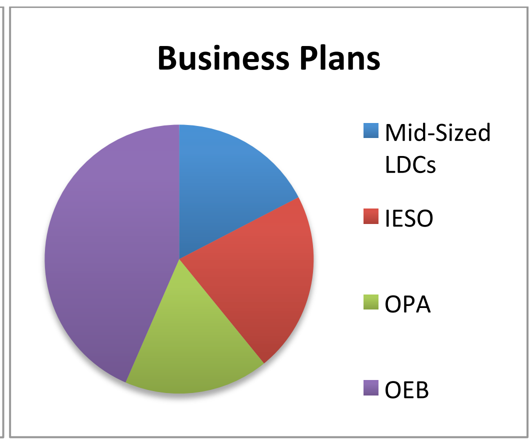


Figure 10: Percentage of Total Strategies by Stakeholder Group (n=4 documents)

Figure 11: Percentage of Total Business Plans by Stakeholder Group (n=22 documents)

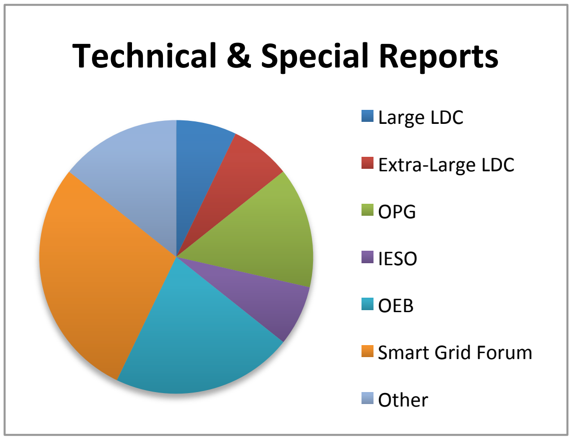


Figure 12: Percentage of Total Special Reports by Stakeholder Group (n=14 documents)

As shown in Table 2, as well as Figures 8 and 9, there is a large proportion of CDM documents and annual reports included in the document analysis in comparison to other types of documents. This is a result of a comparatively large number of LDCs operating in Ontario in contrast to other stakeholder groups (see Chapter 3). Although the high representation of LDCs in the content analysis will be discussed in Section 4.3 as a limitation of this research (as LDC interests are inherently dominant), it is worth mentioning that the high number of LDC documents represented in this study is reflective of broader sector characteristics.

I chose to use only publically available published documents in the content analysis rather than webpage content, media, cabinet debates and Hansard transcripts for two primary reasons. First, published documents provide the most "formal" account of SG deployment from the perspective of electricity stakeholders across the province of Ontario. While media or cabinet debate discourse may provide relevant information on SG deployment and climate change response, the documents that I selected outline the tangible policy, regulatory, operational and technical measures that were taken to deploy SG in Ontario between 2004 and 2013. Second, as discussed in Chapter 2, there was precedent for this approach in the literature. Specifically, policy analysis and content analysis (rather than media reviews or discourse analysis), are methods often employed to study CCA as well as policy integration (Ford et al., 2011; Urwin and Jordan, 2008, Rauken et al., 2014; Brouwer, 2013; Baynham and Stevens, 2014). Furthermore, I only included documents published by electricity stakeholders in Ontario rather than broadening the content analysis to include documents from other provincial ministries (i.e., OMECC) or the Federal government. Not only would the inclusion of these documents do little to answer my research questions, excluding them allows me to maintain a reasonable scope for this research.

I obtained documents using a systematic search of stakeholder websites. Policy, directives, regulations and technical reports were considered "relevant" if they included any explicit reference to any of the following terms: smart grid, smart meters, advanced metering infrastructure (AMI) or time of use (TOU) pricing. Additionally, annual reports, business reports and CDM documents were considered relevant if they were published between 2004-2013 (for an example of a "relevant" verses "irrelevant" document, see appendices B and C). If annual reports were not available online, I sent emails to stakeholders requesting them to send any publically available documents published between 2004 and 2013. In total I contacted 17 stakeholders (primarily LDCs) and obtained 14 documents as a result of these email inquiries. My intention was to provide all stakeholders with an equal opportunity to be represented in the content analysis. However, in many cases I did not receive a response and consequently there are some stakeholders that have more documents included in the content analysis than others (see Appendix B). This will be discussed further in Section 4.3. Documents were saved and categorized in NVivo. Specifically, documents were classified by type of document (i.e., policy, regulation, annual report), year of publication, stakeholder group (i.e., transmission and distribution or operation and planning, etc.), and stakeholder name. In total 576 documents were included in the content analysis.

Section 4.2.2: Methods for Data Collection and Analysis

Methods for Data Collection and Analysis: Manifest Content Analysis

As discussed in Chapter 1, a manifest content analysis refers to the process of analyzing the frequency of words, phrases and concepts in a text. As a starting point for the manifest content analysis, I developed a ranking system entitled the Climate Change Integration Evaluative Framework (CCIEF) as a method of using manifest content to quantitatively evaluate the extent climate change integration was implemented in Ontario's SG deployment regime between 2004 and 2013. Specifically, the CCIEF is a process of evaluation that involves identifying the number of sources a series of keywords appear in and ranking those keywords in comparison to others as a means to understand the relative importance of each keyword in the documents. Recall from Chapter 2, Stephens et al. (2013) identified a list of eight general strategies for electricity stakeholders to ensure that SG deployment either facilitates a response to climate change or avoids the development of an electricity system that increases GHG emissions or is maladaptive. I used the strategies outlined by Stephens et al. (2013) to inform the development of the CCIEF.

The first step of the manifest content analysis was to identify keywords to serve as a series of indicators that reflect the objectives recommended by Stephens et al. (2013) (outlined in Chapter 2). Table 3 provides a list of indicators, corresponding keywords and a brief rationale for the selection of each keyword. The "integration indicators" were concepts presented by Stephens et al. (2013) while the keywords reflect my operationalization of the original indicators. The rationale highlights the reasoning for the operationalization.

Table 3: CCIEF Indicators, Keywords and Rationale

Integration Indicator	Keywords	Rationale
Climate change impact assessments for SG projects	"climate change" "climate" NOT "climate change" "mitigat*" "adapt*"	The keywords selected are reflective of this indicator as they are used to discuss either the impact that SG deployment has on climate change response (CCA or CCM), or how climate change may impact SG deployment. Climate was included as a key term in addition to climate change.

SG initiatives facilitating conservation and efficiency	"conserv*" "efficien*"	Targeted keyword searches in SG discourse will reveal when conservation and efficiency were used in the context of SG deployment.
SG initiatives facilitating use of non-carbon electricity sources	"renewable*" "green" "clean"	Non-carbon electricity sources essentially refer to the use of renewable or nuclear energy sources. In addition to renewable these are also referred to as "green" or "clean" energy sources.
SG-enabled micro-grid or community energy projects	"micro-grid" OR "microgrid" OR "micro grid" "distributed generat*"	Targeted keyword searches will reveal when the term micro-grid was used in the context of SG deployment. Given that community energy projects are proposed as an alternative to centralized generation systems, targeted keyword searches for content related to "distributed generation" is appropriate.
SG initiatives improving the flexibility and redundancy of the grid	"flexibl*" "redundan*"	Targeted keyword searches reveal when the terms flexibility and redundancy have been used in the context of SG deployment.
SG projects with the goal of societal electrification	"electrification" "electric vehicle*" OR "EV*"	In addition to searching for the keyword "electrification," the keyword "electric vehicle" is another relevant keyword as the development of electric vehicles reflects a preliminary step for the electrification of the transportation sector.

Initiatives to educate consumers on the benefits of SG	“educat*” “aware*” “benefit*”	The terms “educate,” “aware” and “benefit” were selected as keywords to reflect this indicator as they provide an indication as to a stakeholders efforts to educate the public and raise awareness about SG benefits during SG deployment.
Consideration of climate change in long-term SG deployment plans	“long term” OR “long-term”	Within the SG deployment discourse, the use of the term “long-term” will indicate whether stakeholders are either using long-term plans for SG deployment or taking measures to consider the long-term. The previous keyword search for climate change reveals the extent that climate change is being explicitly referenced and considered in the SG deployment process.

As shown in Table 3, some indicators have more than one corresponding keyword to address suggestions highlighted by Stephens et al. (2013) as well as to address possible language variation amongst stakeholders. For instance, the keywords “climate change,” “climate,” “mitigate” and “adapt” all correspond with the indicator advocating for climate change impact assessments or project evaluations prior to any SG investment. The use of each of these terms addresses the possibility that different stakeholders use different terminology.

As discussed in Chapter 2, my effort to assess climate change integration was inspired by Brouwer, Rayner and Huitema (2013) (see Section 2.4). To accommodate the quantitative nature of manifest content, I adapted their qualitative ranking method for the CCIEF. I use a similar modification of a 5-point Likert scale to rank indicators in categories ranging from “very integrated” to “not integrated.” In addition, I devised the evaluation to be based on the percentage of total sources that a keyword has been referenced in (See Table 4).

While the text search query function in NVivo identifies both the total number of keyword references as well as the number of sources a keyword appears in, my analysis focuses primarily on the number of sources for two reasons. First, there were several instances when a stakeholder referenced a keyword hundreds of times in only a small number of documents. By studying the number of documents a keyword appears in rather than the total number of references, I mitigate bias resulting from one stakeholder favoring a given keyword. Second, I focus on the number of sources because this provides a better indication of whether use of a keyword is widespread amongst stakeholders.

Following the text search queries, I calculated the percentage of the total 576 documents that a keyword appeared in as a means to apply scores to the CCIEF ranking schemes. To find the total score for the indicator keyword, source percentages were added to the other source percentages within the appropriate indicator category and divided by the number of keywords within the category. The intention was to normalize the keywords and ensure a consistent evaluation of indicators. Given that there was no precedent for this type of manifest content evaluation found in literature, I devised the ranking scheme that reflects a standard academic grading scheme. Table 4 outlines the CCIEF ranking scheme used to quantitatively assess the extent climate change integration has occurred in SG deployment using the objectives outlined by Stephens et al. (2013). Within the table any indicator that is found in 80 percent or more documents would rank as "very integrated" (corresponding to an "A" letter grade). Additionally, if an indicator were not found in any of the documents, it would rank as "not integrated" reflecting an "F" or failing letter grade.

Table 4: CCIEF Ranking Scheme

Level of Integration	Percentage of Sources with Keyword Reference	Description
Very integrated	≥80% of documents	This indicator is a dominant theme in SG discourse. Such emphasis across the sector indicates an **extraordinary level** of climate change integration.
Integrated	60 - 79% of documents	This indicator is a key theme in SG discourse, reflecting a **high level** of climate change integration.
Moderately Integrated	50 - 59% of documents	While many stakeholders reference the keywords corresponding with this indicator, they are not widespread across the electricity sector. This indicates an **intermediate level** of integration.
Minimally Integrated	≤49%, but >0% of documents	This indicator is referenced in less than half of the documents. Given that this indicator is not a priority for the sector, this rank reflects a **low level** of integration.
Not Integrated	0% of documents	The keywords for this indicator are not referenced in any textual SG discourse published by electricity stakeholders in Ontario between 2004 and 2013, indicating **no integration.**

The second step of the manifest content analysis was to use the text query function in NVivo to identify the number of documents each term was referenced in. It is worth mentioning that each keyword search allowed me to identify keyword references in singular, plural or in acronym form. Although I only discuss the most basic variation of the keyword, all variations of the keywords are encompassed in the scores and in further discussion. The findings from these text search queries were ranked using the CCIEF.

A key assumption associated with manifest content analysis is that there is a "relationship between frequency and meaning" (Kohlbacher, 2006, p. 11). Specifically, in the case of my research, I assume that there is a relationship between the frequency of references and relative importance. The more frequently referenced a term is, the more significant it is to the author. Kracauer (1952) notes "one-sided reliance on quantitative content analysis may lead to a neglect of qualitative explorations, thus reducing the accuracy of analysis" (p. 631). Therefore, I employed latent content analysis techniques to triangulate the manifest findings as a means to gain a deeper understanding of climate change integration in SG deployment in Ontario.

Methods for Data Collection and Analysis: Latent Content Analysis

As briefly mentioned in Chapter 1, latent content analysis involves the use of open coding techniques to identify underlying themes in text. Following the manifest content analysis it was critical to utilize latent content analysis techniques to explore findings in greater depth. The first step in the latent content analysis process was to identify the latent content to be analyzed. To do this I used the text search query function in NVivo to identify and isolate two distinct themes in the documents: discourse pertaining to SG and discourse pertaining to climate change. All excerpts containing the term "smart grid" were coded at the "Discourse- Smart Grid" node in NVivo. Similarly, all excerpts containing the term "climate change" were coded at the "Discourse- Climate Change" node. The identification and isolation of content pertaining to smart grid and climate change was intended to narrow the focus of the content to be considered for the latent content analysis.

It is important to highlight that the identified excerpts were sentences or short paragraphs that encompassed the context surrounding the use of the terms "smart grid" or "climate change." Any references to climate change or smart grid not in-text (i.e., in a table of contents or in a footnote) were not coded, as they provided no additional content for analysis. Additionally, as many stakeholders recycle text content from year to year in annual reports, excerpts with identical wording (duplicated excerpts) were also excluded to avoid redundancy in the analysis. The following table (Table 5) summarizes the number of excerpts coded at each set of discourse:

Table 5: Number Excerpts Coded in Each Set of Discourse

Discourse Set	Total Excerpts
Discourse- Smart Grid	1007
Discourse- Climate Change	120

The second step in the data collection process was to use open coding to thematically classify content saved at each node under "sub-nodes." For instance, within the SG discourse node, sub-node categories identified based on thematic content included challenges and barriers, drivers and enablers as well as planning and development (see Figure 7). My rationale for identifying the sub-nodes thematically rather than only coding for the CCIEF keywords was so that I could not only explore the contexts in which CCIEF keywords were referenced in, but also to consider instances when other terminology was used in the same contexts as keywords within the relevant SG and climate change discourse.

Latent analysis content was composed of specific excerpts coded at sub-nodes in NVivo. My intention was to use latent content analysis to triangulate manifest findings, and therefore, the sub-nodes and excerpts chosen for latent analysis were selected based on the findings yielded from the manifest content analysis. The following table (Table 6) identifies the sub-nodes that contained all content included for latent analysis.

Table 6: Sub-Nodes Included in Latent Content Analysis

Primary Node: Discourse- Smart Grid	Primary Node: Discourse- Climate Change
• Policy, Regulatory and Standards Development • SG Uses and Impacts • Objectives • SG Technology • Technological Development and Innovation • Public Education and Consumer Behavior • Complementary Initiatives • Drivers	• Policy Mandates and Regulations • General Discourse • Generation Supply Mix • Promoting Energy Efficiency and Conservation • Reducing GHG • Public Education • Climate Change Impacts

To better organize and display latent content, I created tables to visually assist in further open coding (see Table 7 for example). As shown in the following table, an excerpt is isolated (by NVivo) and the content within the excerpt is further coded (by the researcher). In the example, the excerpt references the implications of the Kyoto Protocol. Key themes within the excerpt are identified as "open codes" (left column).

Table 7: Example of Latent Content Analysis Technique

Open Codes	Excerpt
Kyoto Protocol Reduce GHG Federal Climate Change Plan Technology Investment Fund GHG Regulations	The Kyoto Protocol, to which Canada is a signatory, came into force on February 16, 2005. Under the Protocol, Canada is required to reduce annual emissions of greenhouse gases ("GHG") by six per cent from 1990 levels in the period 2008 to 2012. The Federal Government is preparing to announce revisions to its Climate Change Plan, which are expected to include the creation of a technology investment fund and a regulated GHG limit for large point sources, including the thermal electricity sector (OPG, 2004 Annual Report, p. 32).

Open codes were then classified into themes and summarized allowing me to identify further meanings and trends that were not identified using manifest content analysis.

Section 4.3: Limitations

The reliability, validity and replicability of this research were enhanced through a number of techniques. While reliability refers to "the extent to which results are consistent over time and an accurate representation of the total population under study" (Joppe, 2000; cited by Golafshani, 2003, p. 598), validity "determines whether the research truly measures that which it was intended to measure or how truthful the research results are" (Joppe, 2000; cited by Golafshani, 2003, p. 599). Measures to enhance reliability, validity and ultimately the replicability or the "repeatability of results or observations" (Golafashani, 2003, p. 598), included the inclusion of a large number of documents and the use of both manifest (quantitative) and latent (qualitative) content analysis techniques to triangulate findings. Triangulation is a technique that refers to a practice of combining research methods as a mean to "control bias and [establish] valid propositions" (Mathison, 1988; cited by Golafshani, 2003, p. 603). In addition, I used NVivo 10 software to minimize error. Specifically, I maintain that the use of software enhances both reliability and validity as software ensures consistent findings and is less prone to error than the risk of error associated with the individual researcher counting words. However, despite efforts to enhance the rigor of this study, the research is not without its limitations.

Many documents were written for a particular audience. For instance, annual reports and business reports published by LDCs are primarily written for shareholders and therefore authors are very selective of report content, as they do not want to risk any loss of investment for the company. Additionally, policy and regulatory documents are published within a particular political environment. It is important to recognize that political decisions have implications for taxpayers and affect the potential for leaders to be re-elected. Consequently, it is possible that many documents selected for the content analysis maintain an inherent bias as they were written for a particular audience, primarily frame SG and climate change-related activities in a very positive way, and do not often report any associated challenges or barriers.

Additional limitations associated with this research are with regards to the document selection process. It is possible that key documents regarding SG deployment "slipped through the cracks" during my search for relevant documents and were therefore not included in the content analysis. Furthermore, documents that were not made publically available online and were not shared with me following my inquiries were also not included in the content analysis and therefore the views of those stakeholders were not considered. In addition, as mentioned earlier, given the large number of LDCs operating in Ontario, the highest proportion of documents included in the content analysis were published by LDCs and consequently, the LDC perspectives dominate the manifest content analysis. However, because LDCs consist of the largest group of electricity stakeholders operating in SG deployment, I contend that this representation is appropriate as it is reflective of the composition of stakeholders involved in SG deployment in Ontario.

However, as a result of the large proportion of LDC documents and the fact that some stakeholders publish more documents than others, there is an inherent bias towards the language that is used or the ideas presented by those particular stakeholders. I mitigated this bias in two specific ways. First, I analyzed the number of sources a keyword appeared in rather than the number of times it was referenced. The intention of this was to address the possibility that one stakeholder favoured and possibility overrepresented a keyword, perhaps using it hundreds of times in one document. Second, I used latent content analysis to triangulate manifest content analysis findings. The latent content analysis provided me with an opportunity to consider the content of documents equally regardless of how many documents were included from a particular stakeholder or stakeholder group. As I will show in Chapter 5, there were several instances where the manifest content analysis did not capture the full extent that electricity stakeholders applied a concept because different stakeholders use different language to describe the same concept. It is also important to acknowledge that it is a common practice in content analysis to employ another researcher to verify both the word frequency counts as well as compare the open codes identified by latent content analysis. While I did not employ another researcher to verify my manifest and latent results, I did confirm the word frequency calculations and open code the excerpts several times to ensure consistent interpretation.

With regards to data collection and analysis, limitations exist due to both human error and the possibility of software malfunction. For example, while I was coding, it is possible that NVivo did not identify a keyword and therefore it was not coded at a relevant node. Furthermore, despite efforts to check all nodes to verify correctness, it is possible that a keyword was missed or coded incorrectly. Additionally, I made an effort to ensure that all variations of keywords (singular, plural, verb etc.) were identified in NVivo queries (by using the function "*"). However, it is possible that due to software malfunction NVivo did not identify every single occurrence of a keyword and as a result relevant content in the documents was overlooked in this analysis. Finally, it must also be mentioned that in many cases a word may not be specifically used in a context that is relevant for the content analysis, but was included as manifest content. For example, the term "adapt" is significant for climate change discourse, yet is also relevant in other contexts including business operations. As with the limitation associated with stakeholders using different terminology, I used latent content analysis to triangulate manifest findings and mitigate this risk.

Section 4.4: Data Collection and Analysis Summary

This chapter highlighted the methodology and methods employed for this content analysis and explored the use of content analysis as a means to evaluate climate change integration in Ontario's SG deployment regime. Figure 13 (below) summarizes the data collection and data analysis processes.

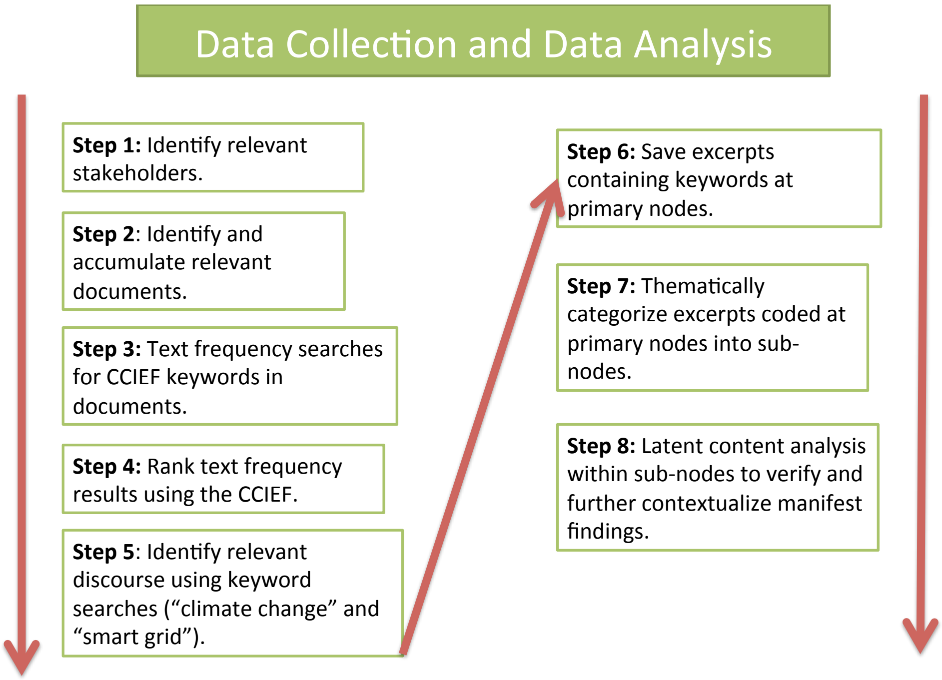


Figure 13: Summary of Data Collection and Analysis Process

In Chapter 5, I outline the results from the CCIEF assessment and the results of the latent content analysis. Additionally, I triangulate the CCIEF and latent content analysis findings to answer the research questions.

Chapter 5: Research Findings

Chapter 5 is divided into three sections. In Section 5.1, I present the findings of the manifest content analysis and apply them to the CCIEF evaluation, while in Section 5.2, I discuss the latent content analysis findings for CCIEF indicators in eight sub-sections. In Section 5.3, I identify additional latent content analysis findings. Following the presentation of manifest and latent content analysis findings, I triangulate and summarize findings in Section 5.4 to answer my research questions.

Section 5.1: Manifest Content Analysis and CCIEF Findings

As discussed in Chapter 4, the manifest content analysis involved the use of text-search queries in NVivo to generate word frequencies for CCEIF keywords. The text search findings were then organized in the CCIEF as a means to quantitatively evaluate climate change integration in Ontario's SG deployment regime between 2004 and 2013. The CCIEF serves as a method to explore the multiple dimensions of climate change integration in the context of SG deployment and provide a basis to assess the relative priorities of electricity stakeholders in terms of SG deployment and climate change response. Table 8 outlines the findings from the targeted keyword searchers in the total 576 documents included in the content analysis and the corresponding CCIEF score and rank. The integration indicators and keywords are identified in two columns on the left of the table, while the middle column shows the percentage of total sources referencing each individual keyword. These percentages were averaged within the indicator groups to determine the total CCIEF score (shown in the column located second from the right labeled "Total Percentage").

Table 8: Evaluation of Climate Change Integration Using the CCIEF

Integration Indicator	Keyword	Percentage of Total Sources (576 sources) Referencing Keyword	Total Percentage (CCIEF Score)	Level of Integration (CCIEF Rank)
Climate change impact assessments for SG projects	“climate change”	9.38%	14.72%	Minimally Integrated
	“climate” NOT “climate change”	4.86%		
	“mitigation”	28.65%		
	“adaptation”	15.97%		
SG initiatives facilitating conservation and efficiency	“conserve”	91.84%	86.2%	Very Integrated
	“efficient”	80.56%		
SG initiatives facilitating use of low-carbon electricity sources	“renewable”	35.24%	42.59%	Minimally Integrated
	“green”	65.97%		
	“clean”	26.56%		
SG-enabled micro-grid and community energy projects	“micro-grid”	1.56%	7.28%	Minimally Integrated
	“distributed generation”	13%		
SG initiatives improving the flexibility and redundancy of the grid	“flexible”	49.82%	32.38%	Minimally Integrated
	“redundant”	14.93%		
SG projects with the goal of societal electrification	“electrification”	0.35%	44.1%	Minimally Integrated
	“electric vehicle”	87.85%		
Initiatives to educate consumers on the benefits of SG	“educate”	72.22%	67.01%	Integrated
	“aware”	64.58%		
	“benefit”	64.24%		
Consideration of climate change in long-term SG deployment plans	“long-term”	60.07%	60.07%	Integrated

As shown in Table 8, this method of evaluation suggests that Ontario's SG deployment process demonstrates varying evidence of climate change integration between 2004 and 2013. As mentioned in Chapter 4, a key assumption associated with manifest content analysis is that the more frequently referenced a term is, the more important it is. Given this assumption, with a CCIEF score of 86.2% and a rank of "very integrated," it is evident that SG stakeholders prioritize initiatives concerning conservation and efficiency. In addition, indicators related to consumer education and long-term plans ranked "integrated" with CCIEF scores of 67% and 60.7% respectively. The remainder of the indicators pertaining to climate change impact assessments and evaluations, low-carbon electricity, micro-grid deployment, flexibility and redundancy, and societal electrification ranked "minimally integrated." It is worth noting that while indicators assessing low-carbon electricity and societal electrification ranked as minimally integrated, their scores rank comparatively higher than other indicators that ranked within the minimally integrated category (42.59% and 44.1% respectively). In contrast, having the lowest CCIEF scores, indicators pertaining to climate change impact assessments as well as micro-grids and community energy ranked as minimally integrated with scores of 14.72% and 7.28% respectively.

Section 5.2: Latent Content Analysis Findings

Recall from Chapter 4, following the manifest content analysis, I identified and isolated document content explicitly relating to SG and climate change using NVivo. Latent content analysis within sub-nodes was used to thematically explore, contextualize and triangulate manifest content analysis findings. The goal of latent content analysis was to identify further evidence of climate change integration (or lack thereof), determine whether the CCIEF ranking was reflective of document content and ultimately, to complement the CCIEF ranking which evaluated the relative priorities of SG stakeholders. Table 9 (below) provides a summary of the open codes identified from the excerpts examined for the latent content analysis. The full results from the latent content analysis can be found in Appendices E, F, and G.

Appendix E shows each individual excerpt, source and their corresponding open codes and Appendix F shows each individual open code identified in SG and climate change excerpts. Appendix G shows each open code categorized by theme. To avoid redundancy in content, duplicated open codes were eliminated while I was consolidating the open codes from Appendix F into Appendix G.

Table 9 (below) is a summary of the open codes considered within SG and climate change excerpts. I developed Table 9 by summarizing the latent data in two ways. First, Table 9 only shows open codes that are relevant to the CCIEF indicators (both explicitly and conceptually) as well as drivers and enablers of SG and climate change initiatives. Second, in Appendix E there are a number of open codes that refer to the same concept but are worded slightly differently. These were combined to summarize the findings in Table 9. For example, the open codes "microFIT" and "FIT Program" can be summarized by the open code "SG-enabled "prosumer"".

In Table 9 (below), the far left column is the broad thematic category (either CCIEF indicators or drivers and enablers of SG deployment and climate change response) into which open codes were grouped. The middle column contains the open codes that were identified within the SG discourse excerpts, while the far right column contains the open codes that were identified from the excerpts containing climate change discourse. In Table 9, open codes are arranged in alphabetical order. It is worth noting that the latent content analysis primarily involves comparing the open codes and corresponding themes in each sets of discourse to find evidence of content overlap. For the purpose of this research explicit overlap refers to references to climate change found within SG excerpts or references to SG identified in climate change excerpts. Thematic overlap refers to the identification of similar open-codes and themes within both sets of discourse. For the purpose of analysis, explicit overlap is an indication that climate change was explicitly integrated with SG deployment activities, while thematic overlap provides evidence that climate change considerations were inadvertently integrated in SG planning or deployment.

Table 9: Summary of Latent Content Analysis Results

Theme	SG Excerpts: Open Codes	Climate Change Excerpts: Open Codes
Climate Change Impacts		Alter rainfall frequency and duration Changes in cloud cover Changes in wind pressure Energy production impacts: - precipitation amount - precipitation timing - precipitation geographical timing - temperature - river flows - reservoir levels Extreme weather Water availability Water flows Water-energy nexus Water temperature Watershed impacts Weather variances
Conservation and Efficiency	Culture of conservation Efficient consumption Efficient production Enhanced price signals Home energy management Load shifting Long-term CDM targets SG- CDM Complementary initiatives SG-enable conservation SG enable DSM resources SG enable efficiency SG-enabled emission reduction - Peak load energy savings - Energy efficient programs SG-enabled home energy management SG Impact: efficient system Smart appliances TOU pricing	CDM Consumption reduction Focus on conservation Focus on energy efficiency Generation efficiency LTEP: energy efficiency Ontario climate change strategy: energy efficiency Reduce carbon footprint - Efficiency - Waste reduction - Electricity conservation Transportation efficiency
Low-Carbon Energy	Coal elimination Evolving supply mix Grid upgrades to accommodate	Coal elimination Emission-free baseline generation Environmental benefit

	Meet future demand Nuclear generation SG-enable renewable Renewable require SG Reduce central generation demand Reduce fossil fuel dependency SG- enable distributed generation SG-enabled emission reduction: - Renewables SG-enable prosumer SG-enable small scale generation Variable generation	Facility conversion Largest NA climate change initiative Nuclear energy Reduce carbon footprint Reduce fossil fuel dependency Reduce pollution Renewable energy Supply reliability Sustainable energy
Micro-Grid and Community Energy	SG demo- micro-grid - renewable energy - storage SG-enable micro-grid SG-enable storage	
Flexibility and Redundancy	AMI- OMS-GIS Interface Automatic reconfiguration Enhance system efficiency Fault Detection Isolation and Restoration system (FDIR) Flexible EV charging Flexibility to market Flexible regulatory framework Integrated Operating Model (IOM) Intelligent Electronic Devices (IEDs) Real-time interface: - Smart meter - SCADA - OMS Redundant service- grid operation SG-enabled emissions reduction - Reduced system losses SG-enabled reliability SG-enabled reroute during outage SG-enabled self healing networks - Re-route power - Outage management SG enhanced flexibility SG- objective: adaptive SG-objective: flexibility SG- rapid error response SG system automation Smart meter System automation	

Electrification	Zero emission mobility SG enable EV EV charging Vehicle-to-home power Off-Peak Charging SG to optimize grid SG required for: • Off-Peak Charging • Avoid increasing peak • Avoid adverse • EV batteries/ storage Increase in EV SG-enabled vehicle battery storage	EVs- CCM EV- economic benefits EV- environmental benefits Electrification of transportation Charging on clean generation Reduce emissions OPG EV Fleet Charging stations Reliable Transportation
Education and Awareness	Blog Posts Building trust Contest EV Charging Demo EV Demo GEO-targeted online ads Hands- On-Learning In person education Interactive website Micro-Grid Demo Public awareness SG benefits SG consumer engagement SG consumer value SG demo SG impressions SG-objective consumer education SG-public education materials Social media campaigns TV advertising Text-materials	Barrie Earth Hour Music Festival Climate change awareness Climate change education Community engagement Earth Hour Encourage Conservation Environmental Awareness Week Environmental messages Fight climate change Global impact Lights off School Education programs Walk Woodbridge Earth Hour Lantern
Long-Term Planning	Continental interoperability standards SG Objective: Coordination - Regional Smart Grid Plans - Economies of scale SG Objective: Economic development - Growth - Job creation - Ontario Based Sourcing SG Objective: Environmental	Adapting operations Biodiversity program Cap and Trade regime Climate change adaptation Climate change committee Climate change mitigation Coal elimination Employee commuter cycling Enhance system resilience Environmental issues impact electricity planning Improve restoration

	benefits - Clean technology - Conservation - Efficient use of existing tech SG Objective: Interoperability - Recognized industry standards - Common operation protocol SG Objective: Reliability - Maintain and improve - Outage management	Manage weather risk New Approach for Energy Use OPG Risk management Outage plans Production forecasting Supply Management Treatment of environmental attributes Tree planting Understand long-term climatic trends Vulnerability assessment
Drivers and Enablers	Aging Infrastructure Consumer and generator demands GEGEA GEGEA- enable CDM GEGEA-enable distributed renewables GEGEA- enabled efficiency GEGEA-enable grid upgrades Green Economy Grid modernization Grid redevelopment Integrate SG policy Long-term CDM targets OEB Programs for SG investment OEB statutory objective Pressure from regulators Provincial conservation and efficiency measures Provincial initiatives: • Conservation • Renewable generation • Smart meters	Clean-tech industry Climate change impact OPG operations Federal carbon policy Federal Climate Change Plan GEGEA GEGEA- enable renewables GHG Regulations Goal: clean energy company Gov mandate: culture of conservation Impact of climate change regulation Kyoto Protocol LTEP Provincial carbon policy Provincial Climate Change Plan Provincial GHG reduction goals Provincial GHG Targets Regional carbon policy Regulated GHG limit large final emitters Technology investment fund Toronto's Climate Change Action Plan Transmission Reinforcement

Table 9 shows that there are several categories with open codes identified both within SG excerpts and within climate change excerpts (low-carbon energy, conservation and efficiency, EV, long-term planning and drivers and enablers). This is a possible indication of explicit and thematic overlap in content within these categories. Additionally, as shown in Table 9, there are also several categories with no overlap in content at all. For example, open codes pertaining to climate change impacts, CCM and CCA were only identified within climate change excerpts, while discussions related to micro-grids and community initiatives as well as flexibility and redundancy were only found within the context of SG. In the following eight sub-sections I will discuss the latent content analysis findings for CCIEF indicators in more detail and in Section 5.3 I will highlight additional latent content analysis findings. It is worth noting that the excerpts shown in the discussion that follows were selected as representative examples after open coding was complete and findings were conceptualized. The particular excerpts that were chosen are intended to assist the reader in conceptualizing the meaning of open codes.

Section 5.2.1: Climate Change Impact Assessments

As shown in Table 9, there were no open codes identified within SG excerpts that explicitly reference climate change impacts. Specifically, despite the fact that electricity stakeholders made reference to the impacts of climate change in climate change excerpts (see Table 9), there is no evidence identified through latent analysis to suggest that such impacts were evaluated prior to SG investment, nor was there any evidence of stakeholders using Environmental Assessments (EAs) to determine any potential negative impacts that a SG project may have on climate change or the environment more broadly. Furthermore, apart from the occasional reference to the benefits that a SG technology or application could have for CCM or CCA (i.e., open codes such as “SG-enabled emission reduction” or “SG-enabled outage management”), there is little evidence that stakeholders considered or evaluated the potential contributions a SG investment may have for climate change response prior to beginning implementation.

In contrast to the SG excerpts, within the climate change excerpts there was evidence that electricity stakeholders considered the impacts of climate change between 2004 and 2013 (see Table 9: open codes identified include: “water availability,” “water temperature,” “energy production impacts,” and “extreme weather”). In particular, the open codes indicate that electricity stakeholders considered climate change impacts to the extent that they effect stakeholder operations in terms of energy supply, distribution and demand. With regards to energy supply, the OPG outlined changing precipitation patterns, changes in cloud cover, changes in wind pressure, and changes in water flows to be key risks associated with climate change that may impact the function of hydroelectric and solar generators. Additionally, the OPG also highlighted the potential for climate change-related temperature changes to impact electricity demand. Stakeholder considerations of the aforementioned climate change impacts are evident in the following excerpts.

> It is recognized that climate change could have far reaching effects on Ontario's watersheds. Energy production is very sensitive to the amount, timing, and geographical pattern of precipitation (supply side), as well as temperature (demand side). Changes in river flows and reservoir levels may have a direct impact on how much and when hydroelectric generation can be produced. The challenge remains to gain understanding of long-term climatic trends in order to understand the potential impacts to our operations, and to assess potential new development. Seasonal variability of precipitation, temperature, evaporation, lake levels and their divergences from normal ranges are the key elements of interest for OPG. (OPG, Sustainable Development Report, 2011, p. 15).

> The extent to which OPG can operate its hydroelectric generation facilities depends upon the availability of water. Significant variances in weather, including impacts of climate change, could affect water flows. OPG manages this risk by using production forecasting models that incorporate unit efficiency characteristics, water availability conditions, and outage plans. (OPG, Annual Report, 2012, p. 56).

As seen in the previous excerpts, it is evident that not only did the OPG acknowledge the impact that climate change may have on energy supply and electricity demand, they also recognized that research and risk management plans are necessary to mitigate the associated risks.

With regards to references to the impacts of climate change on electricity distribution, latent content analysis drew attention to a small number of electricity stakeholders that considered the potential impacts of extreme weather (resulting from climate change) on the operation of electricity transmission and distribution infrastructure (open codes include: "extreme weather," "manage weather risk," "enhance resilience," "improve restoration," and "vulnerability assessment"). Notably, while there was no discussion of climate change impact assessments within climate change excerpts, latent content analysis highlighted the two-phase vulnerability assessment project implemented by the THESL that focused on "identifying its assets, vulnerabilities and uncertainties related to climate change" both based on past weather patterns and future climatic projections (THESL, 2013, p. 9). Although SG was not highlighted as a means to address climate change-related vulnerabilities within climate change discourse between 2004 and 2013, it is evident that some electricity stakeholders considered the impact that climate change may have on energy supply, demand and the operation of distribution infrastructure.

Overall, latent content analysis findings suggest that while SG stakeholders considered the impacts of climate change, there was no evidence that SG projects were subject to climate change impact assessments prior to implementation between 2004 and 2013, nor was there evidence that a SG project is evaluated explicitly for potential contributions to climate change response.

Section 5.2.2: Conservation and Efficiency

As shown in Table 9, content regarding conservation and efficiency was identified in both SG and climate change discourse. Within the SG excerpts it was evident that electricity stakeholders recognized the enabling role of SG technology in encouraging conservation and efficiency initiatives (identified through open codes "SG-enable conservation" and "SG-enable efficiency"). Furthermore, in the SG excerpts, stakeholders referenced the term "conservation" in several contexts including the provincial government's goal of creating a "culture of conservation" in Ontario, Conservation and Demand Management (CDM) programs, or the conservation targets outlined in the *LTEP* (open codes identified include "culture of conservation," "SG-CDM complementary initiatives," "long-term CDM targets"). The following excerpts demonstrate the nature of references addressing provincial conservation targets and "culture of conservation."

> Distributors assume added responsibilities to assist and enable consumers to reduce their peak demand and conserve energy in an effort to meet provincial conservation targets. (London Hydro, Annual Report, 2011, p. 23).

> In preparing for the smart grid future and in compliance with the Ontario government's mandate to build a "culture of conservation", ENWIN began the installation of smart meters in homes and small businesses across Windsor in 2010. (Enwin Utilities, Annual Report, 2013, p. 22).

In addition, within the SG excerpts the term "efficiency" was not always explicitly referenced despite the fact that the demand management components of CDM strategies primarily aim to achieve efficiency in various components of the energy system (see Chapter 2). When "efficiency" was explicitly referenced within SG discourse, it was in terms of production and consumption of energy (open codes: "efficient consumption," "efficient production" and "energy efficient programs"), or as a policy objective (open code: "SG objective- flexibility"). Below there are two excerpts; the first is an example of the term efficiency being used in the context of production and consumption, while the second is an example of the manner in which efficiency is conceptualized as a SG policy objective.

> A Smart Grid, based on communication among generators, transmitters, distributors and consumers, is a big part of a grand plan to make energy production and consumption more efficient and effective. (Enwin Utilities, Annual Report, 2008, p. 7).

> Efficiency: Improve efficiency of grid operation, taking into account the cost-effectiveness of the electricity system. (OME, Directive to the OEB, November 23, 2010).

The second excerpt references the role of SG in improving the efficiency of grid operation; this type of efficiency was also implied when stakeholders discussed matters relating to demand management and reducing peak loads (open codes include: "load shifting," and "peak load energy savings").

Another theme identified in the SG excerpts is the role of SG technology in encouraging consumers to change their behaviour to conserve energy and facilitate demand management practices. Electricity stakeholders discussed this behaviour change as being encouraged through TOU pricing or home energy management (see Table 9). The following excerpt demonstrates the role of TOU pricing (or dynamic pricing) in encouraging consumers to shift electricity consumptions to off-peak times as a means of reducing critical peak demand.

> Dynamic pricing can build on time-of-use and smart grid infrastructure by pinpointing short time periods of extremely high demand – known as critical peaks – and permitting customers to sign up to receive a financial benefit for shifting their consumption from critical peak to the lowest-demand period, typically overnight. (OME, *Conservation First: A Renewed Vision for Energy Conservation in Ontario,* 2013b, p. 6).

In addition to encouraging consumers to change their consumption behaviour, electricity stakeholders highlighted SG technology as having the capacity to enable conservation and efficiency through system automation. Specifically, within the SG excerpts there were several references to the SG technology that facilitates automatic adjustments by household appliances in response to electricity demand and price cues (open codes identified include "smart appliances," and "enhanced price signals"). These technologies and SG applications are used to automatically facilitate a reduction in household electricity consumption at peak times. For example, in his report to the chair of the Electricity Market Forum, George Vegh noted:

> An enhanced price signal can provide a triggering mechanism that will allow the smart grid to automatically adjust customer electricity usage. (IESO, Reconnecting Supply and Demand, 2011, p. 2).

As discussed in Chapter 2, SG technology and applications such as TOU pricing and system automation encourage less electricity consumption and facilitate more efficient production and consumption of energy resources in addition to enabling the grid to operate in a more efficient manner. Although both conservation and efficiency (in production, consumption and grid operation) are relevant strategies to respond to climate change, they were not discussed in this context within the SG excerpts.

With regards to the content discussing conservation and efficiency identified in the climate change excerpts, latent content analysis findings indicated that conservation and efficiency were primarily discussed in the context of CDM programs, Ontario's *LTEP*, conservation targets or Ontario's climate change strategy (open codes include "focus on conservation," "focus on energy efficiency," "LTEP: energy efficiency" "generation efficiency" and "Ontario climate change strategy"). As an example, the following excerpt from the OME's 2011-2012 results based plan briefing book demonstrates the role of Ontario's *LTEP* and climate change strategy in encouraging energy efficiency.

> Energy efficiency is a cornerstone of the province's Long-Term Energy Plan, and an important element of Ontario's climate change strategy. As a result of the government's energy efficiency efforts, Ontario has saved more than 1,700 megawatts of electricity since 2005, equivalent to more than half a million homes being taken off the grid. (OME Results-Based Plan Briefing Book, 2011-2012, p. 10).

In addition, conservation and efficiency related content within the climate change excerpts highlighted the environmental benefits associated with participating in such initiatives (open code: "reduce carbon footprint"). The following excerpt is representative:

> In 2008 Sustainable Waterloo was founded to allow the Waterloo Region business community to be a part of the local solution to global climate change. This not-for-profit has a growing membership dedicated to reducing its carbon footprint through efficiency and waste reduction, with a heavy emphasis on electricity conservation. The CKW Group are supporters of this organization and their local events. Waterloo North Hydro is a Founding Partner. (CDN Hydro, 2011 CDM Strategy, p. 26).

Overall, despite the fact that document content addressing conservation and efficiency were found both within both SG and climate change discourse, latent content analysis provided no evidence of an explicit overlap in excerpt content within discourse pertaining to conservation and efficiency. Specifically, while a few similar themes were brought up in both sets of discourse (i.e., CDM), there were no explicit references to SG found in the climate change excerpts and no explicit references to climate change identified in SG discourse. However, within the climate change excerpts there was an implicit reference to the role of SG in facilitating climate change response (see the following excerpt).

> The Board is committed to promoting conservation in the province. An increased focus on the environment and climate change continues to underpin the importance of, and support for, conservation and energy efficiency. The Board seeks to ensure that its regulation is consistent with the delivery of efficient and effective conservation and demand management (CDM) programs. Key implementation issues are conservation and demand management programs provided by distributors, smart meters and time-of-use pricing. (OEB Business Plan, 2008-2011, p. 12).

In the excerpt, after highlighting the importance of CDM programs for facilitating conservation and efficiency to achieve climate change-related objectives, the OEB noted the critical role of SG technology and applications (smart meters and TOU pricing) for the implementation of CDM programs. Although there is one degree of separation between climate change and SG, this excerpt provided evidence that electricity stakeholders somewhat considered SG, conservation, efficiency and climate change in the same context between 2004 and 2013.

Section 5.2.3: Low-Carbon Energy

As shown in Table 9, open codes identified within SG excerpts discussing low-carbon electricity sources include "SG-enable renewable" and "SG-enable prosumer," "reduce demand central generation," "nuclear generation," "evolving supply mix" and "coal elimination." Specifically, a theme identified within the SG excerpts referencing low-carbon energy was the ability for SG technology to enable electricity generators to integrate renewable energy sources from small-scale distributed generators onto the grid (identified by the open code "SG-enable renewable" and "SG-enable prosumer"). The following excerpt is one example of this.

> The idea is to use smart grid technology to enable customers, large and small, to generate power from renewable sources such as solar power, and sell it back to the Grid. (Burlington Hydro Community Report, 2009, p. 13).

Another theme specifically associated with low-carbon energy in SG excerpts was that SG can facilitate the transition from the current centrally located generation and distribution system towards a more distributed approach (identified by open codes "reduce demand central generation" and "SG-enable small scale generation"). For instance PUC Inc., a mid-sized LDC noted that:

> The smart grid will also allow for better integration of small scale distributed generation facilities, reducing the need for large centrally located generation plants. (PUC Inc., Annual Report, 2008, p. 5).

In addition, within SG excerpts, low-carbon energy was discussed in the context of the coal phase-out initiative implemented by the OME. In particular, it was noted that SG can play a role in integrating renewable energy sources as well as nuclear power in an effort to replace coal in Ontario's generation supply mix and meet future demand (identified by open codes: "coal elimination," "meet future demand," "evolving supply mix," "nuclear generation" and "variable generation"). The following quotations articulate this perspective:

> They include the retirement of Ontario's coal-fired resources and the addition of substantial amounts of variable generation; resource procurement and contracting; the proliferation of demand-side management resources – at residential, commercial and industrial levels, and enabled by smart grid investments. (IESO, Annual Report, 2011, p. 24).
>
> In addition, the transmission system must continue to evolve in response to changes in Ontario's resource mix including the development of renewable resources, integration of storage technologies, increased reliance on demand response, the refurbishment of existing and the development of new nuclear generators and the shutdown of coal-fired generation. To meet these challenges, the transmission system must become even more sophisticated, reliable, efficient and flexible through the implementation of additional smart grid technology. (Smart Grid Forum, Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, 2009, p. 31).

Another theme relating to low-carbon energy identified in the SG excerpts was that SG-enabled energy storage and renewable energy can facilitate positive environmental results (open codes identified include "emission reduction" and "reduce fossil fuel dependency.") For instance, The Ontario Smart Grid Forum articulates the following view:

> As part of the smart grid, energy storage is a kind of insurance policy – it brings flexibility, reliability and predictability to many aspects of system operation, and as an enabler of renewables can help us become less dependent on fossil fuels and achieve other environmental benefits. (Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum, 2011, p. 26).

As discussed in Chapter 2, the replacement of fossil-fuel intensive energy supply to low-carbon energy sources (including renewable energy and nuclear energy sources) is a key CCM strategy. Despite this, in the SG discourse, low-carbon energy sources were not discussed in the context of climate change despite being framed in an environmental perspective.

Within the climate change excerpts, open codes pertaining to low-carbon energy include "renewable energy," "sustainable energy," "nuclear energy" and "facility conversion" as well as "emission-free baseline generation," "coal elimination," "reduce carbon footprint," "reduce fossil fuel dependency" and "environmental benefit." In contrast to excerpts found in SG discourse, references to low carbon energy within climate change discourse either alluded to, or explicitly recognized CCM benefits. In particular, discussion pertaining to low-carbon energy sources (including renewables and nuclear sources) in climate change discourse often related to Ontario's move to eliminate coal from its generation supply mix (identified through open code “coal elimination”). The following excerpt demonstrates this:

> With the closing of our major coal burning facilities at the end of 2013, over 95 percent of our generation now comes from nuclear and hydroelectric sources – which are virtually free of emissions contributing to smog and climate change. (OPG, Annual Report, 2013, p. 4).

Despite the fact that duplicated excerpts were eliminated for the purpose of latent content analysis (see Chapter 4), it is worth noting that it was frequently stated by multiple stakeholders (including the OME, the OPA and the OPG) that the coal elimination initiative was the “single largest climate change initiative in North America” (see Appendix F). Stakeholders also articulated the idea that due to the coal elimination, the development of renewable and nuclear energy sources has been necessary to replace coal in the supply mix (open codes identified include “renewable energy,” “nuclear generation,” facility conversion,” and “largest NA climate change initiative”). The following excerpt illustrates this:

> Ontario is committed to eliminating all coal-fired generation from its energy supply mix by 2014. The initiative is crucial to fighting climate change and protecting the health of Ontarians. Replacing dirty coal-fired generation with conservation, renewables and cleaner sources of supply will reduce Ontario’s greenhouse gas emissions by up to 30 megatonnes (Mt) – representing the largest single climate change initiative in Canada. (OME Results-Base Plan (2009-2010), p. 7).

Notably, the role of the SG in enabling the integration of renewables to assist in the Ontario coal elimination initiative was not mentioned within the climate change excerpts.

Moreover, within the climate change excerpts further development of hydroelectricity, biomass and potentially wood-pellets were referenced as strategies to diversify Ontario’s energy supply mix using renewable energy sources (identified by open codes “renewable energy,” “facility conversion,” and “emission-free baseline generation”). It is also worth noting that in the climate change discourse, electricity stakeholders identified nuclear energy and natural gas as strategies utilized by the OPG to meet electricity demand with low-carbon sources in lieu of coal, to reduce GHG emissions and mitigate climate change. This is highlighted in the following excerpts:

> With the closing of our major coal burning facilities at the end of 2013, over 95 per cent of our generation now comes from nuclear and hydroelectric sources – which are virtually free of emissions contributing to smog and climate change. (OPG Annual Report, 2013, p. 4).

> In December, the OPA awarded a 20-year contract to York Energy Centre LP to design, build and operate a simple-cycle natural gas plant in the Township of King. This plant will address the urgent need for clean, reliable and secure power in one of the fastest-growing areas in Ontario. It will also help the province to close down coalfired generation by 2014 – Canada's single biggest climate-change initiative. (OPA, Annual Report, 2008, p. 19).

Overall, while there was no explicit overlap between SG and climate change discourse within the context of low-carbon energy (i.e., no reference to climate change within the SG excerpts and no reference to SG within the climate change excerpts), open codes pertaining to low-carbon energy were identified in both sets of excerpts and there were overlaps in identified themes (i.e., the coal elimination initiative). Therefore similar to conservation and efficiency, latent content analysis findings indicate a thematic overlap between SG and climate change excerpts pertaining to low-carbon electricity. This suggests inadvertent integration of climate change considerations into Ontario SG deployment regime in this context.

Section 5.2.4: Micro-Grids and Community Energy Initiatives

As shown in Table 9, open codes relating to micro-grids and community energy initiatives were identified within SG discourse but were not identified within the climate change excerpts. Within the SG excerpts, open codes pertaining to micro-grids and community energy initiatives identified through latent content analysis include "SG-enable micro-grid," "SG demo- micro-grid," "SG-enable distributed generation," "SG-enable small scale generation," and "SG-enabled storage." Several of these open codes suggest that electricity stakeholders perceive micro-grids, distributed generation and storage as being applications that are enabled by SG technology. In addition, the open codes also draw attention to the fact that not only have electricity stakeholders used micro-grids for public education but also that they recognize a potential relationship between distributed generation and renewable energy. The following three excerpts highlight these themes. Specifically, the first two excerpts below demonstrate that micro-grids have been used by utilities (such as PowerStream Inc.) to educate consumers on the capabilities of SG technology and illustrate the connection between SG technology, micro-grids, renewable energy and electricity storage, while the third excerpt further displays the relationship between distributed generation and renewable energy.

> The Micro Grid demonstration project marked the next phase in the company's aim of supporting Smart Grid development at the provincial level and raising awareness for the need to leverage innovative 'smart' technologies in Ontario's electricity sector. (PowerStream Inc., Annual Report, 2009, p. 27).

> One of the leading smart grid technology demonstration projects initiated in 2012 was the micro grid project whereby portions of the distribution grid could separate and operate on its own, using renewable energy sources such as solar and wind in combination with storage and clean internal combustion generation. (PowerStream Inc., Annual Report, 2012, p. 29).

> This investment is aimed at enhancing the efficiency of the distribution grid and using smart grid technologies to enable the connection of distributed generation, such as wind and solar, in a more intelligent, cost effective way. (Ontario Smart Grid Forum, 2011, Modernizing Ontario's Electricity: Second Report of the Ontario Smart Grid Forum, p. 30).

As previously mentioned, there was no evidence of micro-grids or community energy initiatives mentioned within the climate change excerpts. In addition, in the SG excerpts there was only one open code pertaining to the ability for these SG applications to enhance reliability of electricity supply (open code: "storage-enabled reliability") and no explicit reference to the capabilities of micro-grid, distributed electricity generation or electricity storage capabilities to enhance the resilience of the electricity system.

Section 5.2.5: Flexibility and Redundancy

Similar to content related to micro-grid, and community energy initiatives, latent content analysis findings indicated that there were no explicit references to grid flexibility and redundancy within climate change excerpts (this is also shown in Table 9). Within SG discourse, document content related to the term flexibility is reflected in open codes such as: "flexibility to market," "flexible regulatory framework," "flexible EV charging," and "SG enhanced flexibility." The aforementioned open codes make it clear that the term "flexibility" was used in a number of different contexts including the economy, industry regulations and grid operation. The following excerpts are examples of the manner in which electricity stakeholders referenced “flexibility” within the SG excerpts.

> This approach provides for a flexible and robust framework. It ensures that the smart grid objectives and policy objectives set out in the Minister’s Directive are considered as part of the overall approach to regulation and rate-setting for regulated entities. (OEB, Supplemental Report on Smart Grid, 2013, p. 6).

> An important aspect of this evolution will be improving the alignment of conservation costs and benefits, as well as giving sector participants greater flexibility to respond to changing market conditions. (OME, *Conservation First: A Renewed Vision for Energy Conservation in Ontario,* 2013, p. 17).

> The goal of a smart grid is to use advanced information-based technologies to increase grid efficiency, reliability and flexibility. (IESO, Business Plan (2010-2012, p. 2).

In addition to using the term “flexibility” to describe the market, regulatory framework, and grid operation, latent content analysis drew attention to the use of the term “flexibility” in the context of SG policy as a mandated objective for SG deployment (open code: “flexibility- SG objective”). As a policy objective emphasized by the OME, “flexibility” was referenced in the following manner:

> FLEXIBILITY: Provide flexibility within smart grid implementation to support future innovative applications, such as electric vehicles and energy storage. (OME Directive to the OEB, November 23, 2010).

In the excerpt above, flexibility is a term used in reference to ensuring that SG deployment results in the development of a flexible grid. Specifically, given that SG technology will evolve over time and additional SG applications will be possible in the future, a flexible grid would allow the grid to accommodate these technological changes without major functional challenges or service disruptions. Notably, within the SG discourse the concept of flexibility was not referenced in the context of climate change despite the fact that grid flexibility is a CCA strategy (see Chapter 2).

With regards to electricity stakeholders’ use of the term “redundancy,” latent content analysis revealed that the term was used in the SG excerpts (open code: “redundant service: grid operation”), and not at all within the climate change excerpts (see Table 9). As discussed in Chapter 2, the term “redundancy” is defined as a component of a system that is “not strictly necessary to functioning but included in case of failure in another component" (Oxford Dictionaries, 2015). The use of redundant components in the design of a system is used to increase the overall reliability of that system. Given this, I interpret Stephens et al.'s emphasis on SG redundancy as being a strategy to enhance the reliability and resilience of an electricity system in response to climate change. Recall from Chapter 2, that there are many SG technologies that serve to enhance the reliability and resilience of a system and arguably fall under Stephen et al.'s conceptualization of "redundancy."

Latent content analysis within SG discourse provided evidence that between 2004 and 2013 several electricity stakeholders worked to implement SG technologies to enhance grid resilience and reliability. These technologies included self-healing grid technology, Fault Detection Isolation Restoration (FDIR) devices, and Outage Management Systems (OMS). Furthermore, some stakeholders took steps to integrate GIS technology with FDIR, Supervisory Control and Data Acquisition systems (SCADA) and OMS systems so that in the event of an outage they are able to quickly identify where the issue is and dispatch crews to repair it so that power is restored quickly (open codes include "SG-enabled reliability" and "SG-enabled reroute during outage").

As previously mentioned, the term "redundant" was not used in any content identified within the climate change excerpts. Moreover, within the climate change excerpts, electricity stakeholders primarily used the term "reliability" to describe the ability for renewable energy to ensure reliable supply or the ability for EVs to facilitate a reliable mode of transportation (open codes: "supply reliability" and "reliable transportation"). While SG technology is relevant to both the development of renewable energy and EV, it was not referenced in this context. Additionally, there was minimal focus on enhancing the reliability of the grid to respond to climate change. While a small number of stakeholders referenced the impact that climate change may have on the operation of electricity distribution infrastructure an even smaller number of stakeholders made reference to having either outage plans as part of their risk management strategy or as working to enhance the resilience of their systems (See Section 5.2.1). This will be discussed further in Section 5.2.8.

Overall, latent content analysis made it clear that while the term flexibility was used in a number of contexts, including in regards to grid operations, it was not applied in the context of climate change response. In addition, electricity stakeholders did not commonly reference the term "redundancy"; however, between 2004 and 2013 a number of stakeholders deployed SG technologies to enhance the resilience and reliability of the electricity system. Within the climate change excerpts, only a small number of stakeholders acknowledged the necessity to manage climate change and weather related risk to ensure system resilience. The remaining references to reliability pertained to either renewable energy or EV. The role of SG technology was not referenced in any of these contexts within the climate change excerpts.

Section 5.2.6: Societal Electrification

With regards to content related to societal electrification, EV deployment was the primary focus within both SG and climate change excerpts. In the SG excerpts, a key theme identified through open coding was the role that SG can play in enabling the development of EV technology. In addition, latent content analysis revealed that electricity stakeholders recognized that EV technology provides an opportunity for zero emission mobility (open code: "zero emission mobility"), as well as drawing attention to the fact that between 2004 and 2013 electricity stakeholders were aware that if EVs and EV charging systems are not implemented with the necessary SG technology, EV could pose a challenge for both grid function and customer service (as illustrated by the open codes "EV charging" and "off-peak charging"). This view is articulated in the following excerpt:

> For the electricity system as a whole, the challenges involve finding ways to move vehicle charging into off-peak periods so as to avoid increasing peak load and the resulting need for additional peaking resources. The opportunity involves using the energy stored in vehicle batteries to provide peak period energy. A smart grid is essential if Ontario is to address the challenges and embrace the opportunities presented by plug-in electric vehicles. (Ontario Smart Grid Forum, *Enabling Tomorrow's Electricity System,* 2009, p. 5).

As discussed in the excerpt above, EV deployment can increase peak load. This is a major risk associated with a lack of climate change integration as discussed in Stephens et al. (2013). Latent content analysis provides evidence that electricity stakeholders both acknowledged the role of EVs in reducing GHG emissions and considered the risk of increasing peak load associated with EV development. This indicates that EV deployment may not necessarily result in a GHG-emitting, maladaptive grid.

There was one open code pertaining to broader societal electrification identified in the climate change excerpts ("electrification of transportation"). The remaining open codes pertaining to electrification primarily refer to EV deployment. In particular, within the climate change excerpts, EV was discussed primarily in the context of their capacity to minimize emissions from the transportation sector and mitigate climate change (open codes identified included "EVs- CCM," "EVs- economic benefits," "charging on clean generation," "reduce emissions" and "OPG EV Fleet"). The following excerpts provide a clear example of the context in which electricity stakeholders reference EVs.

> Electric vehicles (EVs) are a reliable transportation choice and can play an important part in mitigating climate change. By supporting the widespread adoption of EVs, OPG's goal is to maximize the environmental and economic benefits that they bring. Given that Ontario's baseload generation is virtually free of GHG emissions, EVs have the potential to make a significant contribution to Ontario's GHG emission reduction goals. (OPG, Sustainable Development Report, 2011, p. 15).

> Electrification of the transportation sector and charging on clean generation like nuclear and hydro is a key strategy to reducing Ontario's emissions and mitigating climate change. (OPG, Sustainable Development Report, 2011, p. 15).

While the benefits of EVs in terms of CCM were clear themes in climate change discourse (as illustrated in Table 9), there was very little discussion of the role of EVs in the context of CCA between 2004 and 2013. As discussed in Chapter 2, electricity can be stored in EV batteries and fed back to the grid in the event of a power outage or supply shortage. While this was discussed within the SG excerpts (open code: "SG-enabled vehicle battery storage"), it was not discussed within the context of climate change. Moreover, in contrast to SG discourse, there were no mentions of the challenges associated with the improper deployment of EVs in the climate change excerpts, nor were there any references to the role of SG in mitigating this risk.

Overall, latent content analysis findings identified no evidence of explicit overlap between SG and climate change discourse in the excerpts (i.e., no references to climate change in the SG excerpts, and no references to SG in the climate change excerpts). However, similar to discourse pertaining to conservation and efficiency as well as low-carbon energy, latent analysis provided evidence of thematic overlap between open codes identified in both sets of discourse. For example, the role of EVs in reducing GHG emissions was acknowledged by electricity stakeholders in both SG and climate change excerpts. This thematic overlap is an indication that in the context of electric vehicle development, climate change considerations were inadvertently integrated with SG deployment.

Section 5.2.7: Education and Awareness

As shown in Table 9, open codes pertaining to discourse relating to consumer education and public awareness initiatives were identified in both the SG and climate change excerpts. Within the SG discourse, latent content analysis findings indicated electricity stakeholders reference education programs in a number of different contexts including the consumer benefits associated with SG technology (open codes: “SG consumer value” and “SG consumer benefits”) or the medium that was used to reach the public (open codes: “TV advertising,” “SG demo,” “social media campaigns” and “in person education”). Furthermore, latent content analysis drew attention to the fact that consumer education is also a policy-mandated objective for SG deployment (open code: SG objective- consumer education). The following excerpt demonstrates the manner in which consumer education is conceptualized as a SG policy objective.

> EDUCATION: Actively educate consumers about opportunities for their involvement in generation and conservation associated with a smarter grid, and present customers with easily understood material that explains how to increase their participation in the smart grid and the benefits thereof. (OME, Directive to the OEB, November 23, 2010).

Additionally, another theme that emerged through latent content analysis suggests that between 2004 and 2013 electricity stakeholders maintained the mentality that consumer support was necessary for SG success (open codes: “building trust” and “SG impressions”). The following excerpts illustrate this:

> A highlight of this program is the Sunny Side Up roving demonstration trailer, which educates the public on various uses and benefits of smart grid technologies. (Woodstock Hydro, CDM Report, 2011, p. ii).

> These materials are intended to explain how smart meters, time-of-use rates, in-home devices, smart appliances, and other smart grid technologies can bring more control, choice and value to residential electricity consumers and operational benefits to the grid. (The Ontario Smart Grid Forum, Modernizing Ontario’s Electricity System Next Steps, 2011, p. 11).

> When provided with information explaining smart grid and the benefits that it provides, in simple language, customers were receptive to what these new technologies would do for them. (PowerStream, Annual Report, 2012, p. 21).

While the latent content analysis provided evidence that electricity stakeholders referenced the role of SG in enabling initiatives that have positive results for CCM and CCA, there were no explicit references to educational activities that informed consumers on the relationship between SG and climate change.

Latent content analysis within climate change discourse revealed that a small number of stakeholders explicitly referenced climate change in the context of public engagement: PowerStream Inc., Horizon Utilities, and Woodstock Hydro. While PowerStream Inc. emphasized the company’s involvement in public events such as Earth Hour and Environmental Awareness Week, Horizon Utilities emphasized their extensive involvement in a large education program in local schools (open codes: “Earth Hour,” “Environmental Awareness Week,” “school education programs”). The latent content analysis indicated that many of the public education efforts discussed the relationship between climate change and conservation with no references to SG technology (open codes: “encourage conservation” and “lights off”). The following excerpts demonstrate this:

> Earth Hour was established by the World Wildlife Fund to bring attention to the issue of climate change. The idea is that simply turning off the lights for an hour, when done collectively worldwide, could have a noticeable impact. (PowerStream Inc., Annual Report, 2011, p. 20).

> The Barrie Earth Hour Music Festival and Woodbridge Earth Hour Lantern Walk were two events held in March 2010 that PowerStream sponsored to encourage customers to help fight climate change by reducing their electricity consumption. (PowerStream Inc., Annual Report, 2010, p. 22).

> Over the past two years, 100 schools, 500 teachers and student teachers and more than 6,000 children have learned about energy sources, climate change and energy conservation through these educational programs. (Horizon Utilities, Annual Report, 2008, p. 19).

It is also worth noting that, similar to findings within the SG excerpts, the findings of the latent content analysis within the climate change excerpts suggest a potential gap in educational content regarding the relationship between SG, climate change and consumer behavior. In fact, latent content analysis drew attention to the following excerpt from the climate change discourse.

> The marketing of the PeaksaverPLUS program does not highlight the connection to climate change that may motivate greater participation in the program as well as providing public education. (Woodstock Hydro, CDM Report, 2012, p. 39).

The PeaksaverPLUS program is a SG-enabled CDM program that involves the installation of an in-home device that automatically responds to peak demand by reducing air conditioning or thermostat levels in customers' homes. The PeaksaverPLUS program not only "helps ease the strain on Ontario's electricity grid" at peak times, (Hydro One Inc., 2009) but also facilitates automatic electricity conservation and contributes to CCM efforts. However, Woodstock Hydro articulated the view that consumers are unaware of the relationship between climate change and electricity consumption. Furthermore, the excerpt above suggests that highlighting climate change in PeaksaverPLUS marketing would encourage more customer participation. It also suggests that Woodstock Hydro believes that there is a missed opportunity for electricity stakeholders to educate the public on climate change.

Overall, latent content analysis findings suggest that there is a no explicit overlap in SG and climate change educational content. While there is evidence of thematic overlap found in discussion pertaining to conservation within both SG and climate change excerpts, latent content analysis findings suggest that some stakeholders perceived a gap in education content where the relationship between SG and climate change could be explicitly discussed.

Section 5.2.8: Long-Term Plans

Explicit references to long-term planning in both SG and climate change excerpts were typically made in regards to the *LTEP.* In addition to the *LTEP* I used latent content analysis as a means to identify evidence of long-term considerations or planning processes. As shown in Table 9, open codes relevant to these themes were identified in both SG and climate change excerpts. As previously mentioned, both SG and climate change were mentioned in the *LTEP,* however, they were not discussed in the same context or in a concurrent manner. While in the *LTEP* the SG was presented as the technology necessary to enable applications of SG such as EVs, climate change was discussed in the context of renewable energy and reducing GHG emissions. The following excerpts from the *Long Term Energy Plan* (2013) demonstrate the nature of discussion pertaining to SG and climate change within this long-term planning document.

> These smart grid solutions will also help LDCs integrate new promising technologies into Ontario's electricity system that could help operators use grid assets more efficiently, including storage and electric vehicles. (OME, 2013, Long Term Energy Plan, p. 81).

> When clean energy from the wind is available, it reduces our need to rely on fossil fuel sources of electricity that contribute to smog, pollution and climate change. (OME, 2013, Long Term Energy Plan, p. 38).

In addition to the *LTEP,* evidence of long-term thinking within SG discourse was evident upon examination of SG objectives and the expected long-term impacts of SG deployment. For example, the OME directed the OEB to ensure that SG deployment facilitates both economic development and environmental benefits (open codes: "SG objective- economic development," and "SG objective- environmental benefits"). The following excerpts demonstrate the manner in which the OME conceptualizes economic development and environmental benefits as SG objectives.

> ECONOMIC DEVELOPMENT: Encourage economic growth and job creation within the province of Ontario. Actively encourage the development and adoption of smart grid products, services, and innovative solutions from Ontario-based sources. (OME, Directive to the OEB, November 23, 2010).

> ENVIRONMENTAL BENEFITS: Promote the integration of clean technologies, conservation, and more efficient use of existing technologies. (OME, Directive to the OEB, November 23, 2010).

With regards to evidence pertaining to planning processes, latent analysis also drew attention to the planning-related SG deployment objectives mandated by the OME. Specifically, the policy-mandates objectives of coordination and interoperability refer to the processes of planning for SG deployment (see Table 9, open codes: "SG Objective Coordination," "SG-Objective Interoperability"). The following excerpts highlight what is meant by coordination and interoperability in the context of SG planning.

> CO-ORDINATION: The smart grid implementation efforts should be coordinated by, among other means, establishing regionally coordinated Smart Grid Plans ("Regional Smart Grid Plans"), including coordinating smart grid activities amongst appropriate groupings of distributors, requiring distributors to share information and results of pilot projects, and engaging in common procurements to achieve economies of scale and scope. (OME Directive to the OEB, November 23, 2010).

> INTEROPERABILITY: Adopt recognized industry standards that support the exchange of meaningful and actionable information between and among smart grid systems and enable common protocols for operation. Where no standards exist, support the development of new recognized standards through coordinated means. (OME Directive to the OEB, November 23, 2010).

Essentially these two excerpts draw attention to the fact that electricity stakeholders are required to make SG plans on a regional basis to ensure that SG is implemented in a relatively consistent and efficient manner across the province. Furthermore, the concept of interoperability is required to ensure that the deployment of SG in Ontario is consistent with practices and standards across North America. Notably, the concept of climate change was not explicitly referenced in any of the SG excerpts pertaining to consideration of long-term planning, long-term impacts of SG deployment or SG planning processes.

As previously mentioned, climate change was referenced within the *LTEP* in the context of renewable energy development. In addition to the *LTEP,* electricity stakeholders used the term "long-term" in the context of long-term climatic trends (open code: "understand long-term climatic impacts"). As discussed in Sections 5.2.1 and 5.2.5, within climate change excerpts, electricity stakeholders considered the impacts of climate change to the extent that they will affect operations (open codes include: “water availability,” “water temperature,” “alter rainfall frequency and duration,” “energy production impacts,” “changes in cloud cover” and “extreme weather”). In the climate change excerpts it is actions taken by stakeholders to address these climate change impacts and manage risks that provide evidence of long-term thinking and consideration of climate change in planning. Specifically, latent content analysis drew attention to a number of activities taken by electricity stakeholders between 2004 and 2013 to address climate change-related risk to corporate operations, energy supply, and electricity distribution (open codes include: “adapting operations,” “climate change committee,” “supply management,” “production forecasting,” “outage plans” “manage weather related risk,” “enhance system resilience,” and “vulnerability assessment”).

It is worth noting that within the climate change excerpts latent content analysis provided evidence that electricity stakeholders considered the impact that climate change legislation may have on operations (open code: “climate change committee” and “impact of climate change regulation”). For example, the OPA noted that not only are they following the development of climate change regulation, they have also developed a climate change committee to track policy developments pertaining to climate change (see following excerpts).

> As these policies [climate change] evolve, the OPA is examining options and solutions to incorporate mechanisms to deal with changes to climate change regulation and their impacts on the OPA’s procurement processes and contracts. (OPA, 2010 Annual Report, p. 15).

> To oversee the management of climate change issues, the OPA has established a climate change committee composed of representatives from each functional business unit. The committee tracks emerging issues and provides strategic input to the OPA’s senior executive team on climate-related topics. (OPA, 2009 Annual Report, p. 35).

With regards to the risk of supply shortages, the following excerpt highlights risk management activities utilized by the OPG to mitigate risk associated with climate change.

> The extent to which OPG can operate its hydroelectric generation facilities depends upon the availability of water. Significant variances in weather, including impacts of climate change, could affect water flows. OPG manages this risk by using production forecasting models that incorporate unit efficiency characteristics, water availability conditions, and outage plans. (OPG, 2013 Annual Report, p. 56).

In addition, as discussed in Section 5.21 and 5.25, latent content analysis also provided evidence that some LDCs recognized weather related risk and implemented plans to strengthen infrastructure to address this risk (for example the aforementioned THESL vulnerability assessment initiative). The following excerpt from the THESL environmental performance report provides the overall objectives of this initiative.

> The goals of this program are threefold: (1) to manage weather related risks to the THESL system and operations; (2) to enhance system resilience to adapt to climate change and withstand extreme weather events; and (3) improve restoration practices when extreme weather events affect the system. (THESL, Environmental Performance Report, 2013, p. 9).

As shown in the above excerpt the THESL not only made reference to adapting infrastructure to climate change to make it more resilient but also to improving their restoration practices following system damage resulting from extreme weather. Notably, despite the fact that SG technology is relevant for this initiative, it was not referenced in this discussion.

Overall, although evidence of long-term thinking and planning was identified in both the SG and climate change excerpts, there was no evidence of explicit overlap between the two discourses and no evidence that SG and climate change were considered concurrently.

Section 5.3: Additional Latent Content Analysis Findings

Section 5.3.1: Drivers and Enablers

Through latent content analysis it was clear that while there were a number of factors driving SG deployment and climate change response in Ontario's electricity sector, both initiatives were largely enabled by policy. Specifically, in SG discourse it was acknowledged that stakeholder participation in SG deployment (especially the smart meter rollout) was due to the *GEGEA* mandate (open codes included: "GEGEA," "GEGEA-enabled grid upgrades" and "smart meters"). Additionally, electricity stakeholders noted that their participation in CDM programing was largely due to the *GEGEA* and the resulting regulatory framework. This theme is illustrated through the following open codes and excerpt: "GEGEA-enable CDM," "OEB statutory objective."

> The Green Energy Act requires all distributors to file plans with the OEB on facilitating renewable energy generation and implementing a smart grid. It also amended the mandate of the OEB, expanding its objectives to include the promotion of CDM, facilitating the implementation of a smart grid and promoting the use and generation of electricity from renewable energy sources. (Hydro Ottawa, Annual Report, 2012, p. 26).

Furthermore, while several large and mid-sized LDCs such as PowerStream Inc., Enwin Utilities and Burlington Hydro discussed innovative SG projects such as self-healing grids and integrated GIS-AMI and OMS systems, most LDCs presented SG content in a manner that suggests that they engaged in SG deployment and CDM activities because they were legally obligated to do so through policy mandates and a corresponding regulatory framework rather than because they were motivated to invest in new technology. The following excerpts demonstrate this:

> In the coming years, all local utilities will be expected to contribute to Ontario's ambitions for a "green" economy, not only with effective energy conservation and demand management strategies, but also with "smart grid" infrastructure improvements. Government and public expectations are very high. (Horizon Utilities Annual Report, 2008, p. 5).

> The Green Energy Act requires all distributors to file plans with the OEB on facilitating renewable energy generation and implementing a smart grid. It also amended the mandate of the OEB, expanding its objectives to include the promotion of CDM, facilitating the implementation of a smart grid and promoting the use and generation of electricity from renewable energy sources. (Hydro Ottawa, Annual Report, 2012, p. 26).

Additional SG deployment drivers identified within the SG discourse include stakeholders noting the necessity to upgrade aging infrastructure, changing energy demands and electricity as well as accommodating technological innovation (open codes: "aging infrastructure," "grid redevelopment" and "consumer and generator demands"). These themes are demonstrated in the following excerpts:

> A significant portion of our system is now more than 40 years old and needs to be replaced. Capital expenditures will need to increase not only for infrastructure replacement but also to transition to a smart grid that will allow for the connection of as many renewable energy generators as possible and for the development of a more robust and secure electricity delivery system. (PUC Inc., Annual Report, 2009, p. 5).

> The foundation of a Smart Grid comes from two primary building blocks. 1. The installation of Smart Meters and the related systems. 2. A reliable Transmission and Distribution infrastructure which can accommodate the needs of both consumers and generators. (Collingwood Utility Services, Business Plan (2011-2013), p. 18).

Similar to SG discourse, a key theme within the climate change excerpts was the enabling role of policy in facilitating climate change response. Specifically, electricity stakeholders acknowledged the importance of government regulations, targets and programs for enabling climate change response (open codes include: "federal climate change plan," "GHG regulations," "provincial GHG targets," "provincial climate change plan"). While stakeholders were relatively vague in identifying which GHG emission targets they responded to, the *GEGEA* and the *LTEP* were each referenced in the context of climate change response (open codes: "LTEP," "GEGEA-enable renewables"). The following excerpt demonstrates the enabling influence of the *GEGEA* in actions to respond to climate change:

> Through the GEGEA, the Ontario Government is expecting to deliver on the Province's Climate Change Strategy to create a world-leading clean-tech industry that will help facilitate the achievement of aggressive targets. (PowerStream Annual Report, 2009, p. 21).

Notably, in the *GEGEA,* the term "climate change" is referenced once and that reference is in the context of ensuring that stakeholders report on GHG or climate change progress. The remainder of content within the policy itself serves to enable climate change response without specifically articulating the relationship between these initiatives and climate change. This is indicative of inadvertent climate change response.

In addition to federal and provincial regulations and targets, latent content analysis revealed that electricity stakeholders also engaged in climate change activities in response to municipal targets. Specifically, the THESL noted that they adapted operations in response to municipal GHG reduction targets imposed by the City of Toronto (open code: “Toronto’s Climate Change Action Plan”). Finally, stakeholders also discussed their implementation of climate change initiatives in response to the possibility that Ontario introduces a cap-and trade regime and carbon pricing system (open codes: “federal carbon policy,” “provincial carbon policy” and “regional carbon policy”). The following excerpt demonstrates this:

> A key initiative taking place during the planning period is policy development with respect to carbon mitigation. At this time, carbon policies are being developed by federal, provincial and regional governments in Canada and the United States. The OPA will monitor developments and assess their impacts on the OPA’s mandates and the sector as a whole. Options for the treatment of environmental attributes will be explored as government policies on climate change and carbon mitigation evolve. (OPA, Business Plan (2011-2013), p. 23).

Additional drivers identified for climate change response included climate change risk management for both the impacts of climate change on operations and the impacts of climate change legislation on operations as well as the desire to maintain strong customer service and corporate reputation (open codes: “climate change plan OPG risk to operations,” “goal: clean energy company,” “climate change committee,” “smart commute”). These themes are reflected in the following excerpts:

> To achieve further improvements in OPG’s GHG emissions, OPG launched its Greenhouse Gas Management Plan in 2007. The plan focuses on: improving the energy efficiency of OPG’s facilities, the use of biofuels as a partial replacement for coal, researching the impact of climate change on OPG’s operations, expanding the tree planting effort through OPG’s extensive biodiversity program, and an education program for employees. (OPG, Annual Report, 2008, p. 24).

> The company is a proud member of Smart Commute Durham, whose goal is to reduce traffic congestion and to take action on climate change through transportation efficiency. (Veridian, Annual Report, 2009, p. 44).

> The OPA formed a climate change committee in 2009 to monitor greenhouse gas activities in Ontario and surrounding jurisdictions to determine their impacts on the OPA and the province’s electricity sector. Discussions have been held with the Ministry of Energy and Infrastructure, as well as with the Ministry of the Environment, which is taking the lead in developing legislation for a potential cap-and-trade regime and in representing Ontario in various initiatives on greenhouse gases. (OPA, 2009 Annual Report, p. 23).

It is worth noting that within content pertaining to drivers and enablers for SG deployment and climate change response there were no explicit references to climate change in the SG discourse, nor were there any explicit references to SG in climate change discourse. Despite the fact that there is no explicit reference to the relationship between SG technology and climate change response, the latent content analysis findings draw attention to thematic overlap between SG deployment and climate change initiatives in the *GEGEA*. This overlap may be indicative of climate change integration within policy.

Section 5.3.2: Explicit Climate Change Response

Latent content analysis within the climate change excerpts also drew attention to an emphasis on CCM over CCA (see Figures 14 and 15). While Figure 14 demonstrates the proportion of climate change excerpts that made reference to mitigation, adaptation as well as both CCM and CCA (n=120), Figure 15 is a Venn diagram showing open codes identified within the climate change excerpts (found in Table 9) that specifically pertain to CCM, CCA or both. These classifications are based on the conceptualizations of CCM and CCA outlined in Chapter 2.

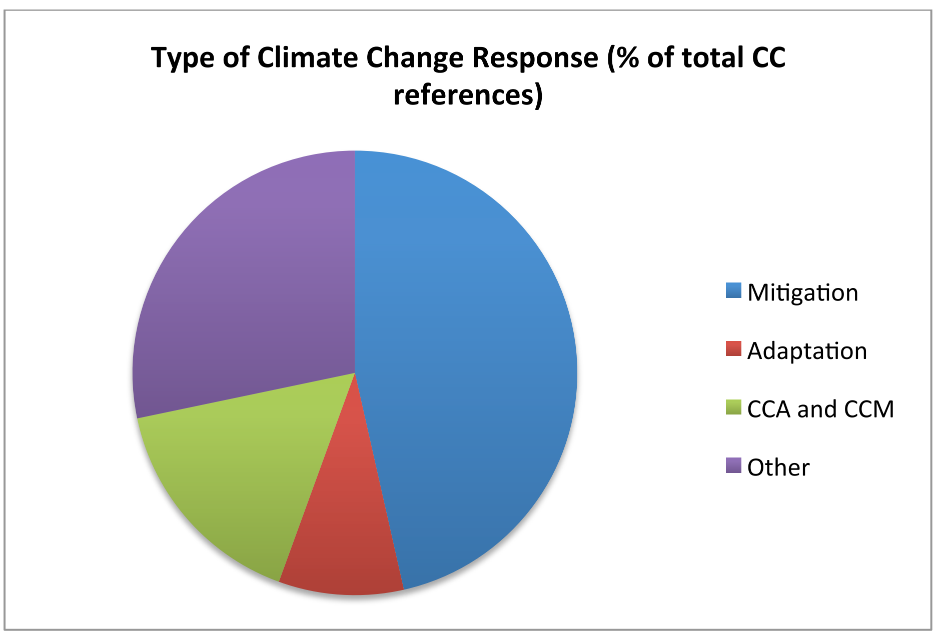


Figure 14: Type of Climate Change Response (% of total 120 climate change references)

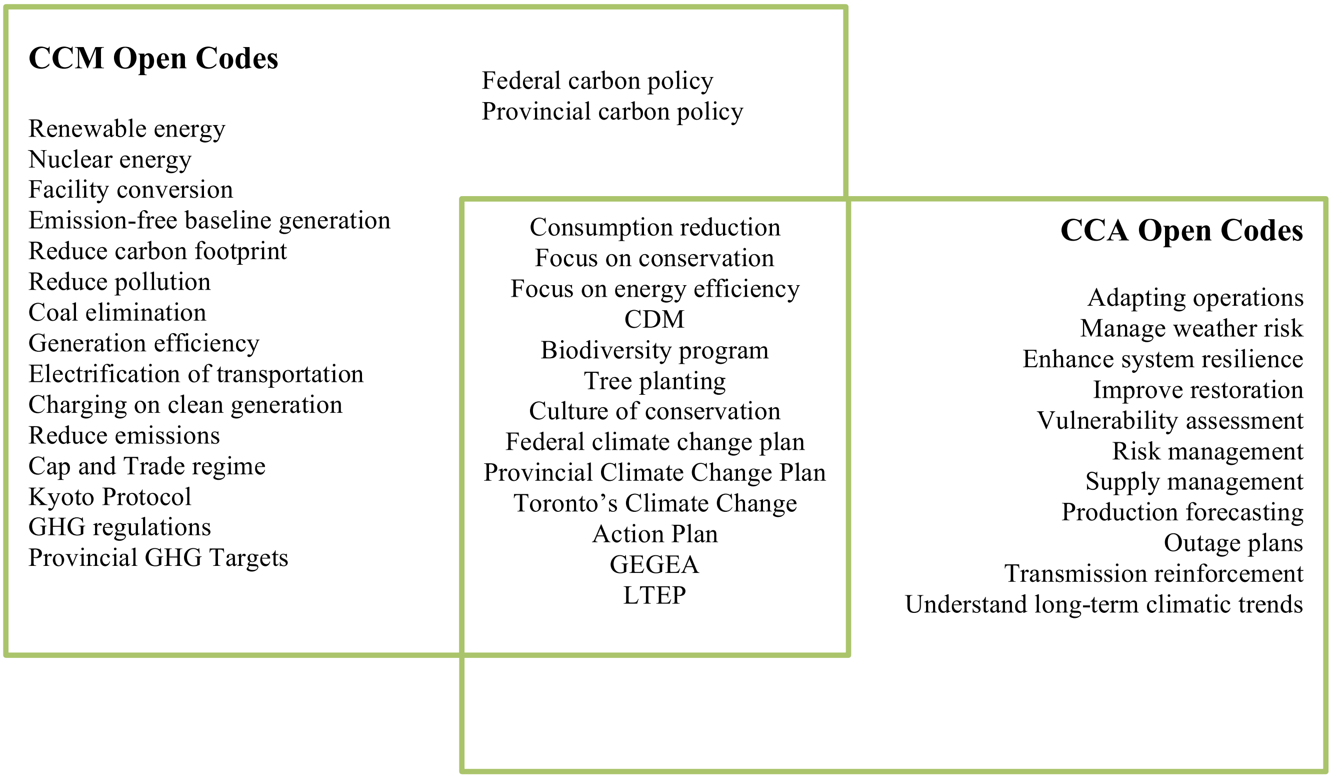


Figure 15: Venn Diagram with CCM and CCA Open Codes

As shown in Figures 14 and 15, in comparison to CCA, measures to facilitate CCM appear to be more prevalently referenced by electricity stakeholders within the climate change excerpts. Although there were initiatives relevant to both CCM and CCA (such as conservation and efficiency, and EV deployment) that were underway in the electricity sector between 2004 and 2013, it is also evident that explicit mitigation efforts were more prevalently referenced in comparison to explicit adaptation activities within the climate change excerpts (see Figures 14 and 15). It is worth noting that many of the open codes shown in Figure 14 that pertain to policy, regulation or a formal climate change program either focus on solely mitigation, or both adaptation and mitigation. There was no evidence of any explicit higher-level efforts to specifically facilitate CCA within Ontario's electricity sector. Moreover, latent content analysis findings within the SG excerpts also indicated that electricity stakeholders took measures to implement technologies that facilitate CCA between 2004 and 2013 (such as self-healing grid technology, FDIR, OMS and integrated operating models). However, not only did CCIEF findings indicate that these initiatives were “minimally integrated” and not heavily prioritized by electricity stakeholders (see Section 5.1) but also, latent content analysis findings suggest there was no explicit discussion on the climate change benefits associated with these technologies (see Section 5.25).

Overall, these findings suggest that climate change response efforts within Ontario’s electricity sector were not comprehensive in terms of both encouraging CCM and CCA.

Section 5.4: Triangulating Key Findings to Address Research Questions

As previously discussed, the use of both manifest and latent content analysis techniques was intended to further contextualize CCIEF scores. The following table (Table 10) provides a summary of the manifest and latent content analysis findings for each CCIEF indicator. The indicators shown in Table 10 are ordered from highest to lowest CCIEF rank.

Table 10: Summary Manifest and Latent Content Analysis Findings

CCIEF Indicator	CCIEF Rank	Latent Content Analysis Finding
Conservation and efficiency	Very integrated	Evidence of thematic overlap between SG and climate change excerpts discussing conservation and efficiency initiatives.
Consumer education	Integrated	Evidence of thematic overlap between SG and climate change excerpts, however also evidence of a gap in educational content discussing the relationship between SG and climate change.
Long-term planning	Integrated	No evidence of overlap identified in the SG and climate change excerpts.
Societal electrification	Minimally integrated	Evidence of thematic overlap between SG and climate change excerpts with content addressing societal electrification.
Low-carbon electricity sources	Minimally integrated	Evidence of thematic overlap between SG and climate change excerpts pertaining to low-carbon electricity sources.
Flexibility and redundancy	Minimally integrated	No evidence of overlap between SG and climate change excerpts.

Climate change impact assessments	Minimally integrated	No evidence of overlap between SG and climate change excerpts regarding climate change impacts, assessments and project evaluations.
Micro-grid and community energy projects	Minimally integrated	No evidence of overlap between SG and climate change excerpts.
Drivers and Enablers	Not Applicable	Both SG and climate change explicitly considered in the GEGEA. While not discussed in the same context there is evidence of inadvertent climate change integration in the GEGEA.
CCM and CCA	Not Applicable	Evidence that there is an emphasis on CCM over CCA within Ontario's electricity sector.

As shown in Table 10, the manifest and latent content analysis provided evidence of varying levels of climate change integration within Ontario's SG deployment regime. Recall from Chapters 1 and 4 that the research questions seek to identify evidence and potential gaps of climate change integration within Ontario's SG deployment regime. The first question that this research seeks to address is outlined below:

Research Question #1: *Given the conceptualization of climate change integration in SG deployment articulated by Stephens et al. (2013) and content found in publically available documents published by electricity stakeholders, what evidence indicates that climate change considerations have been integrated into the SG deployment regime in Ontario?*

Overall, the CCIEF and latent content analysis provided evidence of climate change integration for indicators pertaining to conservation and efficiency, low-carbon electricity, societal electrification and consumer education. Specifically, as shown in Table 10, each of these indicators showed evidence of integration in both the CCIEF findings (ranging from ranks of "minimally integrated" or "very integrated") and the latent content analysis findings through thematic overlap in SG and climate change excerpts.

With a CCIEF rank of “very integrated” and thematic overlap between SG and climate change content, the indicator assessing conservation and efficiency initiatives provides the strongest evidence of climate change integration in Ontario’s SG deployment regime between 2004 and 2013. With a CCIEF score of 86.2%, not only do CCIEF findings indicate that references to conservation and efficiency initiatives were widespread throughout document content, but these findings also suggest that conservation and efficiency was a priority for SG stakeholders between 2004 and 2013. Moreover, the latent content analysis findings provide evidence that during the implementation of conservation and efficiency initiatives involving SG technology, electricity stakeholders inadvertently considered the contribution that these initiatives could make to climate change response without explicitly discussing the relationship between the two.

Indicators pertaining to low-carbon energy and societal electrification also provide evidence of climate change integration in Ontario’s SG deployment regime. Although the CCIEF ranks for these indicators were lower than the rank for conservation and efficiency, similar to latent content analysis findings for conservation and efficiency, latent content analysis findings provided no evidence of explicit overlap but did highlight evidence of thematic overlap. Collectively, the CCIEF scores and the latent content analysis findings suggest that although initiatives pertaining to low-carbon energy and societal electrification were less widespread and prioritized by SG stakeholders in comparison to conservation and efficiency initiatives (CCIEF scores of 42.59% and 44.1% respectively), findings demonstrate that SG stakeholders implementing SG-enabled low-carbon energy projects inadvertently rather than explicitly recognized the associated climate change contributions of these initiatives.

In addition to initiatives involving conservation and efficiency and low-carbon energy, the indicator evaluating consumer education initiatives also provided evidence of climate change integration in Ontario’s SG deployment regime. Specifically, with a rank of “integrated” and a score of 67.01%, CCIEF findings indicated that references to consumer education, public awareness and SG benefits were reasonably prevalent in document content. Moreover, latent content analysis findings suggested thematic overlap in education within SG and climate change discourse. Given that there was no evidence of explicit overlap in discourse, content analysis findings suggest that for consumer education initiatives, climate change and SG are inadvertently integrated. However, despite the fact that both CCIEF and latent content analysis findings yielded evidence of climate change integration in the context of consumer education, it is worth noting that latent content analysis also drew attention to the fact that some stakeholders perceive a gap in climate change integration. This will be considered further when I discuss the second research question (below).

Finally, in addition to indicators evaluating conservation and efficiency, low-carbon electricity, and societal electrification, it is also worth noting that discourse pertaining to drivers and enablers of SG deployment and climate change response demonstrated evidence of thematic overlap. Despite the fact that this indicator was not evaluated using the CCIEF, latent content analysis drew attention to the enabling role of the *GEGEA* in both SG deployment and climate change responses. This thematic overlap is a possible indication of inadvertent climate change integration within SG policy.

With regards to the gaps in climate change integration, the second research question that research seeks to address is outlined below:

Research Question #2: *In which components of SG deployment in Ontario could there be a more targeted effort to integrate climate change considerations into smart grid deployment and ensure that SG technology facilitates a comprehensive response to climate change?*

CCIEF and latent content analysis findings indicated a gap in climate change integration for indicators relating to climate change impact assessments, micro-grids and community energy initiatives, flexibility and redundancy and long-term planning. While each of the aforementioned indicators ranked either “integrated” or “minimally integrated” using the CCIEF, latent content analysis provided no evidence of explicit or thematic overlap in the SG and climate change discourse pertaining to these indicators.

The indicators assessing micro-grids and community energy initiatives as well as flexibility and redundancy provided the least evidence of climate change integration. Each indicator ranked as "minimally integrated" using the CCIEF (scores of 7.28% and 32.38% respectively) demonstrating minimal prevalence in document content. In addition, neither indicator exhibited evidence of explicit or thematic overlap in SG and climate change excerpts through latent content analysis. However, despite the lack of evidence suggesting climate change integration for initiatives pertaining to micro-grids and community energy initiatives as well as efforts to enhance grid flexibility and redundancy, it must be recognized that these technical interventions have the capacity to contribute to CCM and CCA objectives regardless of whether or not they were deployed to do so.

Indicators used to evaluate climate change impact assessments and long-term planning also provided little evidence of climate change integration. Although the long-term planning indicator ranked as "integrated" using the CCIEF (with a score of 60.07%), latent content analysis provided no evidence of explicit or thematic overlap in SG and climate change excerpts. This finding indicates that despite the fact that electricity stakeholders engaged in long-term planning and demonstrated long-term thinking, SG and climate change were not considered concurrently in any long-term deliberations or planning endeavors between 2004 and 2013. Moreover, with a CCIEF rank of "minimally integrated" and a score of 14.72%, the climate change integration indicator was one of the least referenced indicators evaluated for this research. In addition, latent content analysis findings provided no evidence of explicit or thematic overlap in SG and climate change excerpts. This minimal evidence of climate change integration for indicators pertaining to long-term planning and climate change integration is indicative of a gap in climate change integration.

In addition to gaps in climate change impact assessments and project evaluation as well as long-term planning, stakeholders also identified a possible integration gap within consumer education efforts. Specifically, despite the fact that there was evidence of climate change integration within consumer education initiatives (CCIEF score of "integrated" and thematic overlap in latent content), latent content analysis also drew attention to the fact that there are stakeholders that hold the opinion that they could more explicitly discuss the relationship between SG and climate change in consumer education programs. As a result, not only is there evidence of climate change integration in consumer education initiatives between 2004 and 2013, there is also evidence of a possible gap.

Perhaps most importantly, latent content analysis findings provided no evidence of explicit overlap in SG and climate change content. As discussed in Section 5.2, explicit overlap refers to references to climate change found within SG excerpts and references to SG found within climate change excerpts. The lack of explicit overlap identified through latent content analysis is an indication that while there is evidence of inadvertent climate change integration, there was no explicit consideration of climate change in Ontario's SG deployment regime between 2004 and 2013. It is also worth noting that latent content analysis findings indicated a stronger prevalence of CCM efforts in comparison to CCA within the climate change discourse.

Not only is this emphasis on CCM an indication that climate change response is not comprehensive but also, in combination with the lack of explicit climate change integration within Ontario's SG deployment regime, this emphasis on CCM demonstrates a gap in climate change response that could result in system vulnerability. It is possible that strengthening climate change integration to explicitly consider climate change in SG deployment would facilitate a more comprehensive climate change response in the Ontario electricity sector through both mitigation and adaptation. This will be discussed further in Chapter 6.

Section 5.5: Chapter Summary

Chapter 5 presented the findings of the CCIEF and latent content analysis as well as triangulated findings to address the research questions. Overall, research findings indicated varying levels of climate change integration. Specifically, research findings provided evidence of inadvertent climate change integration in SG initiatives involving conservation and efficiency, low-carbon energy, societal electrification and consumer education. In addition, research findings suggest that indicators related to micro-grids and community energy initiatives as well as efforts to enhance grid flexibility and redundancy displayed little evidence of climate change integration. However, initiatives of this nature were both discussed and implemented between 2004 and 2013. Although they were not deployed for the purpose of achieving climate change objectives, these technical interventions have the capacity to yield positive CCM and CCA results.

CCIEF and latent content analysis findings also indicated that initiatives involving climate change impact assessments, project evaluations and long-term planning did not demonstrate characteristics indicative of explicit or inadvertent integration. Such initiatives, as well as consumer education programs are therefore identified as components of climate change integration that potentially offer an opportunity for SG stakeholders to strengthen integration efforts.

Finally, although research findings identified evidence that several SG initiatives had inadvertently demonstrated climate change integration, there is no evidence that electricity stakeholders explicitly considered climate change in SG deployment initiatives between 2004 and 2013. Moreover, latent content analysis findings indicated that CCM was more heavily emphasized than CCA in policy, regulation and stakeholder initiatives related to climate change. Not only do research findings suggest that climate change was not explicitly considered in Ontario's SG deployment regime between 2004 and 2013, but they also indicate that existing climate change initiatives are not comprehensive, demonstrating an additional opportunity for electricity stakeholders to strengthen climate change integration.

These findings will be further explored in the context of broader literature in Chapter 6.

Chapter 6: Discussion

Chapter 5 highlighted the results from the manifest and latent content analysis as well as triangulated the findings to address the research questions. This chapter is divided into two major sections. In Section 6.1 I discuss my findings in the context of broader literature and in Section 6.2 I discuss the broader implications of my findings.

Section 6.1: Interpreting Findings

As discussed in Chapter 5, the CCIEF and latent content analysis findings indicated that between 2004 and 2013, components of SG deployment demonstrated varying degrees of evidence that climate change considerations were integrated into Ontario's SG deployment regime. As outlined by Stephens et al. (2013), climate change integration is reflected by not only planning and implementing SG initiatives in a manner that will facilitate CCM and CCA, but also by deploying SG in a manner that mitigates the potential for electricity infrastructure to be maladaptive or increase GHG emissions. CCIEF and latent content analysis findings yielded minimal evidence of explicit integration, or practices that would suggest that climate change was explicitly considered in SG deployment initiatives between 2004 and 2013. However, findings did indicate varying levels of inadvertent climate change integration and climate change response.

Section 6.1.1: Inadvertent Integration and Climate Change Response

As mentioned above, research findings indicated that although climate change was not explicitly integrated in SG deployment between 2004 and 2013, there was evidence of inadvertent climate change integration and inadvertent climate change response. As discussed in Chapter 5, latent content analysis findings indicated that initiatives such as conservation and efficiency, low-carbon energy, societal electrification and consumer education were referenced both in SG and climate change excerpts. Although the relationship between SG and climate change was not explicitly discussed in these contexts, findings indicate that stakeholders recognized this relationship given that conservation and efficiency, low–carbon energy, societal electrification and consumer education were referenced in both SG and climate change discourse.

Moreover, latent content analysis also drew attention to the enabling role of legislation (the *GEGEA* in particular) for both SG deployment itself and the corresponding applications of SG that facilitate climate CCM and CCA. Although the relationship between SG and climate change was not explicitly defined in the *GEGEA*, the legislation facilitated a number of SG-enabled initiatives that respond to climate change. Similarly, although initiatives involving micro-grid and community energy development or efforts to enhance grid flexibility and redundancy demonstrated no evidence of explicit or inadvertent climate change integration, research findings indicated that such initiatives were discussed and deployed between 2004 and 2013, resulting in an inadvertent climate change response.

It is possible that the varied evidence of inadvertent climate change integration and climate change response within Ontario's SG deployment regime between 2004 and 2013 was the result of a policy framework that does not explicitly define the relationship between SG deployment and climate change response. As mentioned above, the *GEGEA* enables both SG deployment and the SG-enabled climate change responses without acknowledging this connection. It is possible that because there was no explicit reference to the connection between SG technology and climate change within the *GEGEA,* there was only evidence of inadvertent integration and inadvertent references to the relationship in the resulting programs and projects. This was certainly a key finding in Bayham and Stevens' 2014 study of land use planning policy in British Columbia. Specifically, Baynham and Stevens (2014) found that there are many cases where Official Community Plans (OCPs) "establish climate-friendly policy, but do not make explicit connection between climate change and the policy area" (p. 580).

In addition to the lack of explicit connection between climate change and other policy areas, the idea that climate change responses can be inadvertent is also well documented in the literature. In particular, McGray, Hammill and Bradley (2007) argue that response to climate change can be "serendipitous," or "incidentally" facilitate outcomes that support CCM or CCA despite the fact that the action was intended to achieve other objectives (p. 2). Furthermore, Hughes (2015) articulates the view that CCA can be "unplanned" or even reactive (p. 2).

With regards to the specific SG initiatives that facilitate CCM and CCA (see Chapters 2 and 5), my findings indicated that many of these initiatives were inadvertently integrated at varying levels into SG deployment (conservation and efficiency, low-carbon electricity and societal electrification). In addition, it was found that electricity stakeholders also discussed and implemented projects involving the use of SG technology to facilitate micro-grid and community energy development or to enhance grid flexibility and redundancy. Although these projects demonstrated no evidence of integration, they do result in positive CCM and CCA results. Based on discussions pertaining to the relationship of climate change response and SG technology in literature (see Stephens et al., 2013; Bedsworth and Hanak, 2010), it is apparent that the aforementioned inadvertent initiatives are primarily "technical" interventions involving the deployment of specific technologies as opposed to interventions related to regulation or long-term planning.

It is interesting to note that Tompkins and Adger (2005) articulate the view that there are "alternative" approaches to climate change integration that involve "efforts to encourage social change, adopt technology and embrace the future changes associated with climate change" (p. 569). This interpretation of climate change integration is broader, but comparable to the conceptualization articulated in Stephens et al. (2013) and in the CCIEF, as they identify similar characteristics of climate change integration (such as policy, regulation, and the involvement of the public). My research findings indicated that electricity stakeholders in Ontario made an effort to adopt technologies that facilitate climate change response between 2004 and 2013 but did not implement explicit components of climate change integration pertaining to climate change impact assessment and project evaluation, long-term planning and consumer education (to an extent; see Section 5.2.7).

In contrast to "technical" interventions, the regulatory and planning components of climate change integration described by both Tompkins and Adger (2005) and Stephens et al. (2013) require explicit consideration of climate change. This is also the case for the finding that indicates consumer education initiatives could be adapted to more explicitly discuss the relationship between SG technology and climate change response. Given that my findings indicated a gap in climate change integration on matters concerning climate change impact assessments and evaluations, long-term planning, and consumer education, as well as identified no evidence of explicit climate change integration, it is conceivable that SG stakeholders in Ontario favored technical interventions over explicit regulatory and social interventions. A possible explanation for this is that technical interventions not only inadvertently respond to climate change, but also achieve other objectives for the sector including ensuring energy security and enhancing service reliability for consumers. Arguably, the deployment of multi-purpose technological interventions was a more cost effective option for climate change response in comparison to investing to explicitly integrate climate change considerations into regulation and long-term planning. This idea will be explored further in Section 6.2.

Section 6.1.2: Lack of Explicit Integration and Associated Gaps

As previously discussed, in contrast to the "technical" SG initiatives that inadvertently respond to climate change, my research findings identified little evidence that electricity stakeholders explicitly considered climate change prior to SG investments. Specifically, findings indicated no evidence of climate change impact assessments, consideration of climate change in SG project evaluations or concurrent consideration of SG and climate change in long-term planning. Finally, my research findings suggested that there could be a more targeted effort for electricity stakeholders to explicitly discuss the relationship between electricity consumption, SG technology, and climate change.

Although to my knowledge, there is no study primarily focused on assessing climate change integration in a SG deployment regime, my research findings were consistent with findings from other studies evaluating climate change integration. For instance, as discussed above, Baynham and Stevens (2014) argue that in BC's land use planning policy arena, efforts to integrate climate change into OCPs were often not explicit and incomplete in scope. Similarly, Urwin and Jordan (2008) also asserted that in several European states, CCA was not explicitly considered in existing sector-level policies despite higher-level policy mandates for climate change policy integration. Finally, Tompkins et al. (2010) suggest that in the UK, CCAs were primarily driven by legislation, however they noted that it was not climate change specific legislation. Essentially this meant that similar to Ontario's SG deployment regime, in the UK climate change interventions were inadvertent and primarily technical in nature.

The lack of explicit climate change integration highlights the existence of barriers and challenges associated with this style of integration not just within Ontario's SG deployment regime but also in policy areas where there are clear mandates for climate change integration. Interestingly, Biesbroek et al. (2010) further articulate this view in their evaluation of National Adaptation Strategies in Europe. Specifically, they contend that based on their evaluation of policy integration in Europe, "policy integration may be a greater challenge than finding technical solutions [to adapt to climate change]" (p. 448).

Section 6.2: Implications

As previously discussed, my research findings suggest that on a technical level, SG initiatives between 2004 and 2013 demonstrated varying levels of inadvertent climate change integration and inadvertent climate change response while SG initiatives involving regulation and planning showed little evidence of integration or climate change response. Finally, my findings also suggested that electricity stakeholders could more clearly articulate the relationship between SG technology, electricity consumption, and climate change within consumer education and public awareness campaigns. In my opinion, these "gaps" in explicit integration pose an opportunity for stakeholders to strengthen climate change integration and respond to climate change, at the same time, these gaps create the potential for future vulnerabilities related to climate change.

It is my position that explicitly integrating climate change considerations into Ontario's SG deployment regime and electricity sector more broadly would be an effective strategy to address climate change-related uncertainty and vulnerability as well as to ensure that climate change response is efficient, effective and comprehensive in the long-term. In my view, although activities necessary to explicitly integrate climate change into Ontario's SG deployment regime would involve investment with no immediate return, it is advantageous to be proactive, rather than reactive when considering climate change (see Hughes, 2015; Richardson, 2009).

Section 6.2.1: Opportunities

Climate Change Impact Assessments, Project Evaluation and Long-Term Planning

The failure to explicitly integrate climate change considerations into impact assessments, project evaluation and long-term planning has the potential to create infrastructure vulnerability. With regards to the physical impacts of climate change, recall from Chapters 1 and 2 when I discussed the relationship between climate change and the electricity sector. I outlined not only the role of the electricity sector in reducing GHG emissions to mitigate climate change, but I also highlighted the ability for electricity stakeholders to enhance infrastructure resilience as a means to adapt to climate change.

While my findings indicated that there was minimal consideration of climate change in the SG discourse, latent content analysis revealed that a small number of electricity stakeholders considered the impacts that climate change had on generation and energy supply, and an even smaller number of stakeholders explicitly discussed the impact that extreme weather may have on infrastructural assets (see Sections 5.2.1, 5.2.5, and 5.2.8). THESL was the only electricity stakeholder in Ontario to explicitly discuss activities to enhance the resilience of electricity infrastructure and address vulnerabilities related to climate change.

Nierop (2014) clearly articulates the view that electricity stakeholders must conduct climate change impact assessments, while Stephens et al. (2013) highlight the necessity for electricity stakeholders to include climate change response criteria in SG project evaluations. While a climate change impact assessment refers to "an assessment that investigates the possible impacts of future climate change on electricity infrastructure" (Nierop, 2014, p. 81; see also Gerrard, 2013, Nepal and Jamash, 2013; Schaeffer et al., 2012), climate change evaluation criteria essentially require electricity stakeholders to prove how a SG project facilitates CCA and CCM, as well as consider any risks of increased GHG emissions and any potential characteristics that are maladaptive (Stephens et al., 2013). Climate change impact assessments and evaluation criteria, despite adding extra expense associated with conducting the studies, is advantageous for electricity stakeholders as it allows them to assess vulnerabilities and opportunities and essentially mitigate any operational risk to infrastructure prior to implementation.

In addition, Nierop (2014) notes that considering climate change impacts in long-term planning is necessary for electricity stakeholders to minimize supply and infrastructure vulnerability. He argues that electricity stakeholders must not only consider the timing of climate change impact, but also the extent (Nierop, 2014). Given that electricity infrastructure has a lifespan of between 15 and 75 years, it is crucial that the infrastructure be designed in a manner that will allow it to cope with both current conditions, and future climate change-related impacts (Nierop, 2014). In order to consider long-term climate change impacts, long-term planning and funding allocation in terms of operational and capital investments ought to be informed by "the best available data suited to the particular geographic area" (Nierop, 2014, p. 81).

The combination of climate change impact assessment, climate change evaluation criteria, and including climate change considerations in long-term planning is an effective way to ensure that electricity stakeholders are aware of potential climate change risks, address challenges and ultimately mitigate operational risk associated with climate change. Additionally, it is an opportunity to require stakeholders to contribute to CCA and CCM efforts both immediately and in the long-term. It is also worth noting that as per the *GEGEA* and the associated regulatory framework, Hydro One and LDCs are already required to upgrade their transmission and distribution systems to accommodate SG technology and applications. Given the long lifespan of electricity infrastructure, it is worthwhile being proactive and making the necessary climate-proofing investments now while upgrades are underway, rather than waiting until the system is more vulnerable or potentially damaged.

Consumer Awareness and Public Education

As discussed in Chapter 5, findings suggested that while there was evidence of climate change integration in activities to educate electricity consumers, there was also evidence that in promotional and educational campaigns, electricity stakeholders did not explicitly discuss the relationship between SG technology and climate change. Specifically, in Chapter 5, I examined the following excerpt from Woodstock Hydro, a mid-sized LDC.

> The marketing of the PeaksaverPLUS program does not highlight the connection to climate change that may motivate greater participation in the program as well as providing public education. (Woodstock Hydro, 2012 CDM Report, p. 39).

Not only does this excerpt provide evidence of a potential opportunity for electricity stakeholders to strengthen explicit climate change integration, it also suggests that Woodstock Hydro holds the opinion that educating the public on climate change may further motivate the public to participate in the program.

In my opinion, the lack of educational and promotional content related to climate change is a shortcoming in Ontario's SG deployment program and may be detrimental to both SG deployment and broader climate change response efforts in the long-term. It is widely recognized in literature that public opinion and public perception of risk play a significant role in supporting or resisting public policy as well as for "support or opposition to various means of risk regulation" (Leiserowitz, 2005; cited in Uggla, 2008, p. 718). In addition to the role of public support for the purposes of public policy development, individual behavior change towards a more "climate-protecting" way of life is extremely valuable for the success of climate change response (Rees and Bamberg, 2014, p. 466). Bernauer (2013) argues that an effective solution to climate change "will ultimately require a comprehensive transformation of the global carbon-based energy system, with obvious implications at individual and firm levels" and therefore "public support for climate policy is essential" (p. 437).

Although there is little consensus in the literature on the effectiveness of educational campaigns on facilitating behavior change (see Chapter 2), past experience has shown that public education campaigns can play an important role in changing behaviors and norms. For example, in their study examining the effectiveness of the Energymark Program in Australia, a conservation program devised to facilitate changes in consumer electricity consumption habits, Dowd et al. (2012) found that participants who felt that "Energymark enhanced their awareness and information" regarding conservation and climate change had reduced more personal emissions than those who did not mention the educational component of the program (p. 272). Given that my findings indicated that electricity stakeholders in Ontario have not explicitly educated consumers on the relationship between SG technology, electricity consumption and climate change, Dowd et al.'s (2012) findings suggest that it may be advantageous for electricity stakeholders in Ontario to do so.

Furthermore, a key theme in the literature pertaining to long-term climate change responses is the necessity to inform and include the public in climate change-related decisions when integrating climate change considerations into long-term plans. It is particularly interesting to note that Tompkins and Adger (2005) argue, "without… social acceptance any climate change response is destined to failure" (p. 569). Arguably, integrating climate change into SG educational campaigns would not only serve to immediately drive participation in CDM programs, but would also facilitate changes in the norms associated with electricity consumption, thereby yielding positive long-term results for CCM and CCA.

Section 6.2.2: Vulnerabilities

Political Environment

As discussed in Chapter 5, my findings indicate that policy played a key role in driving or enabling both SG deployment and climate change response in Ontario. My findings also provided evidence of inadvertent climate change integration in Ontario's SG deployment regime and inadvertent climate change responses enabled through SG technology between 2004 and 2013. However, given the role of the *GEGEA* and the broader political and regulatory environment in facilitating SG deployment and inadvertent climate change response, there is no guarantee that that SG deployment would continue to inadvertently facilitate climate change response should political circumstances change.

As discussed in Chapter 5, while a small number of LDCs discussed a number of innovative SG initiatives and pilot projects, many LDCs presented SG content in a manner that suggested that SG deployment activities were primarily motivated by government mandate. Given these findings, it is very possible that had SG not been entrenched in policy and regulation between 2004 and 2013, many smaller stakeholders would not have participated in the smart meter rollout. In my opinion, this further demonstrates the importance of formally and explicitly integrating climate change considerations into the SG deployment regime and the broader electricity sector in Ontario. In contrast to SG deployment, which is legally mandated, many of the climate change integration strategies outlined by Stephens et al. (2013) are optional. Should measures to explicitly respond to climate change become less profitable or become a financial burden, it is possible that stakeholders would limit activities to address climate change.

Furthermore, my findings confirm that the current Ontario government is committed to creating a culture of conservation, further developing renewable energy, meeting GHG reduction targets and deploying SG. However, in the literature it is acknowledged that the political environment is a key determinant of the longevity of climate change policies (Bernauer, 2013, p. 425). For instance, Bernauer (2013) argues that in a situation where a government adopts measures to reduce GHG emissions, if businesses and households doubt that the government will enforce measures in the event of an economic downturn or a change in government, they are less likely to make any related investments in the first place. Given that government preferences can change over time, such "uncertainty about such changes can hamper efforts to establish an effective long-term policy in the first place" (Bernauer, 2013, p. 425). An example of this is Canada's decision to withdraw from its commitment to the Kyoto Protocol following a change in Federal leadership (CBC News, 2011). Despite the fact that the Liberal government had previously ratified the legally binding treaty, the subsequent Conservative government withdrew, arguably creating less incentive for Canadians to participate in reducing GHG emissions. By explicitly integrating climate change considerations into impact assessments, project evaluations, long-term planning, and public education, provincial policymakers and energy regulators would mitigate the risk that electricity stakeholders in Ontario abandon climate change efforts should the broader political or economic circumstances change.

CCM and CCA "Dichotomy"

As discussed in Chapter 5, content analysis findings indicated that climate change discourse more explicitly emphasized CCM over CCA. Although many SG initiatives "inadvertently" facilitated both CCM and CCA, climate change excerpts were primarily focused on mitigation initiatives (such as reducing GHG emissions and Ontario's carbon footprint). This emphasis on CCM over CCA in Ontario's electricity sector is consistent with the key trends articulated in the literature. For instance, Tompkins and Adger (2005) note in their research it was evident that "the existing constituencies of adaptation and mitigation in most governments are only marginally overlapping (p. 569). Furthermore, in their evaluation of land use planning policy in British Columbia, Baynham and Stephens (2014) found that there was a higher level of inclusion of "mitigation-related indicators relative to adaptation" (p. 575).

Latent content analysis indicated that broader policy mandates or regulations are key drivers or enablers that have encouraged electricity stakeholders to undertake climate change-related initiatives. As discussed in Chapter 5, latent content analysis findings suggested that a larger proportion of policy, regulations and higher-level climate change programs focused on CCM rather than CCA. It is possible that the higher-level emphasis on CCM in comparison to CCA may be an explanation of why efforts to mitigation climate change appeared to be more prevalent in Ontario's electricity sector between 2004 and 2013.

Specifically, with regards to higher-level CCM initiatives, federal regulations addressing GHG emissions are primarily focused on the electricity and transportation sector and include a ban on new "construction of traditional coal-fired electricity units," and a target of 214 megatonnes (Mt) in cumulative emission reduction between the two sectors (Government of Canada, 2015). Furthermore, in 2007 the Ontario Ministry of Environment and Climate Change outlined targets for GHG reductions in Ontario and in the years since has undertaken a number of initiatives to meet these targets including the elimination of coal from Ontario's supply mix and the adoption of a Cap and Trade program to put a hard limit on GHG emissions.

In contrast, CCA action is far less embedded in regulation or policy. For instance, the Federal Government has invested $235 million in "domestic adaptation initiatives" and published a document entitled *Federal Adaptation Policy Framework* that outlines the actions necessary for the federal government to facilitate CCA. OMECC published a climate change adaptation strategy entitled *Climate Ready: Adaptation Strategy and Action Plan 2001-2014.* While both of these documents highlight the importance of CCA and the necessity to mainstream initiatives, neither document is legally binding. Unsurprisingly, when electricity stakeholders implicitly discussed motivation for adaptation-related activities, it was largely in regards to ensuring reliable service for their customers rather than in response to a policy or regulatory mandate.

Ontario electricity stakeholders are legally required to mitigate climate change, but they are not explicitly required to facilitate CCA. Baynham and Stevens (2014) further articulate this view by noting that in BC the inclusion of mitigation over adaptation initiatives in land use planning can be attributed to "Bill 27's mandate to include GHG reduction targets and policies within OCPs [Official Community Plans]" (p. 575). They go on to argue that as of 2014 there was no similar policy mandate related to adaptation and consequently CCA was less frequently referenced explicitly in BC planning documents.

Interestingly, there is some evidence that this "dichotomy" between CCM and CCA policy has its origins at the international level. Specifically, Tomkins and Adger (2005) argue that at local levels, CCM and CCA typically occur in "different policy domains and [engage] different communities" because they are separated at the international level due to "the nature of impacts and the avoidance of apparent liability for past action" (p. 563). This dichotomy is seen in Canada's policy arena as CCM regulations are targeted towards energy and transportation sectors, while CCA funding targets research, particularly in the North. Given my research findings, this dichotomy between CCM and CCA is also evident in Ontario's electricity sector.

The risks of dividing CCM and CCA and not considering them comprehensively are well documented in previous research. Specifically, Tompkins and Adger (2005) argue that developing policies in a "vacuum" could result in "increased costs of managing climate change with little effect on climate risks" (p. 563; see also Kane and Yohe, 2000). Even more problematic, by not considering CCM and CCA in a comprehensive and coordinated manner, it is possible that adaptation and mitigation efforts may conflict and be counterproductive (Laukkonen et al., 2009; Shaw et al., 2007; Rietig, 2013).

As discussed in Chapter 2, the rapid development of EVs and future electrification of transportation is an example of an initiative that has the potential to result in conflicting CCM and CCA outcomes. While EVs serve as a strategy for reducing GHG emissions from the transportation sector, deploying such technology prior to ensuring the grid can cope with this increased demand can result in a maladaptive “rebound effect” (Mwaskilu, 2014; Ghosh and Blackhurst, 2014). In the case of Ontario’s EV development, my findings showed that between 2004 and 2013 electricity stakeholders in Ontario were working to deploy SG technology to mitigate the risk of rebound effect without explicitly discussing climate change. I argue that in the case of EV development, considering the impact that EV charging could have on the grid is in the interest of utility providers as their business objective is to ensure reliable service to customers. While in the case of EV development, the implementation inadvertently addressed potential conflict between CCM and CCA, this outcome is not guaranteed.

The development of nuclear energy is an example of an initiative that inherently places CCM and CCA at odds. The latent content analysis indicated that policy-makers and the OPG viewed the development of nuclear energy as a key strategy for reducing GHG emissions. However, from the perspective of CCA, not only does the “disposal of nuclear waste and the risk of nuclear meltdown” pose a risk to human health and the environment (Rietig, 2013, 298), but nuclear power plants require water for cooling functions and consequently, energy security associated with nuclear generation in some areas could be compromised due to climate change-related water shortages (Nierop, 2014, p. 79). Finally, given that thermo-electric power plants (including nuclear power plants) are often sited near bodies of water “they could become more vulnerable to coastal flooding due to rising sea levels and increasing storm surges” (Nierop, 2014, p. 79).

There are three nuclear generating facilities currently operating in Ontario: Bruce Nuclear Generating Station, Pickering Nuclear Generating Station, and Darlington Nuclear Generating Station (Canadian Nuclear Safety Commission, 2015). As shown in Figure 16, all three of Ontario’s nuclear facilities are located on the Great Lakes. Although the Great Lakes are not necessarily vulnerable to coastal storm surges, future climate projections indicate that the Great Lakes region may be vulnerable to increased precipitation, extreme weather events and subsequent flooding (Kling et al., 2003). Additionally, there is evidence that lake levels may decline in the future making the security of nuclear energy supply more variable. While I am not necessarily advocating that Ontario eliminate nuclear power, in my view impacts of climate change should be explicitly considered in the daily operations and long-term plans for these facilities.

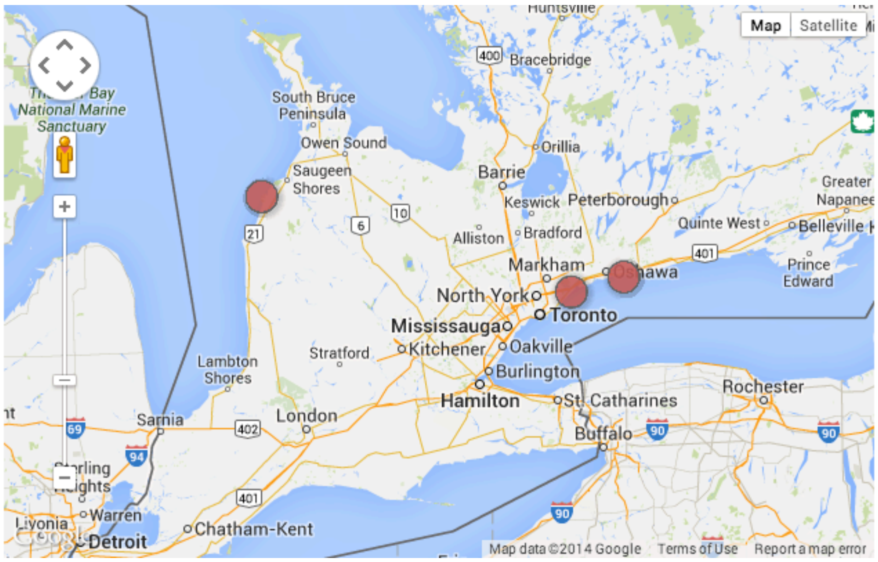


Figure 16: Nuclear Generating Sites in Ontario
Source: Google Maps

My findings indicated that in some circumstances Ontario's electricity stakeholders "inadvertently" ensured that CCM and CCA efforts were not conflicting between 2004 and 2013. However, it is my opinion that this is often coincidental and dependent on stakeholder objectives. There is no guarantee that all initiatives will inadvertently facilitate a comprehensive climate change response. I argue that explicitly integrating climate change considerations into not only Ontario's SG regime but also the electricity sector as a whole would serve as a mechanism to ensure that both CCM and CCA are considered, the synergies are exploited and the conflicts are mitigated. Climate change impact assessments and climate change project evaluations are an effective way to ensure that electricity stakeholders work to implement projects that contribute to climate change response as well as guaranteeing that CCM and CCA initiatives are not counterproductive.

Section 6.3: Moving Forward

Given the gaps in climate change integration identified through my research, I believe that explicit climate change integration should be a priority for stakeholders involved in SG deployment in Ontario as well as the electricity sector more broadly. Not only would this address climate change-related vulnerabilities (such as the risk of extreme weather), it would also ensure that electricity stakeholders consider climate change when planning and implementing future projects. Moreover, by taking action to explicitly integrate climate change, electricity stakeholders have the opportunity to play a key role in increasing public education and awareness. Not only could this facilitate consumer behavior change, but it could also encourage public support for future climate change response. Finally, climate change integration will assist electricity stakeholders in taking measures to ensure that climate change response exploits existing synergies and is comprehensive and complimentary.

My findings drew attention to the enabling role of legislation and regulation in facilitating SG and climate change objectives. Given these findings, I propose that adapting policy and regulations to explicitly recognize the relationship between SG and climate change could be an effective way to facilitate explicit climate change integration in Ontario's SG deployment regime. It is important to recognize that policy and regulation are not the only approaches that could be used to facilitate the overall goal of explicitly integrating climate change considerations into Ontario's SG deployment regime. However, the finding that legislation and regulation were key drivers for both SG deployment and climate change response indicates that using policy and regulation to facilitate climate change integration would be appropriate in this context. Additionally, I contend that investment in research and actions to ensure that climate change-related data (i.e., climate projections) are readily accessible to stakeholders would also address the gaps in climate change integration identified through my research. Additional funding may be required to assist LDCs with integration requirements, such as: public education campaigns, climate change impact assessments and project evaluations. This will be discussed in more detail in the following chapter.

I recognize that explicitly integrating climate change consideration in SG deployment could be controversial in Ontario due to the high cost of investment, the lack of immediate return, and the notable uncertainty surrounding both the impacts of climate change and the effectiveness of climate change response. In my view, the politicization of climate change reflects a broader conflict related to the tragedy of the commons (Hardin, 1968) or the "commons dilemma" (Shultz and Holbrook, 1999, p. 218). The commons dilemma "refers to a phenomenon in which the members of a social group faces choices in which selfish, individualistic, or uncooperative decisions, though seemingly more rational by virtue of short-term benefits to separate players, produce undesirable long-term consequences for the group as a whole" (Shultz and Holbrook, 1999, p. 218). Essentially, the debate pertaining to climate change response (and climate change integration) is an ethical dilemma between individual and collective benefit and those who view climate change as a threat to future generations, and those who view climate change policies as a threat to their current lifestyles (Wagner and Zeckhauser, 2012).

Due to this ethical dilemma, it is widely recognized in literature that in order to facilitate widespread global climate change response, a broad ethical shift is required (Wagner and Zeckhauser, 2012). Not only must climate policy facilitate the "rechanneling" of the market, but also a fundamental change in political thinking (and by extension public thinking) is required to implement a permanent climate change response regime (Wagner and Zeckhauser, 2012, p. 519). In 1968 Hardin argued policy and regulation is necessary to "invoke cooperative choices" (cited in Shultz and Holbrook, 1999, p. 220). Using this logic, the recommendations that I outline in Chapter 7 are primarily geared towards electricity stakeholders involved in policy, regulation, and long-term planning. I acknowledge that integrating climate change considerations into SG deployment in Ontario will not facilitate a global ethical shift towards a collective climate change agenda. However, given that Ontario is seen as a global leader in SG deployment, I maintain that climate change integration in this sector could set precedent for other jurisdictions also pursuing SG technology to do the same, both across Canada and even globally.

Chapter 7: Recommendations and Conclusion

As discussed in the previous section, my findings indicated that while technical components of SG technology and applications “inadvertently” facilitate climate change response, there was no evidence of explicit climate change integration in Ontario’s SG deployment regime. My research findings provided evidence of integration gaps in several components of SG deployment including climate change impact assessments, SG project evaluations, long-term planning and consumer education. Furthermore, my findings drew attention to the role of the *GEGEA* and other regulations in driving and enabling SG deployment and climate change responses in the province. However, from my research it was also found that in SG policy, there was no explicit recognition of the relationship between SG technology and climate change.

In the previous chapter, I argued that the lack of explicit integration and gaps in climate change impact assessments, SG project evaluation, long–term planning and consumer education not only result in missed opportunities for electricity stakeholders to respond to climate change, they also highlight several components of SG deployment and the electricity system that could be vulnerable to the impacts of climate change. Given these gaps and the associated potential opportunities and vulnerabilities, it is my primary recommendation that policymakers and electricity stakeholders take measures to explicitly integrate climate change considerations into Ontario’s SG deployment regime. As mentioned in the previous chapter, the recommendations outlined below reflect one approach to facilitating explicit integration of climate change considerations into Ontario’s SG deployment regime. While there are other approaches that could facilitate the same outcome (i.e., market-driven or targeted funding approaches), the role of policy and regulation in driving and enabling both SG deployment and climate change initiatives identified through this research suggests that a policy and regulatory approach is an appropriate response in this particular context.

In Section 7.1 and 7.2, I outline recommendations for practice and recommendations for research to facilitate explicit climate change integration. Section 7.3 will summarize the research and offer some concluding remarks.

Section 7.1: Recommendations For Practice

Recommendations For Policymakers: To address the aforementioned gaps in climate change integration, I recommend that policymakers in Ontario adapt SG deployment-related legislation and policy frameworks to explicitly recognize the relationship between SG deployment and climate change response. Furthermore, I suggest that legislation and policy frameworks be revised to mandate that stakeholders undergo climate change impact assessments and climate change evaluations for all proposed SG projects. In addition, I recommend that policymakers require electricity stakeholders to promote the relationship between SG and climate change in consumer education programs. Finally, it is my recommendation that policymakers allocate additional funding not only to finance SG and climate change research, but also to assist LDCs in offsetting expenses related to climate change impact assessments and project evaluations.

Recommendations For Regulators: To facilitate explicit climate change integration in Ontario's SG regime and address the aforementioned gaps in climate change integration, I recommend that stakeholders involved in energy and electricity regulation adapt project evaluation criteria and LDC licensing requirements. Specifically, it is my recommendation that regulators revise SG project evaluation criteria to include a component that evaluates a project not only on attributes or characteristics that may increase GHGs or contribute to maladaptation, but also on its potential to facilitate CCM and CCA in a comprehensive manner. Furthermore, it is my recommendation that electricity regulators adapt LDC licensing requirements to include the requirement that LDCs undergo climate change impact assessments for SG projects as well as include climate change-related content in public education initiatives to promote SG.

Recommendations for Transmitters, Distributors, System Operators and Long-Term Planners: It is my recommendation that electricity stakeholders involved in electricity transmission and distribution exploit their positions as being close to consumers and the wider public and strive to educate the public on the relationship between SG technology, electricity consumption and climate change and to encourage behavior change. Additionally, given that SG deployment already requires knowledge sharing and collaboration between electricity stakeholders, it is my recommendation that electricity transmitters and distributors continue to collaborate and knowledge-share information regarding explicit CCM and CCA measures as well as public education programs. Not only will this allow for consistent and comprehensive implementation, it may offset some of the costs relating to research, technical expertise and program planning. Moreover, collaboration and coordination with regards to regional planning is already an objective of SG deployment, and to further build on this collaboration, I recommend that climate change data be shared amongst stakeholders and considered in regional long-term infrastructure plans.

Section 7.2: Recommendations for Research

This research has highlighted several opportunities for future research. First, this research indicated that research pertaining to short-term and long-term climate change projections would be beneficial to the electricity sector in Ontario. I recommend that more research attention be focused towards Ontario-specific climate change projections. I also recommend that such data be made accessible to electricity stakeholders for the purposes of long-term infrastructure planning. My research also opens the door to a number of other interesting research initiatives including:

1. An in-depth examination of internal stakeholder operations to address any SG or climate change activities that were not captured in the content analysis;
2. A cost-benefit analysis comparing a policy framework that integrates climate change and one that does not, and;

3. A follow-up study to monitor the ongoing deployment of evolving SG technology and its role in climate change response given the changing political environment at the Federal level.

Section 7.3: Concluding Remarks

The purpose of this research was to explore Ontario's SG regime within the context of climate change. Specifically, I sought to explore SG deployment between 2004 and 2013 through a climate change lens in order to evaluate evidence of climate change integration within Ontario's SG deployment regime. The overall objective was to highlight components of SG deployment that demonstrate climate change integration as well as to identify components of SG deployment where integration could be strengthened.

Through a manifest and latent content analysis of 576 documents published by electricity stakeholders in Ontario between 2004 and 2013, it was found that through the deployment of SG technology, electricity stakeholders inadvertently, rather than explicitly responded to climate change. This was seen through the implementation of SG technology and applications including renewable energy development, CDM measures, micro-grids, distributed generation, outage management systems, system automation and monitoring and self-healing technology. While these technologies were emphasized in the documents at varying degrees, they were never referenced in SG and climate change discourse concurrently, indicating that CCM or CCA-related outcomes associated with such technologies were inadvertent in nature. The content analysis findings also indicated that climate change was not explicitly considered in SG deployment and that climate change impact assessments, project evaluations, long-term planning and consumer education were components of the SG deployment program that could be strengthened to explicitly consider climate change.

Given these "gaps" in integration identified through my research, it is my opinion that explicit climate change integration ought to be a priority for stakeholders involved in SG deployment in Ontario.

Not only would this address vulnerabilities resulting from climate change risks (such as infrastructure damage associated with extreme weather events), it would provide electricity stakeholders with an opportunity to increase public awareness and education on SG technology and climate change. This would facilitate both behavior change and foster public support for climate change action. Furthermore, explicitly integrating climate change considerations into SG deployment would ensure that climate change response is efficient, exploits existing synergies in policy and practice, and is comprehensive as well as complimentary.

I recognize that explicitly integrating climate change considerations into SG deployment could be costly and have little or no immediate economic return. However, in my view, such an investment upfront could result in long-term economic and social benefits. Moreover, it is recognized in the literature that an ethical shift towards a cooperative model of decision making will be required to effectively respond to the multi-dimensional challenges associated with climate change (Wagner and Zeckhauser, 2012; Hardin, 1968; Shultz and Holbrook, 1999). Consequently, while I acknowledge that SG deployment is only a minor component of the global climate change challenge, I contend that electricity stakeholders in Ontario have an opportunity to set a precedent for climate change integration in the SG community both in Canada and worldwide.

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Appendix A: Stakeholders Considered in Content Analysis

Policy

1. Ontario Ministry of Energy (OME)

Regulatory

2. Ontario Energy Board (OEB)

Operators and System Planning

3. Independent Electricity System Operator (IESO)
4. (Former) Ontario Power Authority (OPA)

Generation

5. Ontario Power Generation (OPG)

Security Standards

6. Information and Privacy Commissioner of Ontario

Stakeholder Collaboration and Expert Support

7. Ontario Smart Grid Forum

Extra Large LDCs

8. Toronto Hydro Electric System Limited (THESL)
9. Hydro One
10. Hydro One Brampton

Large LDCs

11. London Hydro
12. Hydro Ottawa
13. PowerStream Inc.
14. Horizon Utilities Corporation
15. Enersource Hydro Missisauga Inc.
16. Veridian Connections

Mid-Sized LDCs

17. Cambridge and North Dumfies Hydro Inc.
18. Woodstock Hydro Services
19. Thunder Bay Hydro
20. Waterloo North Hydro
21. Milton Hydro
22. EnWin Utilities Ltd.
23. North Bay Hydro

24. Bluewater Power Distribution Company
25. Erie Thames Powerlines Corporation
26. Essex Power Corporation
27. Essex Power Corporation
28. Brantford Power Inc.
29. Guelph Hydro
30. Collus PowerStream
31. Wasaga Distribution Inc.
32. Peterborough Distribution Inc.
33. Orilla Power
34. Festival Hydro
35. PUC Distribution Inc.
36. Burlington Hydro
37. Whitby Hydro Electric Corporation
38. Norfolk Power Inc.
39. Kingston Hydro Corporation
40. Canadian Niagara Power Co. Ltd.
41. Newmarket-Tay Power Distribution Ltd.
42. Oshawa PUC Networks Inc.
43. Innisfil Hydro
44. Entegrus Powerlines
45. Haldimand Country Hydro Inc.
46. Welland Hydro-Electric System Corp.
47. Oakville Hydro Electricity System Distribution Inc.
48. Niagara Peninsula Energy Inc.
49. Halton Hills Hydro
50. Greater Sudbury Hydro
51. Kitchener-Wilmot Hydro Inc.
52. Westario Power
53. St. Thomas Energy Inc.

Small LDCs

54. E.L.K Energy Inc.
55. Tillsonburg Hydro Inc.
56. Co-operative Hydro Embrum
57. Algoma Power
58. Orangeville Hydro
59. Parry Sound Power Corporation
60. Brant County Power
61. Center Wellington Hydro
62. Niagara-on-the-Lake Hydro
63. Gimsby Power Inc.
64. Renfrew Hydro
65. Atikokan Hydro
66. Rideau St. Lawrence Distribution
67. Lakeland Power Distribution
68. West Coast Huron Energy
69. Ottawa River Power Corporation
70. Espanola Regional Hydro Distribution Corporation
71. Lakefront Utilities
72. Midland Power Utility
73. Chapleau Public Utlities

74. Hydro Hawkesbury Inc.
75. Hearst Power Distribution Company Limited
76. Fort Frances Power Corp.
77. Kenora Hydro Electric Corporation Ltd.
78. Wellington North Power Inc.
79. Northern Ontario Wires
80. Sioux Lookout Hydro Electric Commission

Appendix B: Content Analysis Document Reference List

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Appendix C: "Relevant" Document Example

The following document is a directive from the OME to the OEB directing the OEB to begin planning for the implementation of the smart meter roll-out for all Ontario residents and businesses. Given that the content of this document pertains specifically to SG deployment in Ontario, it was included in the content analysis.

OICNA- 10285

MINISTER'S DIRECTIVE

TO: THE ONTARIO ENERGY BOARD

The Government of Ontario has established targets for the installation of 800,000 smart electricity meters by December 31, 2007 and installation of smart meters for all Ontario customers by December 31, 2010.

In order to meet these targets and to maximize the resulting benefits, I, Dwight Duncan, Minster of Energy, hereby direct the Ontario Energy Board (the "Board") under section 27.1 of the *Ontario Energy Board Act, 1998* as follows:

1. By February 15, 2005 the Board shall develop and provide to the Minister of Energy an implementation plan for the achievement of the Government of Ontario's smart meter targets. Full implementation will commence upon the Minister's approval of the Board's plan.

2. During the development of its plan, the Board shall consult with stakeholders to:

    - identify and review options for the achievement of the smart meter targets
    - identify potential barriers to rapid deployment of smart meters and address how those barriers can be mitigated
    - address competitiveness in the provision and support of smart meters, including consideration of third party providers
    - identify and address technical requirements as set out in paragraphs 5 and 6 of this Directive and additional functionality as set out in paragraph 7
    - consider the establishment of common requirements in the office and support operations of distributors in relation to smart meters, including requirements for compatibility, and for billing and reporting
    - consider measures by which and conditions under which customers can have access to full meter data in real time and assign such access to third parties
    - identify and address regulatory mechanisms for the recovery of costs, taking into account the cost savings and other benefits that will be realized (for example, timely access to detailed system usage data) by the installation of smart meters
    - examine the need for and potential effectiveness of the introduction of non-commodity time of use rate structures as a means to complement the implementation of smart meters
    - identify and address other issues as the Board deems advisable.

3. In conjunction with its implementation plan, the Board shall also address the need for and potential effectiveness of the introduction of non-commodity time of use rate structures as a means to complement the implementation of smart meters and maximize the benefits of smart meters.

4. In the implementation plan, priority shall be given to installation of smart meters in new homes and for customers with a demand of 50 kilowatts or more. The Board may authorize the commencement of installation of smart meters for customers with a demand of 50 kilowatts or more as soon as it deems advisable without further report to the Minister. The Board may also establish other implementation priorities, including different priorities for different distributors, to optimize the opportunities for and benefits of deploying smart meters.

5. The Board's plan shall identify mandatory technical requirements for smart meters and associated data systems in accordance with the following criteria:

   - A smart meter must be able to measure and indicate electrical usage during prespecified time periods
   - A smart meter must be adaptable or suitable, without removal of the meter, for seasonal and time of use commodity rates, critical peak pricing, and other foreseeable electricity rate structures.
   - A smart meter must be capable of being read remotely and the metering system must be capable of providing customer feedback on energy consumption with data updated no less than daily.

6. Recognizing the additional capability and flexibility of bi-directional communication, the Board's plan shall identify mandatory technical requirements for bi-directional communication, except in those circumstances where the Board finds the options available are impractical.

7. In developing its plan, the Board shall consider and identify additional functionality for smart meters, on either a mandatory or optional basis. Functionality to be considered includes:
   - stand-alone customer feedback (providing immediate feedback, such as usage, pricing or spending data, to the customer by way of customer display or interface)
   - load control capabilities that can be utilized either by the distributor or the customer
   - capability of multi-meter readings (for example, gas and water metering in addition to electricity metering)
   - any other functionality the Board deems advisable.

8. The Board may establish different technical requirements and functionalities for different customer groups.

____________________ ____________________
(Minister of Energy) (Date)

Appendix D: Excluded Document Example

The following document, while discussing content that may be related to SG deployment (including storage and renewable generation), was not included in the content for two key reasons. First, this document does not include any explicit reference to SG deployment or technology. Second, this document pertains to gas utilities, stakeholders that were not identified as key stakeholders involved in SG deployment in Ontario.

MINISTER'S DIRECTIVE

Re: Gas Utility Undertakings Relating to the Ownership and Operation of Renewable Energy Electricity Generation Facilities, Facilities Which Generate Both Heat and Electricity From a Single Source and Energy Storage Facilities and the Ownership and Operation of Assets Required to Provide Conservation Services.

Enbridge Gas Distribution Inc. and related parties gave undertakings to the Lieutenant Governor in Council that were approved by Order in Council on December 9, 1998 and that took effect on March 31, 1999 ("the Enbridge Undertakings"); and Union Gas Limited and related parties gave undertakings to the Lieutenant Governor in Council that were approved by Order in Council on December 9, 1998 and that took effect on March 31, 1999 ("the Union Undertakings").

The Government of Ontario has, with the passage of the *Green Energy and Green Economy Act, 2009,* embarked upon a historic series of initiatives related to promoting the use of renewable energy sources and enhancing conservation throughout Ontario.

One of those initiatives is to allow electric distribution companies to directly own and operate renewable energy electricity generation facilities of a capacity of not more than 10 megawatts or such other capacity as is prescribed by regulation, facilities which generate both heat and electricity from a single source and facilities for the storage of energy, subject to such further criteria as may be prescribed by regulation.

The Government also wants to encourage initiatives that will reduce the use of natural gas and electricity.

Pursuant to section 27.1 of the *Ontario Energy Board Act, 1998*, and in addition to a previous directive issued thereunder on August 10, 2006 by Order in Council No. 1537/2006, in respect of the Enbridge Undertakings and the Union Undertakings, I hereby direct the Ontario Energy Board to dispense,

- under section 6.1 of the Enbridge Undertakings, with future compliance by Enbridge Gas Distribution Inc. with section 2.1 ("Restriction on Business Activities") of the Enbridge Undertakings, and

- under section 6.1 of the Union Undertakings, with future compliance by Union Gas Limited with section 2.1 ("Restriction on Business Activities") of the Union Undertakings,

in respect of the ownership and operation by Enbridge Gas Distribution, Inc. and Union Gas Limited, of:

(a) renewable energy electricity generation facilities each of which does not exceed 10 megawatts or such other capacity as may be prescribed, from time to time, by regulation made under clause 71(3)(a) of the *Ontario Energy Board Act, 1998* and which meet the criteria prescribed by such regulation;

(b) generation facilities that use technology that produces power and thermal energy from a single source which meet the criteria prescribed, from time to time, by regulation made under clause 71(3)(b) of the *Ontario Energy Board Act, 1998*;

(c) energy storage facilities which meet the criteria prescribed, from time to time, by regulation made under clause 71(3)(c) of the *Ontario Energy Board Act, 1998*; or

(d) assets required in respect of the provision of services by Enbridge Gas Distribution Inc. and Union Gas Limited that would assist the Government of Ontario in achieving its goals in energy conservation and includes assets related to solar-thermal water and ground-source heat pumps;

(e) for greater certainty, the use of the word "facilities" in paragraphs (b) and (c) above shall be interpreted to include stationary fuel-cell facilities each of which does not exceed 10 Megawatts in capacity.

This directive is not in any way intended to direct the manner in which the Ontario Energy Board determines, under the *Ontario Energy Board Act, 1998,* rates for the sale, transmission, distribution and storage of natural gas by Enbridge Gas Distribution Inc. and Union Gas Limited.

George Smitherman
Deputy Premier, Minister of Energy and Infrastructure

Appendix E: Latent Content Analysis Results

The following tables show all of the SG and climate change excerpts coded for the latent content analysis. Recall from Chapter 4 when I discussed how only excerpts within certain sub-nodes were chosen for consideration, each table consists of the excerpts found within those sub-nodes with excerpts ordered alphabetically by source. The far left column is the excerpt; the middle column shows the source and page number in which the excerpt was found and the right column shows the open codes selected to describe the excerpt content.

SG Excerpts: Complementary Initiatives

Excerpt	Source	Open Codes
Our goal is to be an innovative and attractive proving ground for Green Energy technologies, smart grid research, best practices and products that can be applied to--and replicated in-other places.	Burlington Hydro, 2009 Community Report, p. 4.	Green economy
Ensure CDM efforts are dovetailed with smart grid planning to ensure consistency and efficiency in these efforts.	Erie Thames Powerlines, 2013 CDM Report, p. 18	CDM-SG Complementary
The Act is expected to create more than 50,000 jobs in the province within three years for those who wish to pursue a career path in renewable technologies, energy conservation and the smart grids that tie these initiatives together.	Horizon Utilities, 2009 Annual Report, p. 34.	GEGEA SG enable renewable SG enable Conservation
We believe having the profile of individual customer energy intensity will have very strong applicability for both smart grid and CDM.	Horizon Utilities, 2011 Annual Report, p. 22.	Individual customer energy intensity
The supporting communications network that Hydro One is establishing is an important step in realizing the vision of a smart grid.	Hydro One, 2008 Annual Report, p. 4.	Communication networks
The increasing focus on renewable distributed generation, such as wind, solar, hydroelectric and biofuels will require development of the Smart Grid concept, which would leverage the smart meter technology to support continued reliable and safe operation of the distribution system.	Hydro One, 2008 Annual Report, p. 43.	SG enable renewable SG enable distributed generation
Our plan identifies the expansion and reinforcement of the distribution system required to accommodate the connection of renewable energy generation facilities and plans for the development and implementation of the smart grid in relation to our distribution system.	Hydro One, 2009 Annual Report, p. 10.	SG enable renewables Upgrade system to SG
In 2010, we continued our focus on building an advanced distribution solution and launched our smart grid initiative to leverage the infrastructure from our smart meter investment which is required to connect and manage large volumes of distributed generation on our distribution system (see Future Capital Expenditures).	Hydro One, 2010 Annual Report, p. 20.	Leverage smart meter Enable Distributed generation
Looking forward we intend to focus on the conservation initiatives mandated by the province, development of smart grid plans, and construct key performance indicators that will be used in conjunction with our Asset	Kenora Hydro, 2010 Annual Report, p. 3.	Conservation mandate Pressure from regulators

Management Plan that was developed in 2010. We will continue to face the pressures of the regulators, integrate distributed generation into our system, and above all, maintain a safe and reliable distribution system for Kenora.		Integrate distributed generation Safe and reliable system
Green Energy programs authorized by the OEB include renewable generation facilities, renewable enabling improvements and investments towards smart grid.	London Hydro, 2013 Annual Report, p. 3.	OEB Programs Renewable Generation Facilities Enable Renewable SG Investments
Smart Grid (Conservation) ∞ Complete the four year targeted energy savings ∞ Sell the saveONenergy HOME ASSISTANCE PROGRAM to 500 customers (Low Income Consumers) ∞ Introduction of self-help power factor analysis tool	London Hydro, 2014-2016 Strategic Plan, p. 1.	SG enable conservation Energy saving targets
Deliver Excellent Smart Grid (Conservation) Projects	London Hydro, 2014-2016 Strategic Plan, p. 2.	SG Enable Conservation
"Electricity is the new fuel for zero emission mobility. PowerStream's leadership in smart grid technology makes them a perfect partner for Nissan Canada to work with," said Neetika Sathe, Nissan Canada's Senior Marketing Manager. One of the two electric cars is used as a commuting vehicle for a pilot program by PowerStream employees while the other is mostly made available for shows and community events. But the vehicles have a much wider practical application for the community and the environment.	PowerStream, 2011 Annual Report, p. 23.	Zero emission mobility SG Enable EV
Sathe cited PowerStream's innovative work, its smart grid technology, its exploration of level three charging technology and its development studies of vehicle-to-home power supply technology (which allows the home to power the car and the car to power the home), as integral to the practical use of electric cars.	PowerStream, 2011 Annual Report, p. 23.	SG technology EV charging Vehicle-to-home power
The increase was mainly the result of additions to distribution assets, including renewable generation and Smart Grid assets, as well as solar PV projects.	PowerStream, 2013 Annual Report, p. 38.	Solar PV Projects SG Assets Renewable generation distribution assets
Collaborations with the DSEA partners and other Durham Region utilities have resulted in important work with electric vehicle charging and the smart grid.	Veridian, 2010 Annual Report, p. 23.	EV Charging
As a leader in smart grid technologies that will help with successful EV deployment, Veridian is a strong partner in bringing this vision to life. The ability to use off-peak electricity to make vehicle charging more economical, combined with smart technologies that optimize the use of the grid, will make Veridian's service territories ideal places for EVs.	Veridian, 2011 Annual Report, p. 30.	SG enable EV Off-Peak Charging SG to optimize grid
Meanwhile, WHSI is moving forward with other initiatives that demonstrate the interconnection of CDM, renewable energy, and the smart grid.	Woodstock Hydro 201 CDM Report, p. 39.	SG enable renewable SG enable conservation
WHSI is looking forward that talks about the need to integrate conservation, renewables and smart grid. Integrating these elements would treat the energy system holistically, and bring benefits to customers and the system.	Woodstock Hydro 2012 CDM Report, p. 42.	SG enable renewable SG enable conservation Consumer benefits System benefits
To better understand these dynamics, WHSI launched a unique Smart Grid project in 2013 that is bringing together renewable energy, energy storage,	Woodstock Hydro, 2013 CDM Report, p. 1.	Integrate Renewables

smart meters, electric vehicles and more		Energy storage, smart meters, EV
An important aspect of this evolution will be improving the alignment of conservation costs and benefits, as well as giving sector participants greater flexibility to respond to changing market conditions. To that end, new technologies, such as the smart grid and Green Button Initiative, will strongly enhance the ability of the sector to serve consumers more effectively.	Ontario Ministry of Energy (2013). Conservation First: A Renewed Vision for Energy Conservation in Ontario, p. 17.	Flexibility to market SG consumer benefit
Over the past few years, Ontario has undertaken bold initiatives that both underscore the need for a smart grid and help move us toward it. To reduce the environmental footprint of the electricity sector, the Province has: • Required the shut-down of Ontario's coal-fired generation; • Worked to create a culture of conservation; and • Procured renewable generation sources to meet future electricity needs.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 2.	Coal elimination Culture of conservation Reduce environmental footprint Renewable generation Future demand
Provincial initiatives on conservation, renewable generation and smart meters begin the move towards a new electricity system, but their full promise will not be realized without the advanced technologies that make the smart grid possible.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 2.	Provincial initiatives - Conservation - Renewable generation - Smart meters
For the electricity system as a whole, the challenges involve finding ways to move vehicle charging into off-peak periods so as to avoid increasing peak load and the resulting need for additional peaking resources. The opportunity involves using the energy stored in vehicle batteries to provide peak period energy. A smart grid is essential if Ontario is to address the challenges and embrace the opportunities presented by plug-in electric vehicles.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 5.	SG required for: - Off-Peak Charging - avoid increasing peak - EV batteries/ storage
Ontario's move to a culture of conservation and its substantial commitment to renewable energy will also be supported by the smart grid.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 11.	Culture of conservation Renewable commitment SG enable conservation SG enable renewable
To serve the emerging needs of the smart grid, communication must be pervasive, rapid, robust even in emergency conditions, scalable (but with high initial capacity), and most of all, secure.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 34.	Communication technology • Pervasive • Rapid • Robust • Scalable • Secure
To be effective, communications must be governed by clear standards and support the interoperability of the many devices that will connect to the smart grid.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, p. 34.	Communication standards Interoperability of devices
First, smart grid communications development must match smart grid development. While the initial communications deployment can be configured and sized to accommodate the first generation of smart grid equipment, such as smart meters; ultimately the communications infrastructure must be capable of servicing the full range of smart grid equipment installed. Given the uncertain pace at which smart grid technologies will be implemented, communications system should be scalable to allow for the addition of new devices as they are developed. Communications systems also will need to be in place for the anticipated service lives of smart grid equipment, which can range from years to decades.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 35.	Communication to accommodate smart meters Scalable communication Adaptable communication devices
Second, smart grid communications must be developed based on open standards so that the widest possible range of devices can be employed and the development of new devices and entry by new vendors is encouraged.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of	SG communications Open standards

	the Smart Grid Forum,p. 35.	Accommodate devices
The smart grid is necessary to facilitate the large scale adoption of electric vehicles by enabling them to be charged in ways that are convenient and reduce the potential for adverse impacts on electricity infrastructure and customer service.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 38.	SG Enable EV EV Charging Avoid adverse impacts Electricity infrastructure Customer service
This study is evaluating impacts on transformers, lines and substation equipment. Again, depending on the degree of electric vehicle penetration, innovative charging methods, such as staged charging through the use of smart grid technologies, may be needed to accommodate significant penetration of electric vehicles without adversely impacting local distribution equipment and, as a result, service to customers.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 39.	SG Technology EV charging Adverse impacts Distribution equipment Customer service
The connection between electric vehicles and a smart grid is fundamental. With smart technology, the grid can be an enabler of electric vehicles by maximizing charging flexibility; without it, the grid may be a barrier to the widespread adoption of electric vehicles.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 40.	SG enable EV Flexible EV Charging
The sensing, communications and computer analytics that constitute smart grid technology will be required to ensure that electric vehicle charging is accomplished efficiently and that any impacts on the electricity system are addressed.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum,p. 40.	SG Enable EV Avoid Grid Impacts
Significant progress is being made on these fronts and the IESO is actively supporting plans within the sector to increase the contributions from renewable resources, accelerate smart grid developments and find new opportunities to increase demand-side involvement in the marketplace.	IESO, 2011 Annual Report, p. 2.	Renewable resources SG development Demand-side involvement
They include the retirement of Ontario's coal-fired resources and the addition of substantial amounts of variable generation; resource procurement and contracting; the proliferation of demand-side management resources – at residential, commercial and industrial levels, and enabled by smart grid investments; the potential introduction of carbon pricing policies; and the expected increase in electric vehicles.	IESO, 2011 Annual Report, p. 24.	Coal elimination Variable generation Resource procurement SG enable DSM resources Carbon pricing Increase in EV
As mentioned, the OPA continues to administer several programs that influence and inform smart grid development, including the FiT and microFiT, demand-response, and other initiatives designed to encourage conservation and the efficient use of electricity.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 13.	FiT Program microFIT SG-Enabled DSM SG-Enabled CDM
The Board also has new responsibilities with respect to conservation and the oversight of the plans to expand the province's distribution and transmission infrastructure to accommodate both the anticipated new investment in renewable generation and "smart grid" technologies	OEB, Annual Report (2008-2009), p. 1.	OEB responsibilities - Conservation Grid upgrades to accommodate - Renewable - SG technology
The intensified generation of data from these activities also connects to the growing field of 'data analytics' which also has important touch points with the smart grid and the ability of customers, utilities and service providers to better understand the changing dynamics of the power system.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment- A Vignette, p. 3.	Role of data analytics

The smart grid can aid in achieving societal objectives and can enable options for addressing future goals as well. Here in Ontario, various policy initiatives such as the shutdown of coal-fired power plants, promoting renewable energy, economic development and load shifting are all examples of where the smart grid has already provided assistance.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment- A Vignette, p. 5.	SG Enable Societal Obj: - coal elimination - renewable energy - economic development - load shifting
Ontario's conservation and efficiency measures have increasingly relied upon the smart grid, and as with many facets of the smart grid, the province is only beginning to scratch the surface of the potential at hand.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment- A Vignette, p. 12.	SG enable conservation SG enable efficiency Provincial conservation and efficiency measures
At the time of publication of this paper, Ontario's long-term targets for conservation and demand management are currently under review. Already, smart grid is playing an important role in the realization of that goal. Ontario's public sector investment portfolio in conservation and demand management programs are both extensive and span the full range of customer classes.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment- A Vignette, p. 14.	Long-term CDM targets SG enable CDM progress
Ontario's smart grid-related policy developments have paralleled its efforts to integrate renewable sources of generation.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment- A Vignette, p. 14.	SG policy parallel renewable generation development
To fully exploit these opportunities however, government and regulators may need to examine the smart grid in a manner that does not silo electricity policy from these broader issues.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment- A Vignette, p. 19.	Integrate SG policy
There is an important connection between achieving Ontario's conservation targets and developing a smart grid in the province.	OPA, 2009 Annual Report, p. 11.	SG enable conservation
They are also expected to be supporting elements of other conservation programs and the development of the smart grid.	OPA, 2009 Annual Report, p. 12.	OPA support conservation OPA support SG
This program promotes the expansion of distributed generation across the electricity system, while the smart grid will enable the connection of these local generating facilities.	OPA, 2009 Annual Report, p. 12.	SG enable distributed generation
The development of a smart grid will be better defined in the near term as the province develops a strategic map for its evolution in Ontario. It will enable the increasingly distributed nature of the electricity system as more local generation and conservation are implemented.	OPA Business Plan (2010-2012), p. 11.	SG evaluation SG enable distributed generation SG enable conservation
The OPA will continue to be an active participant in the Smart Grid Forum to help evaluate opportunities for enhancing more effective and reliable electricity delivery through distributed generation, energy efficiency and demand management initiatives offered by the future development of a smart grid.	OPA Business Plan (2010-2012), p. 22.	OPA on SG Forum SG Results in Reliable Electricity SG-enabled distributed generation SG-enabled efficiency SG-enabled demand management
Customer adoption and trust of Smart Grid energy savings programs is an integral factor in the success of energy conservation.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 32.	Consumer adoption SG
Toronto Hydro's Smart Grid roadmap includes several initiatives focused on climate protection, energy security and customer satisfaction. Toronto	Information and Privacy Commissioner of Ontario	THESL SG Roadmap

Hydro's activities will be in the area of conservation and demand management, distribution grid automation and home energy management systems.	(2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 1.	SG- Goal Climate Protection SG-Goal energy security SG-Goal customer satisfaction SG-enabled CDM SG-enabled grid automation SG-enabled home energy management
In November 2009 the Information and Privacy Commissioner of Ontario (IPC) released a white paper with the Future of Privacy Forum entitled, Smart Privacy for the Smart Grid: Embedding Privacy into the Design of Electricity Conservation, to call attention to the privacy concerns related to the Smart Grid, and argue that energy conservation can be achieved without sacrificing the privacy of energy consumers.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 3.	Ensure Privacy with SG Ensure Conservation with Privacy
Even while leveraging these foundational building blocks, much work will be required to achieve the Smart Grid. Toronto Hydro's Smart Grid Roadmap shows the timeline for implementation of climate protection, energy security and customer satisfaction goals.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 10.	THESL SG Roadmap SG-goal climate protection SG-goal energy security SG-goal customer satisfaction
Potential "game changers" that are expected to have significant impacts on the Ontario electricity system in the medium and long-term include the adoption of electric transportation on a commercial scale, the full deployment and utilization of smart grid technologies to assist electricity management and demand management, and the need to adapt to one or more carbon-pricing or environmental cost regimes.	Electricity Market Forum Report (2011). Reconnecting Supply and Demand, p. 1	Electric transportation SG-Enable demand management Carbon-Pricing Environmental Cost Regimes

SG Discourse- Impacts of SG Deployment

Excerpt	Source	Open Codes
Its aim is to showcase how smart grids integrate electricity production, delivery, and consumption to produce a more efficient, reliable and responsive system that is better for the environment.	Burlington Hydro, 2009 Community Report, p. 4.	SG Integrate System SG Impact: efficient system SG Impact: reliable system SG Impact: Responsive system SG Impact: environmental benefits
The idea is to use smart grid technology to enable customers, large and small, to generate power from renewable sources such as solar power, and sell it back to the Grid.	Burlington Hydro, 2009 Community Report, p. 13.	SG Enable consumer renewable generation
A Smart Grid, based on communication among generators, transmitters, distributors and consumers, is a big part of a grand plan to make energy production and consumption more efficient and effective.	Enwin Utilities, 2009 Annual Report, p. 10.	Efficient and effective production Efficient and effective consumptions
The meters are part of our ongoing investment in Smart Grid technologies that will provide ENWIN and our customers with additional information on power demand and consumption while automating the system to enhance reliability. This includes capabilities that will automatically reroute electricity to ensure reliable supply during power outages, which will eventually be available across the city.	Enwin Utilities, Annual Report, 2013, p. 3.	SG consumption data SG system automation SG-enabled reliability SG-enabled reroute

The Green Energy Act encourages and facilitates such distributed renewable energy projects and requires that distribution grids be upgraded to accommodate them, including “Smart Grid” investment which will impact future Haldimand County Hydro capital expenditures.	Haldimand County Utilities, 2010 Annual Report, p. 6.	GEGEA-enable distributed renewables GEGEA-enable grid upgrades
For the consumer, the smart grid will mean that the management of electricity for a household or a business can be more efficient with the help of sophisticated energy monitoring tools.	Horizon Utilities, 2009 Annual Report, p. 36.	SG-enabled home management Energy monitoring tools
A smarter grid also improves reliability and enables the integration of alternative methods of energy generation like solar and wind.	Horizon Utilities, 2009 Annual Report, p. 36.	SG-enabled reliability SG-enabled alternative energy
And in order for Hydro One to connect small, renewable sources of generation, we need the two-way flow capabilities that a smart grid will bring.	Hydro One, 2008 Annual Report, p. 5.	SG-enabled renewable
Incorporating communications and sophisticated operating and control technologies, the smart grid will allow small distributed generators, like a farmer with a bio-fuel generator, to access the grid in order to both draw and contribute electricity.	Hydro One, 2008 Annual Report, p. 10.	SG-enabled small scale renewable
The smart grid will also enable customers to better control smart appliances in homes and businesses; it will support the networking of energy management systems in smart buildings, and will help consumers manage energy use and costs more effectively by giving them access to time-of-use electricity pricing as it comes into effect.	Hydro One, 2008 Annual Report, p. 10.	Smart appliances TOU-energy management
This includes the gradual implementation of smart grid technologies, which allow a better response to changes in power demand and faster restoration of power outages.	Hydro Ottawa, 2012 Annual Report, p. 16.	SG-enabled demand response Faster restoration
With the addition of smart meters and the sophistication of data, the Smart Grid will ensure stability with the introduction of renewable generation and reduce outage frequency and duration.	Kenora Hydro, 2009 Annual Report, p. 7.	SG-enabled renewables SG-enabled outage management
The introduction of distributed green energy, smart meters, smart grid, and deregulation has changed our billing practices and systems completely.	Kenora Hydro, 2012 Annual Report, p. 2.	Changing billing practices Changing systems
The smart grid will also allow for better integration of small scale distributed generation facilities, reducing the need for large centrally located generation plants.	PUC Inc., 2008 Annual Report, p. 5.	SG-enabled small scale renewable Reduce demand central generation
Over the next 10 years we expect to invest between $90 and $100 million of capital to renew the distribution system (including stations). In addition to infrastructure replacement, we will be making Smart Grid investments which will also help to reduce the extent and frequency of outages.	PUC Inc., 2012 Annual Report, p. 9.	SG-reduce outages
These ‘smart grid’ investments are expected to provide dramatic improvements in system performance in the areas that the equipment is deployed..	Veridia, 2008 Annual Report, p. 22.	SG to improve system performance
For customers, the most visible element of the smart grid is the smart meter. The information supplied by smart meters will drive efficiencies in the delivery of electricity as well as help Veridian to pinpoint and repair the causes of outages faster than ever before.	Veridian, 2009 Annual Report, p. 10.	Smart meter Efficient delivery Outage management
Dynamic pricing can build on time-of-use and smart grid infrastructure by pinpointing short time periods of extremely high demand – known as critical peaks – and permitting customers to sign up to receive a financial benefit for shifting their consumption from critical peak to the lowest-demand period, typically overnight.	Ontario Ministry of Energy (2013). Conservation First: A Renewed Vision for Energy Conservation in Ontario, p. 6.	TOU Load shifting Consumer benefit

Consumers: Smart grid technologies, particularly home energy management systems, will change how consumers use electricity by increasing their ability to control household appliances and equipment and thereby manage their electricity cost and contribute to a better environment.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 3.	Home energy management Manage consumption Manage costs Environmental benefit
Smart grid technologies will also enable many different types of companies outside the utility sphere to enter the market for home energy management systems and services to help spur innovation.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 3.	Home energy management market Innovation
Smart grid technology can help maximize the amount of generation that can be connected to the distribution system while maintaining safety and service quality to consumers.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 3.	SG maximize generation Service quality
Smart grid technologies facilitate demand response by giving customers the ability to see prices and the tools to react to them.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 4.	SG-enabled demand response
Beyond the challenges it poses for cyber security, the smart grid may enhance physical security at substations and other facilities by facilitating remote monitoring via cameras and sensors.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 5.	SG to enhance security Remote monitoring technology
Smart meters, a major smart grid component, can give consumers timely information on price and consumption.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 5.	Smart meter generated Consumption data
The institutional structure of the electricity industry makes it easy to look at how the smart grid will impact each piece of the system in isolation, but the most profound impact of a smart grid may be its ability to link these pieces more closely together.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 11.	SG Integrated System
In Ontario we have numerous distribution utilities, one large transmission company and a few smaller ones; one large generating company and many smaller ones. The province has a system/market operator and a corporation responsible for longer-term system planning, and procuring electricity supply and demand resources. While the smart grid will affect each of these segments in different ways, it will affect all of them by increasing their ability to work together to better serve consumers.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 11.	SG integrating system
A smart grid includes diverse and dispersed energy resources and accommodates electric vehicle charging. It facilitates connection and integrated operation. In short, it brings all elements of the electricity system – production, delivery and consumption closer together to improve overall system operation for the benefit of consumers and the environment.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 1.	SG-enabled distributed generation SG-enabled EV charging Improve system operation Consumer benefits Environmental benefits
The Forum's research has uncovered many potential benefits from a smart grid in the areas of economics, environment and operating performance.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 13.	SG economic benefits SG environmental benefits Improved operating performance

The smart grid offers enhanced operational performance	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 13.	Improved operational performance
Greater awareness of system conditions can help anticipate and address problems before they lead to outages, minimize the scope of outages that do occur, and enable more rapid restoration of power. With a smart grid, these fixes may increasingly occur automatically so that the grid becomes self healing.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 13.	Outage management Rapid restoration Self-healing
The information provided by a smart grid also can be used to improve power quality, which is increasingly important in operating today's sophisticated equipment controlled by digital electronics.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 14	Improve power quality
By automating functions that are controlled manually today, the smart grid will increase productivity, which will be essential in managing the more complex grid of tomorrow and helpful in addressing the demographic issues facing the electric system as the baby boomers retire and new workers need to be hired and trained.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 14.	System automation Increase productivity Managing complexity
Finally, the smart grid can provide significant operational advantages through its ability to improve both public and worker safety by increasing the amount of system information available for protection and control and by enabling remote operation and automation of equipment.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 14.	Improved system performance Improve safety Remote operation Equipment automation
The smart grid will impact virtually every aspect of the distribution system by making system conditions more visible right down to the customer level. This visibility will promote reliability, faster service restoration, enhanced maintenance practices and improved planning.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 11.	SG-enabled reliability Faster service restoration SG enhanced maintenance SG planning
In the future, the smart grid will enable distribution systems that can use sensors and computer analysis to predict system disturbances, take action to avoid their occurrence, and automatically reconfigure the grid to minimize the impacts of faults that do occur.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 21.	Automatic reconfiguration Minimize faults
Current business processes will also need to be modified in light of the new information available and the capabilities of smart grid technologies.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 23.	Modify business practice New information
In addition to impacting operations, the smart grid will also enable much more detailed planning as utilities gain more precise information on the loading of their equipment down to the individual customer level.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 23.	SG enable detailed planning Precise information available
Smart grid technology can help address the technical issues by allowing distribution lines to accommodate more generation without compromising service to consumers on those lines, overall grid reliability (including upstream impacts on the transmission system) and safety.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 26.	SG enhanced service SG enhanced reliability Transmission impacts Safety impacts

In addition, the transmission system must continue to evolve in response to changes in Ontario's resource mix including the development of renewable resources, integration of storage technologies, increased reliance on demand response, the refurbishment of existing and the development of new nuclear generators and the shutdown of coal-fired generation. To meet these challenges, the transmission system must become even more sophisticated, reliable, efficient and flexible through the implementation of additional smart grid technology.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 31.	Accommodate resource mix SG-enabled storage SG-enabled demand response Coal elimination Nuclear generation SG enhanced reliability SG enhanced flexibility
Beyond visibility, however, the focus of smart grid investment will be on technologies that allow for more efficient use and greater control of the transmission system.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 32.	SG-enabled efficiency SG enhanced control of transmission
Technology will also facilitate increased coordination between transmission and distribution operations. This coordination will be enabled by the implementation of the smart grid within the distribution sector and necessitated by the changing role of the distribution system and Ontario's evolving generation mix.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 32.	SG-enhanced coordination Evolving supply mix
Addressing transmission congestion is another important function of smart grid technology. The more congestion can be reduced, the greater the province's ability to move generation to load.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 32.	SG address transmission congestion
The risks, which are always more prominent in any security discussion, arise because smart grid development will entail placing millions of devices on poles, lines and the sides of houses throughout the province, all of which can communicate back into utility computer systems.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 36.	SG complicate security
The smart grid may also allow the energy stored in batteries to become a source of energy to help meet peak demand.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 38.	SG-enabled storage
Finally, a smart grid also is necessary to enable the large-scale use of electricity stored in vehicle batteries as a resource to meet peak demand	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 40.	SG-enabled vehicle battery storage
A smart grid will enable tomorrow's electricity system to use advanced information-based technologies to increase grid efficiency, reliability and flexibility. It enables the better use of the existing delivery infrastructure and offers benefits for both the consumer and the environment.	IESO, 2008 Annual Report, p. 4.	SG-enabled efficiency SG-enabled reliability SG-enabled flexibility Use of Existing infrastructure Consumer benefits Environmental benefits
These initiatives are building a thriving smart grid ecosystem that can lead to innovation that both enhances the grid's operation and	Ontario Ministry of Energy (2013). *Long Term Energy*	SG improve asset management

improves asset management to help mitigate system and customer costs.	*Plan*, p. 81.	Mitigate system costs Mitigate customer costs
These smart grid solutions will also help LDCs integrate new promising technologies into Ontario's electricity system that could help operators use grid assets more efficiently, including storage and electric vehicles.	Ontario Ministry of Energy (2013). *Long Term Energy Plan*, p. 81.	SG-enabled efficiency SG-enabled storage SG-enabled EV
Technological innovation from the Smart Grid could also help bring clean energy to remote communities that have economic challenges connecting to the province's transmission grid.	Ontario Ministry of Energy (2013). *Long Term Energy Plan*, p. 81.	SG-enabled clean energy to remote communities
The task force, facilitated by the Forum but not exclusive to its members, would seek the active participation of public and private-sector organizations in a position to help Ontario realize the broader economic development potential, including export opportunities, related to the smart grid over the longer term.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 8.	Public participation Private sector participation SG economic development Export opportunities
A day after its release, Ontario Premier Dalton McGuinty spoke of the importance of a smart grid to the province's future. "A smart grid opens up a whole new world of convenience, new jobs and green electricity," he said. "Our province will be greener, stronger, and in a much better position to compete and win against the rest of the world."	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 9.	Smart grid Convenience New jobs Green electricity
"This kind of information can be combined with other data, such as work location and hours, and family status, to derive all kinds of assumptions that may be of interest to insurers, marketers, social service workers, and criminals," according to Ontario's Information and Privacy Commissioner, who calls privacy a "sleeper issue" for the smart grid	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 21.	Consumer data Security risks Privacy risks
These questions need to be answered to assure smart grid activities in Ontario create Customer Value, a smart grid principle. Just as the Internet has challenged the traditional domains of telecommunications, media, and entertainment, the emergence of the smart grid will open up the grid to competition and increased innovation.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 22.	SG- Customer Value
Electricity consumers need to have confidence that products and services delivered through a modernized electricity system will be reliable, secure, privacy friendly, and deliver enough benefits to make utility, industrial, commercial and household investments in new smart grid technologies worthwhile.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 23.	Customer confidence SG-enabled reliability SG-enabled security SG-enabled privacy SG benefits
As part of the smart grid, energy storage is a kind of insurance policy – it brings flexibility, reliability and predictability to many aspects of system operation, and as an enabler of renewables can help us become less dependent on fossil fuels and achieve other environmental benefits.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 26.	SG-enabled storage Storage-enabled flexibility Storage enabled reliability Storage enabled predictability Environmental benefit Reduce fossil fuel dependency
This investment is aimed at enhancing the efficiency of the	Ontario Smart Grid Forum	Enhance system efficiency

distribution grid and using smart grid technologies to enable the connection of distributed generation, such as wind and solar, in a more intelligent, cost effective way.	(2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 29.	SG-enabled renewables
But this is more than simply renewing and maintaining the grid of yesterday; it's about investing in a smart grid of tomorrow that will deliver more economic value over the long term. "Increasing levels of distributed generation use, smart grid developments, and changing electricity requirements will all affect future distribution investments," the Conference Board acknowledges. EPRI, which calculates that U.S. smart grid investments could reach $479 billion (U.S.), estimates that every $1 invested toward a fully functional smart grid has the potential to return roughly $4 in benefits.21	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 30.	SG long-term economic value SG-enabled distributed generation SG affect future electricity investments
Ontario is aiming to achieve similar returns, as well as capture the economic development opportunities and jobs that will come from smart grid activities and investments.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 30.	SG- economic return Job creation Economic development
LDCs are also investing in the demonstration and study of various consumer technologies that bring the benefits of the smart grid directly to homes and businesses.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 31.	LDCs research investments Consumer benefits
A smart grid can detect the problem so quickly that a crew can be on the scene before customers realize there's a problem.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 31.	SG- rapid error response
Finally, smart grid investments in this category are giving customers more control and choice. Consumers will have an unprecedented ability to participate directly in the electricity marketplace and have access to a broad array of new products and services expected to emerge as the smart grid develops.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 32.	SG- consumer control SG- consumer market participation
Already well underway, Ontario's smart metering initiative provides the base infrastructure for not only time-of-use, but other smart grid technologies that will further empower the consumer to participate in conservation and demand management.	OME, Results-Based Plan Briefing Book (2010-2011), p. 23.	Smart meter TOU SG- enabled CDM
The 'smart home' is emerging as one of the most visible facets of the smart grid from the consumer's standpoint. A combination of overall internet access, smart metering, smart appliances, distributed generation, building codes and a growing array of services are all combining to turn residential 'consumers' of energy into sophisticated 'prosumers' of energy (in various forms) and related services.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 3.	Smart home - internet access - smart meter - smart appliances - distributed generation - consumers="prosumers"
In a recent International Energy Agency (IEA) report, it was recognized that worldwide, "Smart grid technologies contribute between 0.2 and 0.5 GtCO2 emissions reductions in 2020, through both direct and enabled reductions. Direct reductions include energy savings from peak load management, accelerated deployment of end-use and system energy-efficiency programmes, and reduced system losses; enabled reductions include reductions from integration of large-scale, variable renewable power generation and facilitation of electric vehicle deployment."	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 3.	SG-enabled emission reduction - Peak load energy savings - Energy efficient programs - Reduced system losses - Renewable integration - EV deployment

job creation is one of the many expected benefits that are enabled by the smart grid	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 11.	Job creation
The notion of a net zero house which produces at least as much energy as it consumes from the legacy electricity system, represents one of the many profound changes that loom from the smart grid over the longer term.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 12.	SG –enabled net zero house
Across Ontario, smart grid implementation efforts are moving well beyond the pilot stage and this will have an important impact on the electricity system's ability to integrate renewable generation.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 15.	SG progress SG-enabled renewables
Some of the emerging, system-wide benefits of integrating smart grid-related technologies include: • New sources and types of ancillary services (a concept the IESO is beginning to explore through its Alternative Sources of Regulation RFP) • Greater wholesale market liquidity • Transmission and distribution asset deferral • Reduced economic costs of wind forecast errors • Market efficiency gains along the lines called for in the IESO's Market Forum Report38. • Renewable integration and efficient asset utilization. • Absorb Surplus Baseload Generation (SBG) and reduce/economize Global Adjustment payments	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 22.	SG-enabled- ancillary services SG-enabled – market liquidity SG-enabled transmission and distribution asset deferral SG-enabled reduced economic costs SG- enabled market efficiency gains SG- enabled renewable integration
The smart grid would give electricity consumers opportunities to become more active participants in the real-time management of electricity demand through price signals and more options for managing their electricity demand.	OPA, 2008 Annual Report, p. 21.	SG- enabled consumer participation SG- enabled demand management
Engaged in activities to develop Ontario's electricity sector, including the development of the smart grid to enable conservation, distributed generation and transmission of renewable energy supply.	OPA, 2009 Annual Report, p. 1.	SG- enabled conservation SG- enabled distributed generation SG-enabled renewables
The smart grid will enable the development and integration of innovative technologies, such as a mobile charge infrastructure to support electric vehicles and dedicated electricity storage to increase reliability of supply.	OPA, 2009 Annual Report, p. 12.	SG-enabled EV charging SG-enabled storage Storage-enabled supply reliability
The smart grid will also improve operation of the electricity grid, including facilitating the connection and operation of distributed generation and particularly the connection of more renewable energy.	OPA, 2009 Annual Report, p. 12.	SG-enabled distributed generation SG-enabled renewables
The changing nature and vast increase of information gathered on the Smart Grid is also resulting in changes in the nature of utilities as power providers	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 2.	Access to consumer data - Changing utility roles
The paper explored how the nature of utilities as power providers will shift due to the large amounts of personal information they will be collecting from consumers as a result of advancements in the Smart Grid, such as the installation of smart meters and the use of smart appliances by households.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 3.	Access to consumer data - Changing utility roles
Identified impacts of the Smart Grid on utility functions as it relates to consumers include the primary operation areas of home energy management, metering, and demand-side management.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design-	SG- enabled home energy management SG-enabled DSM

	Achieving the Gold Standard in Data Protection for the Smart Grid, p. 14.	
The real opportunity for engaging the demand-side of the market is less through expecting customers to manually change their energy usage than through aggregation of customer demand and the use of smart grid and smart home technology.	Electricity Market Forum Report (2011). Reconnecting Supply and Demand, p. 7.	SG-enabled DSM
An enhanced price signal (discussed in greater detail below) can provide a triggering mechanism that will allow the smart grid to automatically adjust customer electricity usage.	Electricity Market Forum Report (2011). Reconnecting Supply and Demand, p. 7.	Enhanced price signal SG-enabled automatic home energy management
The Smart Grid gives consumers more control over their electricity usage. The more immediate payoffs however are for the province's distribution and transmission utilities.	Ontario Distribution Sector Review Board (2012). Renewing Ontario's Electricity Distribution Sector: Putting the Consumer First, p. 18.	SG-enabled consumer control
The Smart Grid allows them to integrate the variable output that comes from renewable energy sources and accommodate the charging of electric vehicles. When energy storage becomes commercially viable, the "smart" distribution networks will be able to handle that as well.	Ontario Distribution Sector Review Board (2012). Renewing Ontario's Electricity Distribution Sector: Putting the Consumer First, p. 18.	SG-enabled renewables
Smart Grid switches also allow utilities to create self-healing distribution networks that can quickly reroute power around outages.	Ontario Distribution Sector Review Board (2012). Renewing Ontario's Electricity Distribution Sector: Putting the Consumer First, p. 18.	SG-enabled self healing networks - Re-route power - Outage management

SG Excerpts: Policy, Regulations and Standards

Excerpt	**Source**	**Open Codes**
Under the Green Energy and Green Economy Act, electricity distributors are required to facilitate the connection of renewable energy sources to their systems and to undertake activities that will lead to a smart grid.	COLLUSPowerStream, 2013 Annual Report, p. 17.	GEGEA- enable SG GEGEA- enable renewables
In preparing for the smart grid future and in compliance with the Ontario government's mandate to build a "culture of conservation", ENWIN began the installation of smart meters in homes and small businesses across Windsor in 2010. We were required to complete these installations in preparation for the move to Time-of-Use pricing, which we anticipate for late 2012.	Enwin Utilities, 2010 Annual Report, p. 19.	Gov mandate: culture of conservation Smart meter roll out TOU pricing
The Green Energy Act, 2009 permits ENWIN and other Ontario electricity distributors to own renewable energy generation facilities, obligates LDC's to provide priority connection access for renewable energy generation facilities, empowers the OEB to set CDM targets for electricity distribution companies as a condition of license, and requires LDC's to accommodate the development and implementation of a smart grid in their systems.	Enwin Utilities, 2013 Annual Report, p. 22.	GEGEA- enable renewables GEGEA- enable CDM GEGEA- enable SG OEB set CDM targets
In the coming years, all local utilities will be expected to contribute to Ontario's ambitions for a "green" economy, not only with effective energy conservation and demand management strategies, but also with "smart grid" infrastructure improvements. Government and public expectations are very high.	Horizon Utilities, 2008 Annual Report, p. 5.	Green economy CDM strategies Smart grid
On September 21, 2009, the Minister of Energy and Infrastructure asked our company to proceed with the planning, development and	Hydro One, 2009 Annual Report, p. 4.	Infrastructure upgrades- SG

implementation of specific transmission projects, to develop and implement smart grid infrastructure, and to proceed with upgrades to enable distributed system connected generation.		Infrastructure upgrades- distributed generation
The Green Energy Act requires all distributors to file plans with the OEB on facilitating renewable energy generation and implementing a smart grid. It also amended the mandate of the OEB, expanding its objectives to include the promotion of CDM, facilitating the implementation of a smart grid and promoting the use and generation of electricity from renewable energy sources.	Hydro One, 2012 Annual Report, p. 26.	GEGEA OEB mandate
In its Guidelines released June 16, 2009, the OEB created four new deferral accounts to allow distributors to begin recording expenditures for certain activities relating to the connection of renewable generation or the development of a smart grid.	Hydro One, 2012 Annual Report, p. 53.	OEB deferral accounts - renewable generation - SG development
The GEA will also require the asset management plan to support the Smart Grid plans.	Kenora Hydro, 2009 Annual Report, p. 7.	GEGEA- enabled SG
Distributors assume added responsibilities to assist and enable consumers to reduce their peak demand and conserve energy in an effort to meet provincial conservation targets and also gain new responsibilities in transforming their local distribution networks into smart grids harnessing advanced technologies to facilitate the connection of small-scale generators and the two-way flow of information.	London Hydro, 2011 Annual Report, p. 23.	LDCs- consumers reduce peak demand LDCs- consumers conserve Provincial conservation targets LDC- SG implementation LDCs- enable renewables
Under the Green Energy and Green Economy Act, 2009, the Corporation and other Ontario electricity distributors have new responsibilities for enabling renewable generation, including investing in a smart grid, to accommodate any changes this may have on the local distribution of electricity.	PowerStream, 2009 Annual Report, p. 47.	GEGEA- enabled renewables GEGEA- enabled SG
Under the Green Energy and Green Economy Act, electricity distributors are required to facilitate the connection of renewable energy sources to their systems and to undertake activities that will lead to a smart grid	PowerStream, 2011 Annual Report, p. 47.	GEGEA- enabled renewables GEGEA- enabled SG
The Ontario Information and Privacy Commissioner has written extensively about privacy principles to govern the smart grid and smart metering data.	Ontario Smart Grid Forum (2012). *Access to Consumer Data: A Vignette*, p. 5.	Privacy principles
The Board shall provide guidance to licensed electricity distributors and transmitters, and other regulated entities whose fees and expenditures are reviewed by the Board, that propose to undertake smart grid activities, regarding the Board's expectations in relation to such activities in support of the establishment and implementation of a smart grid.	Ontario Ministry of Energy, Directive to the OEB, November 23, 2010, p. 2.	OEB evaluation criteria OEB SG guidance
For licensed distributors and transmitters, the guidance referred to in paragraph 1 shall be provided in particular to: (a) guide these regulated entities in the preparation of plans for the development and implementation of the smart grid, as contemplated in subparagraph 70(2.1)2(ii) of the Act ("Smart Grid Plans"); and (b) identify the criteria that the Board will use to evaluate Smart Grid Plans.	Ontario Ministry of Energy, Directive to the OEB, November 23, 2010, p. 2.	OEB evaluation criteria OEB SG guidance
The Lieutenant Governor in Council may make regulations governing the smart grid and its implementation, including regulations, (a) in respect of the timeframe for the development of the smart grid; (b) assigning roles and responsibilities for the development, implementation and standardization of the smart grid; (c) prescribing the standards for communications and any other aspects in respect of	Ontario Ministry of Energy (2009). *Green Energy and Green Economy Act,* p. 17.	GEGEA- enabled SG

the operation of the smart grid.		
The Minister may issue, and the Board shall implement directives, approved by the Lieutenant Governor in Council, requiring the Board to take such steps as are specified in the directive relating to the establishment, implementation or promotion of a smart grid for Ontario.	Ontario Ministry of Energy (2009). *Green Energy and Green Economy Act,* p. 25.	GEGEA-enabled SG
To make investments for the development and implementation of the smart grid in relation to the licensee's transmission system or distribution system.	Ontario Ministry of Energy (2009). *Green Energy and Green Economy Act,* p. 27.	GEGEA- enabled SG
Recognizing that the seven Privacy by Design principles developed by the Ontario Information and Privacy Commissioner provide valuable guidance with respect to compliance with applicable privacy laws and protecting consumers, these principles should be considered as best practice in the implementation of the smart grid in Ontario for both regulated and unregulated service providers.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 6.	SG privacy principles
Three weeks later, the government tabled Bill 150, the Green Energy and Green Economy Act 2009 (GEGEA), which included a specific mandate for smart grid development. The bill was passed into law on May 14, 2009, and established a firm base from which to push forward on smart grid policies and programs.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 10.	GEGEA-enabled SG
Ensure that renewable generation connection and smart grid implementation are incorporated into distribution system design and operations, and that distributors meet these requirements while delivering cost-effective and reliable service to consumers	OEB, Annual Report (2010-2011), p. 8.	OEB SG Guidance
During the past year stakeholders were invited to participate in a number of Board policy initiatives, including the Renewed Regulatory Framework for Electricity (RRFE), reviewing time-of-use price-setting, developing guidance for implementing Smart Grid, low-income customer service rules for the electricity sector, submetering code amendments and a new competitive process to select a company to ultimately build the East-West Tie transmission line in northwestern Ontario.	OEB, Annual Report (2011-2012), p. 4.	Renewed Regulatory Framework for Electricity OEB SG Guidance
Issue policy guidance for the review and approval of smart grid plans (1.1.2)	OEB, Annual Report (2011-2012), p. 8.	OEB SG Guidance
Distributors develop and implement smart grid systems consistent with the Smart Grid Directive and Board guidance.	OEB, Business Plan (2011-2014), p. 5.	LDC- SG implementation
The Board will issue guidance regarding Smart Grid.*	OEB, Business Plan (2010-2013), p. 3.	OEB SG Guidance
Issue policy guidance for the review and approval of smart grid plans.	OEB, Business Plan (2011-2014), p. 5.	OEB SG Guidance
The Board's approach to regulation is aligned with the policy framework established by the Government, including the policy framework relating to energy conservation and efficiency, to the implementation of a smart grid, and to the use and generation of electricity from renewable energy sources.	OEB, Business Plan (2013-2016), p. 12.	OEB SG Guidance GEGEA-enabled conservation GEGEA- enabled efficiency GEGEA-enabled renewables
Distributors will be required to file 5-year capital plans to support their rate applications. Planning will be integrated in order to pace and prioritize capital expenditures, including smart grid investments.	OEB (2012), Renewed Regulatory Framework for Electricity Distributors: a Report of the Board, p. 3.	OEB SG Evaluation Criteria
To facilitate the implementation of a smart grid in Ontario.	OEB (2012), Renewed Regulatory Framework for Electricity Distributors: a Report of the Board, p. 4.	OEB SG Deployment

With the coming into force of the Green Energy and Green Economy Act, 2009, several provisions were added to the OEB Act in relation to the development and implementation of a smart grid in Ontario. The Board now has a statutory objective to facilitate the implementation of a smart grid on Ontario, and it is a deemed condition of Report of the Ontario Energy Board - 46 - October 18, 2012 Renewed Regulatory Framework for Electricity license for all licensed electricity distributors and transmitters to plan for and make smart grid investments as directed by the Board	OEB (2012), Renewed Regulatory Framework for Electricity Distributors: a Report of the Board, p. 46.	OEB Statutory Objective OEB SG Guidance OEB SG Evaluation
On November 23, 2010, the Minister of Energy issued a Directive to the Board requiring it to provide guidance to licensed electricity distributors and transmitters (among possible others) regarding the Board's expectations in relation to smart grid activities.	OEB (2012), Renewed Regulatory Framework for Electricity Distributors: a Report of the Board, p. 47.	OEB SG guidance
Development of the Smart Grid: To develop the regulatory documents to implement the Minister's Directive and the Board's conclusions in the Report.	OEB (2012), Renewed Regulatory Framework for Electricity Distributors: a Report of the Board, p. 50.	OEB-enable SG
The Board will issue a Supplemental Report providing the Board's guidance on smart grid, including the integration of smart grid development into the overall regional and 18 The redefinition of certain line connection assets may also require proposed amendments to other regulatory instruments of the Board. Report of the Ontario Energy Board - 53 - October 18, 2012 Renewed Regulatory Framework for Electricity network planning filing requirements. The Board expects to issue the Supplemental Report on smart grid policy in January 2013, and to integrate the smart grid work into the Consolidated Capital Plan Filing Requirements.	OEB (2012), Renewed Regulatory Framework for Electricity Distributors: a Report of the Board, pp. 53-54.	OEB SG Guidance OEB SG Evaluation Criteria
In accordance with the Directive from the Minister of Energy dated November 23, 2010 ("Minister's Directive") the Ontario Energy Board (the "Board") is required to provide guidance to licensed distributors, transmitters and other entities, such as the Ontario Power Authority, the Independent Electricity System Operator, and the Smart Metering Entity whose fees and expenditures are reviewed by the Board, that propose to undertake smart grid activities (collectively the "regulated entities").	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 50.	OEB SG Guidance
The Minister's Directive states that the guidance provided by the Board is to set out the Board's expectations for regulated entities in the preparation of their plans for the development and implementation of the smart grid and identify the criteria that the Board will use to evaluate such plans.	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 1.	OEB SG Guidance OEB SG Evaluation Criteria
In 2009, the Green Energy and Green Economy Act, 2009 ("GEA") established an additional objective1 for the Board, namely, "to facilitate the implementation of a smart grid in Ontario"	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 2.	GEGEA-enabled SG
The Minister's Directive was issued pursuant to the authority provided by the GEA (by way of an amendment to the OEBA) and set out a number of objectives for the Board to consider in providing guidance on smart grid implementation, namely: customer control, power system flexibility and adaptive infrastructure.	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 2.	OEB Statutory Objective OEB SG Guidance SG-Objective Customer control SG-Objective Power System Flexibility SG-Objective Adaptive Infrastructure
Of most relevance to smart grid activities and related guidance to regulated entities are the policies regarding capital planning, innovation, and coordination.	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 4.	OEB SG Guidance - capital planning - innovation

		- coordination
This approach provides for a flexible and robust framework. It ensures that the smart grid objectives and policy objectives set out in the Minister's Directive are considered as part of the overall approach to regulation and rate-setting for regulated entities.	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 6.	Flexible regulatory framework
The Board has determined that smart grid activities by regulated entities should facilitate data access.	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 11.	Data access
Regulated entities must demonstrate in their investment plans that they have investigated opportunities for operational efficiencies and improved asset management, enabled by more and better data provided by smart grid technology.	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 15.	OEB SG Evaluation Criteria - operational efficiencies - asset management
These consultations will conclude with the issuance of filing requirements and guidance, code amendments, and/or supplemental Board policies that will provide further information to distributors and other regulated entities regarding the implementation of smart grid.	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 22.	OEB SG Guidance OEB SG Evaluation Criteria
The proposed Green Energy Act envisages a 21st century "smart" power grid that would make it easier for renewable energy sources such as wind, water and biomass to get online and realize their full potential. The smart grid would also enable the launch of smart meters and time-of-use pricing, as well as prepare Ontario for new technologies like electric cars.	OME, Results-Based Plan (2009-2010), p. 7.	GEGEA- enabled SG SG-enabled renewables SG-enabled smart meters SG-enabled TOU SG-enabled EVs
Building on the successful rollout of the smart meter infrastructure, and the objectives laid out in the GEGEA, the ministry developed a policy framework for smart grid implementation in Ontario. This framework outlined a set of principles and objectives for Ontario's smart grid and was sent as a Ministerial Directive to the Ontario Energy Board (OEB).	OME, Results-Based Briefing Book (2012-2013), p. 31.	GEGEA- SG Objectives
The OEB, in consultation with a working group consisting of various sector participants, is currently using the Directive to develop a framework for LDCs to use for the smart grid implementations.	OME, Results-Based Briefing Book (2012-2013), p. 31.	OEB SG Guidance LDC- SG Implementation
In February 2013, the OEB issued its Supplemental Report on Smart Grid. This report provides further guidance on the Board's expectations for regulated entities in the preparation of their plans for the development and implementation of the smart grid and identifies the criteria that the Board will use to evaluate such plans.	OME, Results-Based Briefing Book (2013-2014), p. 36.	OEB SG Guidance OEB SG Evaluation Criteria
The Board shall provide guidance to licensed electricity distributors and transmitters, and other regulated entities whose fees and expenditures are reviewed by the Board, that propose to undertake smart grid activities, regarding the Board's expectations in relation to such activities in support of the establishment and implementation of a smart grid.	Ontario Ministry of Energy (2010). Directive to the OEB: November 23, 2010, p. 2.	OEB SG Guidance OEB SG Evaluation Criteria
For licensed distributors and transmitters, the guidance referred to in paragraph 1 shall be provided in particular to: (a) guide these regulated entities in the preparation of plans for the development and implementation of the smart grid, as contemplated in subparagraph 70(2.1)2(ii) of the Act ("Smart Grid Plans"); and (b) identify the criteria that the Board will use to evaluate Smart Grid Plans.	Ontario Ministry of Energy (2010). Directive to the OEB: November 23, 2010, p. 2.	LDC- SG Implementation OEB SG Evaluation Criteria
In developing the guidance referred to in paragraph 1, and in evaluating the Smart Grid Plans and activities undertaken by the regulated entities referred to in that paragraph, the Board shall be	Ontario Ministry of Energy (2010). Directive to the OEB: November 23, 2010, p. 2.	OEB SG Evaluation Criteria SG Objectives

guided by, and adopt where appropriate, the parameters for the three objectives of a smart grid referred to in subsection 2(1.3) of the definition for "smart grid" as provided for under the Electricity Act, 1998, where such elements of said objectives are set out in Appendices A through C.		
For example, development of interoperability standards is a crucial element of smart grid development and is an effort that no single national government should have a monopoly over.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 12.	Interoperability Standards
As noted earlier, the Ontario Energy Board (OEB), has clarified its position allowing for competition for behind the-meter services as part of its Renewed Regulatory Framework for Electricity. Given this regulatory development, the Smart Grid Forum intends to continue to monitor the impact on smart grid investment as it takes effect over the coming years.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 13.	Renewed Regulatory Framework for Electricity SG Forum monitor SG investment
With the recent completion of the OEB's Renewed Regulatory Framework for Electricity, this stream of smart grid investment will become even more entrenched in the fabric of Ontario's electricity system.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 14.	Renewed Regulatory Framework for Electricity SG Investments
Definition of "smart grid" and its objectives, has also provided an expansive test of a power system's ability to integrate variable, renewable sources of generation at both the bulk electricity system level and the distribution level. For example, in the regulatory arena, the Ontario Energy Board has signalled in a recent report that it will be regularly monitoring distributor performance in the areas of "Customer Focus, Operational Effectiveness, Public Policy Responsiveness, and Financial Performance" as part of the same framework that will provide oversight to LDC expenditures on smart grid-related products and services	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 1.	SG Objectives LDC Evaluation Guidelines - Customer focus - Operational effectiveness - Public policy responsiveness - Financial performance SG Evaluation Criteria
As noted earlier in this paper, there has been a multitude of public policy developments in Ontario's smart grid arena. In the space of five years, this province's smart grid-related policy landscape has gone from a relatively narrow focus on smart meter implementation to a broad framework for smart grid development spanning legislation, regulatory instruments and strategic public investments	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 18.	SG-related legislation SG-related regulatory instruments SG-related public investments
The Ontario Energy Board's recently-completed Renewed Regulatory Framework for Electricity, developed on the foundation of the high-level smart grid principles established over the course of 2010 holds the promise of addressing a wide swath of issues and recommendations raised by the Smart Grid Forum over the past five years.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 18.	Renewed Regulatory Framework for Electricity SG Principles
Earlier in 2013, the Ontario Energy Board began to clarify its own role with respect to ensuring publicly-regulated utilities take measures to "…require regulated entities to provide evidence of meeting appropriate cyber-security and privacy standards."34 The Forum has previously noted however, that overall cyber-security of the smart grid will increasingly rely on the actions of non-regulated third parties who don't necessarily fall under this framework.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 18.	OEB SG Guidance OEB SG Evaluation Criteria Privacy principles Security standards
Going forward, the Ontario Energy Board's Renewed Regulatory Framework for Electricity, will govern distribution-side investment in the smart grid over the coming years.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment: A Vignette, p. 19.	OEB SG Guidance
The Green Energy Act sets the framework for a smart grid to enable changes in electricity consumer behaviour, implementation of innovative technologies and connection of more renewable generation.	OPA, 2009 Annual Report, p. 11.	GEGEA- enable SG SG-enable change in consumer behavior

		SG-enabled renewable connections
Changes were made by the Ontario Energy Board to existing codes and guidelines to ensure compatibility with these new programs and the government's energy policy and to enable the smart grid.	OPA, 2009 Annual Report, p. 23.	OEB-enabled SG
This will involve examining ways to streamline the regulatory framework to enable distributed generation, as well as participating in Ontario smart grid initiatives to determine their implications for distributed generation development, contracting and pricing.	OPA, Business Plan (2009-2011), p. 24.	OEB-enable distributed generation SG- impacts on distributed generation - contracting - pricing
We hope this best practice document will assist utilities, including those in the United States and around the world, to understand how Fair Information Practices (FIPs) and Privacy by Design can be incorporated into the design and architecture of Smart Grid systems. Utilities will benefit enormously from striving to achieve the Gold Standard in Data Protection for the Smart Grid	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. iii.	Privacy principles
Privacy by Design (the Gold Standard for data protection), is the standard to be adopted for Smart Grid implementation for data protection.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 1.	Privacy principles
Functional specifications were issued by the Government that all electricity providers must meet in achieving smart meter policy goals to support the Smart Grid, and the Smart Metering Entity is responsible for the consolidation, management and storage of consumer electricity consumption information.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 1.	Consumer data storage Consumer data management
This is illustrated through two use case scenarios describing the implementation of Privacy by Design into Smart Grid projects in the areas of 1) customer information access and 2) customer enablement.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 2.	Privacy principles
Privacy standards are needed against which utility stakeholders can map their Smart Grid developments and implementation.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 4.	Privacy principles
The purpose of this paper is to put forward Privacy by Design (the Gold Standard for data protection) as the standard to be adopted for Smart Grid implementation, in order to protect data privacy.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 4.	Privacy principles
In addressing challenges arising from changes experienced by utilities in implementing the Smart Grid, utilities may find opportunities to adopt Privacy by Design when introducing new technologies, integrating communications, operational and information systems, as well as when updating business processes.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 14.	Privacy principles
We have developed the following best practices for new Smart Grid projects by adapting the language and concepts contained in the IPC's paper Privacy by Design: The 7 Foundational Principles Smart Grid projects involving consumer information require privacy considerations to be integrated into their development, right from the project inception phase.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 15.	Privacy principles
illustrates how a supplementary requirement such as an "Access	Information and Privacy	Privacy principles

Failure Threshold" can be incorporated and traced within the design of a Customer Information Access program, which would then be reviewed by the Smart Grid project team to ensure that it also meets their business needs:	Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 19.	
The requirement definition stage of any adopted Smart Grid project methodology involves the creation of one or more use cases to satisfy core foundational privacy requirements, such as "Access Failure Threshold," showing interactions between various actors (people and systems), as well as the functionality that will be delivered by the systems involved.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 12.	Privacy principles
The requirement definition stage of any adopted Smart Grid project methodology involves the creation of one or more use cases to satisfy core foundational privacy requirements, such as "limit data," showing interactions between actors (people and systems), as well as the functionality that will be delivered by the systems involved.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 20.	Privacy principles
This distinction demonstrates several tenets of the Smart Grid Privacy by Design.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 25.	Privacy principles
To that end, the Green Energy Act has amended the Ontario Energy Board Act, 1998 to, among other things: add to the Board's statutory objectives those of facilitating the implementation of a smart grid and of promoting the use and generation of electricity from renewable resources;	OEB (2010). Report of the Board: Regulatory Treatment of Infrastructure Investment for Ontario's Electricity Transmitters and Distributors, p. 2.	OEB Statutory Objective OEB facilitate SG OEB promote renewables
require electricity distributors and transmitters to plan for and implement infrastructure investments designed to accommodate the connection of anticipated increased levels of renewable generation or to develop and implement a smart grid in the manner and at the times mandated by the Board.	OEB (2010). Report of the Board: Regulatory Treatment of Infrastructure Investment for Ontario's Electricity Transmitters and Distributors, p. 3.	OEB SG Guidance LDC- SG Implementation
Ratepayer groups took the position that electricity utilities do not need incentives to undertake these investments since they are already mandated under the Green Energy Act to expand or reinforce their systems to accommodate the connection of renewable generation and to develop and implement the smart grid.	OEB (2010). Report of the Board: Regulatory Treatment of Infrastructure Investment for Ontario's Electricity Transmitters and Distributors, p. 7.	GEGEA- enabled renewable generation GEGEA- enabled SG

SG Excerpts: Smart Grid Objectives

Excerpt	**Source**	**Open Codes**
The collaboration can take many forms with the objectives to create sustainable efficiencies in its field operations, asset utilization, maintenance and replacement and leveraging smart grid technologies all in the effort to provide reliable service to the customer base within a capital efficient model.	COLLUSPowerStream, 2013 Annual Report, p. 37.	SG-enabled reliability
The third objective is for the OEB to facilitate the promotion of a smart grid.	PUC Inc., 2009 Annual Report, p. 6.	OEB facilitate SG
In developing the guidance referred to in paragraph 1, and in evaluating the Smart Grid Plans and activities undertaken by the regulated entities referred to in that paragraph, the Board shall be guided by, and adopt where appropriate, the parameters for the three objectives of a smart grid referred to in subsection 2(1.3) of the definition for "smart grid" as provided for under the Electricity Act, 1998, where such elements of said objectives are set out in Appendices A through C.	Ontario Ministry of Energy (2010). Directive to the OEB: November 23, 2010	OEB- SG Guidance OEB Evaluation criteria Government Policy Objectives
Standards and security are vital if the smart grid is to develop	Smart Grid Forum (2009). Enabling	Security standards

efficiently over time.	Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 5.	Efficient SG development
To deliver on its promise, the smart grid must enable the transparent exchange of operating and price information to efficiently link customer choices with the dispatch of resources and the operation of the electricity grid.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 7.	Consumer Data SG-enhanced consumer control
The Forum believes that a smart grid must enable devices that will allow these consumers to gain greater control over their electricity usage to lower costs, improve convenience and support growing environmental awareness.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 16.	SG-enabled consumer control SG-support environmental awareness
A smart grid must also facilitate consumer installation of small-scale self-generation through renewable technologies and help them sell any excess generation back to the grid.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 16.	SG-enable small-scale generation SG-enable renewable technologies
The goal of a smart grid is to use advanced information-based technologies to increase grid efficiency, reliability and flexibility.	IESO, Business Plan (2010-2012), p. 2.	SG-objective grid efficiency SG-objective grid reliability SG- objective flexibility
In collaboration with government, it defined high-level smart grid principles that are being used to guide development and rulemaking (see Appendix A).	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 5.	SG Principles
Much work was also done by the Forum, in collaboration with the Ontario Ministry of Energy, to develop high-level principles and objectives that will inform the crafting of smart grid policies and selection of technologies over the coming years	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 10.	Ontario SG Forum SG principles and objectives - inform policy - inform selection of technologies
After extensive discussion, the following 10 Smart Grid Principles were identified: Efficiency, Customer Value, Coordination, Interoperability, Security, Privacy, Safety, Economic Development, Environmental Benefits, and Reliability. In addition, 14 specific objectives were identified that fall under the banners of customer control, power system flexibility and adaptive infrastructure – the three broad smart grid objectives recognized under the GEGEA.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 13.	SG Forum SG Principles: - Efficiency - Customer Value - Coordination - Interoperability - Security - Privacy - Safety - Economic Development - Environmental benefits - Relilability Specific Objectives - customer control - power system flexibility - adaptive infrastructure
In November 2010, the Minister of Energy recognized these principles and specific objectives through an Order in Council, a significant milestone that laid the foundation for smart grid development in the province and set the stage for broader industry participation.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 10.	SG Principles SG Objectives SG Foundations
In November, the Minister also directed the OEB to use high-level smart grid principles and specific objectives, established in collaboration with the Forum, to develop guidance for regulated companies as they move to develop and implement their smart grid plans.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 12.	SG Principles SG Objectives OEB SG Guidance
Privacy is one of the 10 high level smart grid principles developed	Ontario Smart Grid Forum (2011).	SG Principle: Privacy

in consultation with the Forum and now recognized by government directive. The Privacy Commissioner's seven foundational Privacy by Design principles have also been formally recognized by the Forum. Consumers need to know that their personal information is protected. Otherwise, they may lose confidence in smart grid efforts.	Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 21.	Privacy principles
Security, another smart grid principle, is essential to protecting consumer privacy and is integral to many aspects of grid operation.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 21.	SG Principle: Security
Customer Value is a smart grid principle.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 22.	SG Principle: customer value
From the perspective of Environmental Benefits, a smart grid principle, electric vehicles make tremendous sense for a province such as Ontario.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 26.	SG Principle: Environmental benefits - EV
Principles guiding smart grid development in Ontario – specifically the principles of Coordination and Interoperability – will assure that the province's utilities and broader industry align with procurement and deployment efforts across the continent.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 28.	SG Principles: coordination SG principles: interoperability Continental standards
The Smart Grid Directive has provided policy guidance to the Board and industry regarding the development of the smart grid. The Directive highlights the following objectives: operational efficiency, customer value, regional coordination, interoperability, security, privacy, safety, economic development, environmental benefits, and reliability.	OEB Business Plan (2011-2014), p. 4.	OEB SG Guidance Policy Objectives - operational efficiency - customer value - regional coordination - interoperability - security - privacy - safety - economic development - environmental benefits - reliability
Additional objectives in relation to electricity are economic efficiency and cost-effectiveness, smart grid implementation and the use of renewable energy sources.	OEB, Business Plan (2013-2016), p. 18.	Electricity Objectives: - economic efficiency - cost effectiveness - smart grid implementation - renewables
In developing that guidance, the Board is to be guided by certain parameters for three objectives for the smart grid, namely, customer control objectives, power system flexibility objectives and adaptive infrastructure objectives.	OEB (2012), Renewed Regulatory Framework for Electricity Distributors: a Report of the Board, p. 47.	OEB SG Guidance SG Policy Objectives - customer control - power system flexibility - adaptive infrastructure objectives
The Board is also to be guided by 10 policy objectives of the government, including policy objectives pertaining to efficiency, customer value, interoperability, and privacy.	OEB (2012), Renewed Regulatory Framework for Electricity Distributors: a Report of the Board, p. 47.	SG policy objectives - efficiency - customer value - interoperability - privacy
This approach to smart grid investments and activities will best support the achievement of the objectives of the renewed regulatory framework.	OEB (2012), Renewed Regulatory Framework for Electricity Distributors: a Report of the Board, p. 48.	Renewed regulatory framework objectives
One of the objectives of the smart grid set out in the Minister's	OEB (2012), Renewed Regulatory	SG Obj- consumer control

Directive is customer control. Parameters for that objective include enabling access to data by authorized parties, enabling consumers to better control their consumption and providing consumers with opportunities to participate in small-scale renewable generation.	Framework for Electricity Distributors: a Report of the Board, p. 48.	- authorized access to data - consumer control consumption - prosumer
As discussed above, the Minister's Directive requires the Board to provide regulated entities with the Board's guidance and expectations in relation to the establishment and implementation of a smart grid within the parameters of three objectives set out in the Minister's Directive: customer control, power system flexibility, and adaptive infrastructure.	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 5.	OEB SG Guidance Policy Objectives - consumer control - flexibility - adaptive infrastructure
The Board is of the view that, in fulfilling the adaptive infrastructure objective the Working Group could be relied upon to provide advice to the Board regarding the deployment of smart grid technologies and activities.	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 16.	SG Obj: Adaptive Infrastructure SGWG to advise OEB on SG technologies
In developing plans in response to the Board's smart grid guidance, distributors will be expected to demonstrate how their plans address safety.	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 18.	OEB SG Guidance OEB Evaluation Criteria
Further, in developing the guidance referred to in paragraph 1 and in evaluating the smart grid activities of the regulated entities referred to in that paragraph, the Board shall be guided by the following policy objectives of the government:	Ontario Ministry of Energy, Directive to the OEB, November 23, 2010	OEB SG Evaluation Policy Objectives
(i) (ii) (iii) Efficiency: Improve efficiency of grid operation, taking into account the cost-effectiveness of the electricity system. Customer value: The smart grid should provide benefits to electricity customers. Co-ordination: The smart grid implementation efforts should be coordinated by, among other means, establishing regionally coordinated Smart Grid Plans ("Regional Smart Grid Plans"), including coordinating smart grid activities amongst appropriate groupings of distributors, requiring distributors to share information and results of pilot projects, and engaging in common procurements to achieve economies of scale and scope. (iv) Interoperability: Adopt recognized industry standards that support the exchange of meaningful and actionable information between and among smart grid systems and enable common protocols for operation. Where no standards exist, support the development of new recognized standards through coordinated means. (v) (vi) Security: Cybersecurity and physical security should be provided to protect data, access points, and the overall electricity grid from unauthorized access and malicious attacks. Privacy: Respect and protect the privacy of customers. Integrate privacy requirements into smart grid planning and design from an early stage, including the completion of privacy impact assessments. (vii) Safety: Maintain, and in no way compromise, health and safety protections and improve electrical safety wherever practical. (viii) Economic Development: Encourage economic growth and job creation within the province of Ontario. Actively encourage the development and adoption of smart grid products, services, and innovative solutions from Ontario-based sources. (ix) (x) Environmental Benefits: Promote the integration of clean technologies, conservation, and more efficient use of existing technologies. Reliability: Maintain reliability of the electricity grid and improve it wherever practical, including reducing the impact, frequency and duration of outages.	Ontario Ministry of Energy, Directive to the OEB, November 23, 2010	Efficiency - Operation efficiency - Cost effective Customer value - SG benefits Coordination - Regional Smart Grid Plans - Economies of scale Interoperability - Recognized industry standards - Common operation protocol - Develop standards Security - Cybersecurity - Physical security - Protect data - Unauthorized access - Malicious attacks Privacy - Protect and Respect - Consumers privacy - Privacy impact assessments Safety Economic development - Growth - Job creation - Ontario Based Sourcing Environmental benefits - Clean technology - Conservation - Efficient use of existing tech Reliability - Maintain and improve

		- Outage management
EDUCATION: Actively educate consumers about opportunities for their involvement in generation and conservation associated with a smarter grid, and present customers with easily understood material that explains how to increase their participation in the smart grid and the benefits thereof.	Ontario Ministry of Energy, Directive to the OEB, November 23, 2010	Consumer Education - generation involvement - conservation involvement - SG benefits
FLEXIBILITY: Provide flexibility within smart grid implementation to support future innovative applications, such as electric vehicles and energy storage.	Ontario Ministry of Energy, Directive to the OEB, November 23, 2010	Flexibility - support applications
FORWARD COMPATIBILITY: Protect against technology lock-in to minimize stranded assets and investments and incorporate principles of modularity, scalability and extensibility into smart grid planning.	Ontario Ministry of Energy, Directive to the OEB, November 23, 2010	Forward Compatibility - modularity - scalability - extensibility
ENCOURAGE INNOVATION: Nest within smart grid infrastructure planning and development the ability to adapt to and actively encourage innovation in technologies, energy services and investment / business models.	Ontario Ministry of Energy, Directive to the OEB, November 23, 2010	Encourage Innovation
MAINTAIN PULSE ON INNOVATION: Encourage information sharing, relating to innovation and the smart grid, and ensure Ontario is aware of best practices and innovations in Canada and around the world.	Ontario Ministry of Energy, Directive to the OEB, November 23, 2010	Maintain Pulse on Innovation - information sharing - best practice
The forum is developing a vision for a provincial smart grid that would provide consumers with more efficient, responsive and cost-effective electricity service. Its goals are to increase the efficiency, reliability and flexibility of the grid through the use of advanced, information-based technologies that enable two-way flows of both information and electricity.	OPA, 2008 Annual Report, p. 21.	SG-goal: grid efficiency SG-goal: grid reliability SG-goal: grid flexibility
Smart Grid systems must avoid any unnecessary trade-offs between privacy and legitimate objectives of Smart Grid projects;	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 2.	Privacy principles
Smart Grid systems must be visible and transparent to consumers — engaging in accountable business practices — to ensure that new Smart Grid systems operate according to stated objectives;	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 2.	Privacy principles

SG Excerpts: SG Technology

Excerpts	Source	Open Codes
Testing of smart metering solutions at BHEI attracted the attention of our industry peers: most notably, the fibre-enabled smart grid test pilot initiated in Kilbride in 2007.	Burlington Hydro, 2008 Community Report, p. 4.	Smart meter
COLLUS Power will continue to invest in the SCADA technologies to help identify areas where distribution infrastructure can be reinforced to facilitate smart grid technologies.	Collingwood Utility Services Business Plan, 2009-2011, p. 19.	SCADA to Facilitate SG technology
Future plans for smart grid development include a real time interface between Smart Metering, SCADA and OMS. Collus PowerStream continues to monitor Smart Grid development pilots around the province and other jurisdictions.	COLLUSPowerStream, 2013 Annual Report, p. 15.	Real-time interface: - Smart meter - SCADA - OMS
SMART GRID OPERATIONS TECHNOLOGY—MICRO GRID	COLLUSPowerStream, 2013 Annual Report, p. 48.	SG-enable micro-grid
Last year, Enersource invested more than $49 million in critical	Enersource, 2008 Annual Report, p.	Infrastructure investments:

distribution infrastructure assets, with a focus on system reliability, customer care, growth and smart grid technologies including the Integrated Operating Model and smart meters.	5.	- system reliability - customer care - growth SG Investments: - Integrated operating model - Smart meter
Enersource launched a significant smart grid initiative through the creation of the Integrated Operating Model (IOM). This innovative operations software solution enhances distribution system intelligence, operating performance, reliability, customer outage responsiveness and public safety.	Enersource, 2009 Annual Report, p. 10.	Integrated Operating Model (IOM) - distribution system intelligence - operating performance - reliability - customer outage - responsiveness - public safety
ENWIN also continued to invest in Smart Grid technology to automate the system while providing the organization with detailed, realtime information that can be used to identify potential issues and correct them	Enwin Utilities, 2013 Annual Report, p. 6.	System automation Real-time information
Smart meters are a key component of "Smart Grid" and Haldimand County Hydro began its mass deployment of these meters in July 2009 and, by December 31, 2010, 20,245 smart meters, representing 97% of the total, were installed as well as the required telecommunications infrastructure.	Halimand County Utilities, 2010 Annual Report, p. 6	Smart meter rollout
Smart meters are an essential part of building a smart grid for Ontario.	Hydro One, 2008 Annual Report, p. 11.	Smart meters
Hydro One played a leadership role in the technical assessment and acquisition of the 1.8–1.83 GHz spectrum for Smart Grid applications.	Hydro One, 2009 Annual Report, p. 4	1.8–1.83 GHz spectrum for Smart Grid applications.
With this, the Company installed six WiMax base stations that will allow it to test smart grid applications related to the ADS project. In recognition of these innovations, the Utilities Telecom Council awarded Hydro One the 2010 APEX Award for Smart Grid System Design.	Hydro One, 2011 Annual Report, p. 9.	SG Applications- ADS project
A new Supervisory Control and Data Acquisition (SCADA) system was installed to meet the ever changing needs of smart grid and protection systems. This system allows for real time monitoring of all circuits and allows for archiving of the interruption data for use in our annual reporting to the regulator, the Ontario Energy Board.	Kenora Hydro, 2012 Annual Report, p. 8.	SCADA Real time monitoring Archive interruption data
Investment in information and communications technology systems has been significant and is expected to remain so into the future to facilitate and integrate the smart-meter, smart-grid, Outage Management System (OMS) and other key systems. This investment is expected to continue at approximately $3 million to $5 million per year.	London Hydro, 2011 Annual Report, pp. 8-9.	System Integration - smart meter - smart grid - OMS
Even with the requirement to communicate with all consumers, however the communication systems that the utilities are developing for smart meters will not be adequate to support full smart grid development. The communications needs associated with the collection of meter data are different from those of grid operations. Additional bandwidth and redundant service will be needed for grid operations because of the quantity of operational data, the speed required to use it and its criticality.	Ontario Smart Grid Forum (2009). Enabling Tomorrow's Electricity System: Report of the Ontario Smart Grid Forum, p. 35.	Communication system upgrades Additional with bandwidth- grid operation Redundant Service- grid operation
This included continuing to add smart grid capabilities to our distribution network by installing advanced monitoring and control	Oshawa PUC Networks, 2012 Annual Report, p. 4.	Advanced monitoring technology

technology as part of the scheduled replacement of two of our municipal substations.		Advanced control technology
Steps have already been taken to increase reliability through the installation of "self-healing" technologies such as digital Fault Detection Isolation Restoration (FDIR) devices and digital fault indicators for feeders on the FlexNet Advance Metering Infrastructure (AMI) system which, with the installation of smart meters for all customers, are the building blocks in the creation of a Smart Grid system.	PowerStream, 2009 Annual Report, p. 25.	Self-healing technology FIDR Advanced Metering Infrastructure
A smart grid requires a communications layer to be "smart" – PowerStream utilizes fibre optics communications for data collection, control, meter data transmission and video. (bottom right) Smarter protective relays used in PowerStream's transformer stations helps to reduce the impact of outages in the company's service area.	PowerStream, 2009 Annual Report, p. 27.	Fibre Optics Communications - data collection - data control - meter data transmission - video Smart protective relays: Reduce outage impacts
Two essential Smart Grid projects were successfully implemented in 2009; specifically, the Advanced Meter Infrastructure – Outage Management System – Geographic Information System (AMI-OMS-GIS) interface project which significantly improves outage management reporting and the transformer-based smart energy management system.	PowerStream, 2009 Annual Report, p. 35.	AMI- OMS-GIS Interface
the installation of another 71,379 smart meters and the continued enhancement of our distribution system through implementation of Smart Grid initiatives.	PowerStream Annual Report, 2010, p. 8.	Smart meter rollout
PowerStream's commitment to excellence in electricity distribution operations was also evident through our Smart Grid initiatives. In addition to finalizing our Smart Grid Strategy document, we installed another 71,379 smart meters and migrated 214,625 residential customers to Time-of-Use (TOU) rates.	PowerStream Annual Report, 2010, p. 17.	LDC Smart grid strategy Smart meter rollout TOU rates
One of the leading smart grid technology demonstration projects initiated in 2012 was the micro grid project whereby portions of the distribution grid could separate and operate on its own, using renewable energy sources such as solar and wind in combination with storage and clean internal combustion generation	PowerStream, 2012 Annual Report, p. 19.	SG demo- micro-grid - renewable energy - storage
The Micro Grid demonstration project marked the next phase in the company's aim of supporting Smart Grid development at the provincial level and raising awareness for the need to leverage innovative 'smart' technologies in Ontario's electricity sector.	PowerStream, 2013 Annual Report, p. 27.	SG Demo- Micro-grid - consumer awareness - leverage SG technology
The marquee Smart Grid initiative for 2013 was the installation of PowerStream's Micro Grid Demonstration Project at PowerStream's Head Office in Vaughan.	PowerStream, 2013 Annual Report, p. 39.	Micro-grid demo
There were a number of Smart Grid initiatives undertaken and completed in 2013 including the Transformer Loading Analytical Tool, Plug-N-Drive EV Mapping Project, Green Button Initiative, High Speed Breaker Re-Closing, SmartGrid Success Metrics (with NRCan and CANMET),	PowerStream, 2013 Annual Report, p. 40.	SG Initiatives: - Transformer loading analytical tool - EV mapping project - Green button initiative - High speed breaker - Smart grid success metric
The current process for treating these incidents in the Outage Management System relies on the smart meter "last gasp" communications and automated switching in order to effectively track customer outages. This process works well under normal outage situations, due to the smart grid and remote switching functionality currently in place, in which power is generally restored	PowerStream, 2013 PowerStream Ice Storm Review, p. 26.	OMS Automated switching

within a short timeframe.		
Smart meters will be the foundation upon which a smart grid will evolve.	PUC Inc., 2008 Annual Report, p. 5.	Smart meter
While SCADA is central to Veridian's management of the grid, new technologies are giving the company intelligent networks, outage management systems, Internet-based applications, and system automation equipment that will pay dividends in better reliability and efficiency. The smart grid is giving companies like Veridian the capability to resolve system issues instantly and independent of human action.	Veridian, 2009 Annual Report, p. 10.	OMS System automation - reliability - efficiency
Veridian has initiated investments in this new technology, which will increase the company's ability to remotely monitor network performance and will see the deployment of intelligent switches that are capable of automatically rerouting and restoring power flow in the event of a system disruption.	Veridian, 2010 Annual Report, p. 18.	Network monitoring Intelligent switches - automatic power reroute TOU
Veridian is aligned with the Ministry of Energy's vision for Ontario to be the leading centre for smart grid technology. With 99.7 per cent of households being billed under time-of-use (TOU) rates by the end of 2011, Veridian had completed its transition to the new system.	Veridian, 2011 Annual Report, p. 17.	Ontario SG leader TOU System Transition
These companies are also developing or exploring smart grid activities beyond smart metering. Examples of these activities include ongoing efforts to increase available communications options and promote the creation of a communications spectrum for use by electric utilities; projects to install distribution transformer monitors and related communications equipment; and increased installation of automated distribution equipment.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 3.	Communication spectrum Distribution monitors Transformer monitors System automation
By 2011, the most visible elements of smart grid deployment will be the completion of smart meter installation and the introduction of residential time-of-use rates with the customer communications necessary to support them.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 15.	Smart meter TOU
Utilities will be demonstrating smart grid technologies in operations and planning.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 15.	LDC SG demonstrations
Additional work to demonstrate the use of smart grid technologies to help integrate distributed energy resources will be underway.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 15.	SG-enabled distributed generation
Many of the technologies that will be used to collect, manage and analyze smart grid information are currently being developed.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 22.	SG Data management technologies
The OCE currently funds a number of projects in areas related to the smart grid. These areas include: small scale solar photovoltaic plant impacts on the distribution system and integrating large-scale photovoltaic plants into the grid; developing tools for the competitive provision of reactive power in electricity markets; working to establish a communications protocol for home energy management systems; developing a web-based tool to control energy use; and technology to improve the detection and isolation of system faults.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 42.	SG-enabled small scale generation SG-enabled reactive power Communication protocol for home energy management Web-based tool to control energy use Detection and isolation of system faults

The OCEE also has begun a process to search for new smart grid projects involving large capacity energy storage, large scale penetration of PHEVs, consumer information and methods of increasing grid capacity.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 42.	SG-enabled storage SG-enabled renewables SG-enabled increased grid capacity
The report also aims to highlight gaps that have emerged and ensure that the province can take full advantage of certain smart grid technologies, such as distributed energy storage.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 6.	SG-enabled distributed generation
The Forum also looked at what the smart grid would mean to electricity consumers by providing greater visibility and control over energy use and enabling the widespread adoption of electric vehicles, "smart" appliances, energy management services, and distributed forms of generation, such as rooftop solar photovoltaic panels.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 9.	SG-impact consumer visibility SG-impact consumer control EV deployment Smart appliances Energy management services Distributed generation Renewables
The level of sophistication of the smart home is seen to rise considerably by 2030, when smart homes, appliances, electric cars, and distributed generation will be capable of seamless and secure interaction, embodying the two-way flow and management of electricity envisioned in a mature smart grid.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 11.	Smart homes Smart appliances EV Distributed generation
PowerStream, a large LDC that serves 11 communities north of Toronto, is testing a new software system that, when fully implemented, will demonstrate a real application of a self-healing grid. "It's the ability of the grid to detect a fault, isolate it, initiate switching and reconfigure the system so only the minimum number of customers are affected," explained John Mulrooney, the utility's director of smart grid technologies.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 15.	Self-healing grid
The utility and its partners, including environmental organization Pollution Probe, will study driving habits, charging patterns, and vehicle performance in an urban setting. The data collected from this project will guide the utility's smart grid investments by helping it anticipate the future impacts of vehicle charging on its local system.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 15.	EV Charging Impacts
It has also opened an electric vehicle education and demonstration centre in downtown Toronto. Plug 'N Drive Ontario and EC3 Initiative are two groups also collaborating with industry and utilities to better understand and facilitate the introduction of electric vehicles and enabling smart grid technologies.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 16.	EV Demo SG-enable EV
Smart grid technologies, such as lighting and heating, ventilating, and air conditioning (HVAC) automation systems, are also being tested and deployed in many of the province's largest commercial buildings under the stewardship of the Building Owners and Managers Association (BOMA), which in Ontario includes affiliates BOMA Toronto and BOMA Ottawa.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 17.	Smart grid technology - HVAC - Automation systems
A project in downtown Toronto, led by Electrovaya Inc. with support from NRCan, HydroOne, Manitoba Hydro, Ryerson University and OCE is currently exploring the potential of using old lithium-ion batteries from electric vehicles for a variety of smart grid applications.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 27.	Old batteries for SG applications

Utilities, as operators of Ontario's publicly owned electricity system infrastructure, bring invaluable expertise to the table that can guide innovation around energy storage, distributed generation, energy management, electric transportation and other smart grid-related technologies. But their investment in this area, relative to spending on infrastructure, will be small.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 31.	SG-enabled energy storage SG-enabled distributed generation SG-enabled energy management SG-enabled electric transportation
Smart grid development and implementation activities will be a central focus of that effort, given that grid-enhancing advanced technology systems and equipment are at the heart of the smart grid.	OEB: Renewed Regulatory Framework for Electricity Distributors: A Report of the Board, p. 49.	SG Development and Implementation Advanced Technology Systems and Equipment
Ontario's local distribution companies (LDC) continue to build on their smart grid efforts and piloting leading edge technologies. One example is PowerStream's Fault Detection Isolation & Restoration (FDIR) system which helps the Distributor to reduce outage duration for customers on non-faulted sections of the faulted feeder.	OME, Results Based Plan Briefing Book (2013-2014), p. 17.	Fault Detection Isolation and Restoration system (FDIR) • outage reduction
New projects funded included a smart grid enabled household appliance initiative, an innovative algae biomass industrial cogeneration system and a web-based commercial lighting field control demonstration.	OPA, 2009 Annual Report, p. 10.	Smart appliances Biomass industrial cogeneration system Web-based commercial lighting field control demo
Hydro One will identify elements to be included in Hydro One's implementation of the Smart Grid through: acquisition of "smart devices" to showcase proposed technologies; acquisition of system integration technologies (both real-time and enterprise applications) that monitor, control and remediate faults, outage management/restoration systems, Geographic Information System ("GIS") technology, Energy Storage devices such as battery/compressed air energy storage ("CAES") as well as stationary power systems such as hydrogen fuel cells that can be used to power station services; deployment for proving both technology and inter-operability, as well as business benefits which will drive further adoption in other areas of Hydro One's networks.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 9.	System integration technologies - monitor - control - remediate faults - OMS - restoration systems - GIS - Storage
Toronto Hydro Smart Grid projects touch on the following areas: customer display integration, web energy portal, OMS integration — customer portal, smart meter connect / disconnect, smart meter — outage identification, network meters integration, network monitoring integration, integration architecture and design, access network, internal network readiness, and smart grid network security.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 20.	Smart grid projects - Customer display integration - Web energy portal - OMS integration - Network monitoring integration - Integration architecture - Network readiness - SG network security
The change is in part due to the large amount of information that utilities will be collecting from devices as a result of advancements towards the Smart Grid, such as the installation of smart meters and Intelligent Electronic Devices (IEDs).	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 14.	Consumer data Smart meters Intelligent Electronic Devices (IEDs)

SG Excerpts: Consumer Education and Public Awareness

Excerpt	Source	Open Codes

Plenary presentations were followed by three breakout workshops which focused on the 'Innovator's Vision,' 'The Customer's Vision,' and the 'View from the Grid.' While a number of themes emerged, they focused primarily on the customer dynamic and the importance of demonstrating value to the customer for the investment in smart grid.	Burlington Hydro, 2010 Community Report, p. 11.	SG consumer value
Groundwork has been underway to evaluate the available technologies and infrastructure required to deliver an effective, future-proof solution to customers. CND Hydro supported an application by Energate for a pilot on Consumer Engagement for the Smart Grid which will be credited towards this Initiative in 2013.	CND Hydro, 2012 CDM Report, p. 17.	SG consumer engagement
In October and November 2012, PowerStream's "Follow the Smart Grid to Win" initiative helped to increase customer awareness of Smart Grid and its benefits, as well as the "following" of the company's social media properties, in particular PowerStream's Twitter page	COLLUSPowerStream, 2013 Annual Report, p. 46.	Customer awareness Smart Grid Benefits Social media campaign
1.822 million impressions about Smart Grid through advertisements on CTV Barrie • 219,207 impressions about Smart Grid through online advertisements on the websites of Metroland newspapers in York Region and Simcoe County 694,165 impressions about Smart Grid through tweets and re-tweets on Twitter • 160 % increase in the number of Followers of @PowerStreamNews on Twitter (from 289 to 750).	COLLUSPowerStream, 2013 Annual Report, p. 46.	Public awareness SG impressions Online Ads Social media
"PowerStream is committed to ensuring our customers are fully aware of what we provide and how we can help, so it's both fitting and thrilling that our smart grid campaign has been recognized as industry-leading," said Frank Scarpitti, PowerStream Board Chair and Mayor of the City of Markham.	COLLUSPowerStream, 2013 Annual Report, p. 46.	Customer awareness SG campaign
PowerStream employees were also able to answer questions about renewable energy, smart grid, health and safety, conservation and general questions about the wide range of services the utility provides to its customers.	PowerStream, 2011 Annual Report, p. 19.	Utility service In-person promotion Renewable energy education Health and safety education Conservation education
'Follow the Smart Grid to Win' contest held by PowerStream educates consumers about the benefits of smart grid.	PowerSteam, 2012 Annual Report, p. 15.	Contest Consumer education SG benefits
This was evident from the findings of a 2012 customer focus group study conducted by the Independent Electricity System Operator (IESO) and SmartGrid Canada in PowerStream's service territory which indicated that there was little to no awareness among customers of what a smart grid is, or its benefits.	PowerSteam, 2012 Annual Report, p.	Little awareness of SG (2012) SG benefits
When provided with information explaining smart grid and the benefits that it provides, in simple language, customers were receptive to what these new technologies would do for them.	PowerSteam, 2012 Annual Report, p. 21.	SG benefits Simple language Consumers receptive
The 'Follow the Smart Grid to Win' campaign was an innovative customer communications initiative executed in 2012 to increase awareness among customers of smart grid and its benefits as well as to promote the 'following' of PowerStream's new social media properties, in particular the company's Twitter page.	PowerSteam, 2012 Annual Report, p. 21.	Contest Customer communication SG awareness

		SG benefits Social media
Using a contest requiring customers to follow @PowerStreamNews on Twitter in order to learn about smart grid and its benefits, the success of the campaign in achieving its objectives was measured	PowerSteam, 2012 Annual Report, p. 21.	Contest Social media SG benefits
Campaign television advertising generated 1.822 million impressions about the contest and smart grid.	PowerSteam, 2012 Annual Report, p. 21.	TV advertising Contest SG impressions
Geo-targeted online advertising with newspaper websites in York Region and Simcoe County produced a total of 219,207 impressions about the contest and smart grid.	PowerSteam, 2012 Annual Report, p. 21.	Geo-targeted online ads Newspaper websites SG impressions Contest
Weekly blog posts by PowerStream employees who specialize in areas such as community relations, conservation, power-outages, safety, smart grid or solar generation are published on eStream.	PowerSteam, 2012 Annual Report, p. 21.	Blog posts - Community relations - Conservation - Power outages - Smart grid - Solar generation
PowerStream, in collaboration with the IESO and the Ontario Power Authority (OPA), continued a major smart grid initiative called the Home Energy Management project, to demonstrate different communications technologies to control residential customer energy consumption using the existing smart meter AMI infrastructure.	PowerSteam, 2012 Annual Report, p. 28.	Home energy management demo
Georgian College students are getting hands-on learning opportunities to become leaders in the integration of EV's, renewable energy and smart grid technology.	PowerStream, 2013 Annual Report, p. 5.	Students Hands on leaning - EV - Renewable - SG
A highlight of this program is the Sunny Side Up roving demonstration trailer, which educates the public on various uses and benefits of smart grid technologies.	Woodstock Hydro, 2011 CDM Report, p. ii.	Demo trailer - SG use - SG benefits
In meeting with the environmental committee of an area high school and public school, conversation holds promise of a partnership program for 2011 in recognition of the enthusiasm and technology expertise of the students that could boost Woodstock Hydro‟s Smart meter and Smart grid development. Specific ideas discussed include the concept of a Smart meter pilot among students, and an Internet web page challenge for our „Sunny Side Up‟ microFIT installation.	Woodstock Hydro, 2011 CDM Strategy, p. 7.	Student environmental committee - Conservation - Recognition of SG technology Internet web-page Smart meter development Micro-FIT
Which technology and smart grid innovations do you believe could offer the greatest benefit to you, your community and the system as a whole?	Ontario Ministry of Energy (2013). Conservation First: A Renewed Vision for Energy Conservation in Ontario, p. :	SG innovation Personal benefit Community benefit
Ontario must continue to educate and train employees who are capable of designing, developing and operating the smart grid. Together, technology, people and processes will permit the realization of a modern electricity	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 3.	Educate and train employees

system that benefits all Ontarians.		Modern electricity system Benefits Ontario
A smart grid can change how consumers, utilities, retailers and other service providers interact by offering new ways for them to communicate and expanding the types of service available to consumers.	Smart Grid Forum (2009). Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 18.	SG change service
Getting the consumer on side was a key focal point of a well attended event held in January 2011: "Smart Grids in the North American Context: A Policy Leadership Conference."	IESO, 2011 Annual Report, p. 19.	Consumer on-side SG leadership conference
The Ontario Smart Grid is an interactive website that helps educate consumers on how their response to price and system signals can help grid reliability.	IESO, 2013 Annual Report, p. 15.	Interactive website Consumer education
The roadmap addresses a recommendation in the Forum's first report that the province consult with industry stakeholders to develop smart grid educational materials for the public.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 11.	SG roadmap Stakeholder consultation SG public education materials
These materials are intended to explain how smart meters, time-of-use rates, in-home devices, smart appliances, and other smart grid technologies can bring more control, choice and value to residential electricity consumers and operational benefits to the grid.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 11.	Text materials - Smart meters - TOU rates - In-home devices - Smart appliances - SG technologies SG benefits Consumer value Operational benefits
Regulated entities must provide information and education to their customers regarding the potential benefits of smart grid.	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid, p. 10.	Educational regulatory requirement
In order for customers to be able to take advantage of the new services and data access that smart grid will provide, they will need to be informed.	OEB (2013), Report of the Board: A Supplemental Report on Smart Grid. p. 10.	Informed consumers
Whether they realize it or not, customers are embracing smart grid technologies and services as fast as any utility company – and in some cases even faster. Many of those consumer expenditures are already beginning to integrate with 'smart homes' and ultimately, the smart grid.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment- A Vignette, p. 17.	Customers embrace SG Consumer expenditures Smart homes
While the term "smart grid" may not be top of mind with most customers, their individual investment and participation decisions have the potential to have a profound impact on Ontario's electricity system – a topic investigated in detail as part of the Smart Grid Forum's 2011 report and a joint study on consumer attitudes towards the smart grid, published by the IESO and Smart Grid Canada in 2012.	Ontario Smart Grid Forum (2013). Ontario Smart Grid Progress Assessment- A Vignette, p. 17.	Consumer impact on electricity system
In the first scenario, protecting access to customer information will foster trusting relationships — allowing the customer to trust the utility, and therefore increasing the likelihood of his/her participation to realize the benefits of the Smart Grid.	Information and Privacy Commissioner of Ontario (2010). Privacy by Design- Achieving the Gold Standard in Data Protection for the Smart Grid, p. 2.	Building trust Benefits of SG

SG Excerpts: Drivers and Enablers

Excerpt	Source	Open Codes
The foundation of a Smart Grid comes from two primary building blocks. 1. The installation of Smart Meters and the related systems. 2. A reliable	Collingwood Utility Services, Business Plan (2011-2013), p. 18.	Smart Meters

Transmission and Distribution infrastructure which can accommodate the needs of both consumers and generators.		Consumer and Generator Demands
As mandated by the Ontario Government, Collus PowerStream has completed the installation of Smart Meters to all customers and implemented TOU Billing. Future plans for smart grid development include a real time interface between Smart Metering, SCADA and OMS. Collus PowerStream continues to monitor Smart Grid development pilots around the province and other jurisdictions.	COLLUSPowerStream, 2014 Annual Report, p. 15.	GEGEA Smart Meters
Nonetheless, the full implementation of these programs, and their integration into new, more efficient utility distribution models, represents one of the greatest opportunities for addressing growing demands for better operating, economic and community results from aging utility infrastructure. With an ever-increasing pace in technology advancements, including smart grid and distributed generation solutions, the lines are blurring, and thus separating utility operations and information technology, communication type enterprises.	COLLUSPowerStream, 2013 Annual Report, p. 8.	Aging Infrastructure Growing Demands
Bill 150, the Green Energy and Green Economy Act, 2009 (the "Green Energy Act"), was enacted on May 14, 2009. The Green Energy Act, among other things, (i) permits electricity distribution companies to own renewable generation facilities, (ii) obligates electricity distribution companies to provide priority connection access for renewable generation facilities and to prepare plans that identify expansion or reinforcement of the distribution system required to accommodate these connections, for approval by the OEB as well as assigning cost responsibility between a distributor and a generator, (iii) empowers the OEB to set CDM targets for electricity distribution companies as a condition of licence and, (iv) requires electricity distribution companies to accommodate the development and implementation of a smart grid in relation to their systems.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum, p. 10.	GEGEA
Distributors assume added responsibilities to assist and enable consumers to reduce their peak demand and conserve energy in an effort to meet provincial conservation targets and also gain new responsibilities in transforming their local distribution networks into smart grids harnessing advanced technologies to facilitate the connection of small-scale generators and the two-way flow of information.	London Hydro, 2011 Annual Report, p. 23.	Smart Grid Upgrades
A significant portion of our system is now more than 40 years old and needs to be replaced. Capital expenditures will need to increase not only for infrastructure replacement but also to transition to a smart grid that will allow for the connection of as many renewable energy generators as possible and for the development of a more robust and secure electricity delivery system.	PUC Inc., 2009 Annual Report, p. 5.	Aging Infrastructure Grid Modernization
Much of Ontario's electricity grid has been in place for decades. It is a key part of the infrastructure that homes and businesses depend on for a reliable supply of energy. This delivery framework is being transformed into a smart grid – the modern electricity system of tomorrow.	Veridian, 2009 Annual Report, p. 10.	Aging Infrastructure Grid Modernization
The adoption of smart meters enables the development of Ontario's Smart Grid.	Ontario Ministry of Energy (2013). Conservation First: A Renewed Vision for Energy Conservation in Ontario, p. 6.	Smart Meters
These changes will require a paradigm shift in the electricity system. Today, the grid is primarily a vehicle for moving electricity from generators to consumers. Tomorrow, the grid will enable two-way flows of electricity and information as new technologies make possible new forms of electricity production, delivery and use. The smart grid is the name given to the new electricity system that will emerge from this paradigm shift.	Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 1.	Grid Modernization Paradigm shift
The prominence of renewable energy in Ontario's resource portfolio requires an increased ability to accommodate variable generation from wind and solar. Where today the grid serves primarily as a vehicle to move electricity generated in large central facilities to consumers, in the very near future, the	Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 13.	SG Required for Renewable SG to accommodate

grid will need to do much more. As the number and distribution of smaller generators grows, the operational challenge of incorporating these energy resources, while maintaining safety and reliability, will also grow. Meeting this challenge will require a smart grid.		system upgrades
Other features of Ontario also drive development of a smart grid. Like most jurisdictions in North America that saw substantial growth after World War II, Ontario is facing the need to replace a significant amount of its electricity infrastructure. This need creates an opportunity to use smart grid technology both to maximize the use of existing equipment and to improve the efficiency of the grid as it is replaced. Growth and redevelopment also present opportunities to introduce smart grid technologies in newly developed and reconstructed areas. Demands by industry and consumers for increased reliability and power quality technology are also pushing toward a smarter grid.	Enabling Tomorrow's Electricity System, Report of the Smart Grid Forum, p. 13.	Aging Infrastructure Grid Modernization Market Demand Redevelopment and new development opportunities
Within a very short timeframe, the Act has encouraged the development of new renewable generation resources. It is also driving the enhancement of Ontario's transmission and distribution systems, and will lay the foundation for a smart grid in Ontario.	IESO, 2009 Annual Report, p. 2.	GEGEA
The most substantive move in that direction was the introduction of the Green Energy and Green Economy Act 2009 (GEGEA). The legislation created a specific mandate to develop a smart grid, implicitly recognizing the need to modernize Ontario's aging electricity system. It put focus on three objectives: giving electricity consumers more control over, and information about, their energy use as a way to encourage conservation and off-peak consumption; making the grid flexible enough to accommodate increased use of renewable energy sources and clean energy technologies on the distribution system; and creating a modern grid infrastructure that can adapt as new energy-saving and system-control technologies emerge.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 12.	GEGEA Modernize Grid
The smart grid is clearly a priority for the government. The province's 20-year Long-Term Energy Plan, issued in November 2010, emphasized the smart grid's strategic importance, describing it as "an essential element of Ontario's clean energy future."	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 13.	LTEP Complementary Goals
The smart grid is not an end in itself. There is no measure by which to verify its arrival. The smart grid will be developed to meet the unique needs of the consumers, businesses, and industries it serves. It is constantly evolving, becoming more efficient, automated, adaptable, robust, secure – and "smarter." What the smart grid does represent is a dramatically new phase of development for the electricity system, one that will bring environmental and economic benefits for decades to come.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 33.	Grid Modernization Long-Term Benefits
As this report makes clear, the smart grid is happening now. Ontario, generally, has done a good job of laying the foundation. Indeed, there are other jurisdictions envious of the province's progress. And this progress, to a large extent, is being driven by market demand. More consumers want tools that will help them better manage their energy spending. They want more choice of tools. Consumers want reliable service. Whether for environmental or financial reasons, more want to participate in the market by generating green power. This is all enabled by the smart grid. It is driving smart grid investment.	Ontario Smart Grid Forum (2011). Modernizing Ontario's Electricity System: Second Report of the Ontario Smart Grid Forum. p. 33.	Market Demand
Distributors throughout North America are starting to replace their aging infrastructure with new technology that is being widely described as the Smart Grid.	Ontario Distribution Sector Review Board (2012). Renewing Ontario's Electricity Distribution Sector: Putting the Consumer First, p. 18.	Aging Infrastructure Grid Modernization

Climate Change Excerpts: Generation Supply Mix

Excerpt	Source	Open Codes
The $13 million Mohawk Street Landfill Gas Collection and Utilization was developed to reduce methane and CO2 emissions, and to convert them to enable the generation of electricity. Using landfill methane gas as a fuel has a sound environmental benefit. It recycles a material that would otherwise be burned as a waste and it reduces the amount of energy that must be	Brantford Energy, 2013 Annual Report, p. 12.	Landfill Gas Collection and conversion

generated from greenhouse gas-generating fossil fuels. The facility is one of 64 landfill gas recovery projects in Canada diverting more than seven million mega-tonnes of C02 equivalent a year. This initiative reflects current public opinion where the overwhelming majority of Ontarians believe it is important to have more renewable, green energy in Ontario to deal with climate change and help reduce record levels of greenhouse gases in the atmosphere.		Environmental benefit Green energy Reduce GHGs
With the closing of our major coal burning facilities at the end of 2013, over 95 per cent of our generation now comes from nuclear and hydroelectric sources – which are virtually free of emissions contributing to smog and climate change.	OPG, 2013 Annual Report, p. 4.	Coal elimination No emission
This includes those in our thermal operations, who not only witnessed but helped implement the wind-down of an important and historic part of the company. In doing so, they helped make possible the single biggest climate change initiative in North America.	OPG, 2013 Annual Report, p. 6.	Coal elimination Biggest NA climate change initiative
OPG's commitment to stop burning coal at our thermal stations by the end of 2014 is a significant step to fight climate change.	OPG, 2011 Sustainable Development Report, p. 4.	Coal elimination
An environmental approval application to convert Atikokan from coal to 100 per cent clean wood pellets was submitted to the Ministry of the Environment for approval and posted on the Environmental Registry for public comment. The application and posting followed a public and First Nations' consultation process which exceeded the requirements for a project of this scope. The majority of comments received were supportive of the conversion and its importance to the economy of Northwestern Ontario, although a few reservations over the sustainability of the use of wood for power generation and the resulting climate change benefits were expressed. If approved, construction will begin in 2012.	OPG, 2011 Sustainable Development Report, p. 13.	Wood pellets generation Climate change response
Wood and agricultural based biomass are recognized around the world as renewable sources of energy that have significant climate change benefits. OPG's biomass program does not use food crops for fuel.	OPG, 2011 Sustainable Development Report, p. 13.	Wood biomass Climate change benefits No food crops for fuel
Conversion represents investment in renewable energy generation from a sustainable fuel recognized as beneficial to climate change mitigation.	OPG, 2011 Sustainable Development Report, p. 42.	Renewable energy Sustainable fuel Climate change mitigation
In 2013, the Government of Ontario announced plans to convert Thunder Bay GS from coal to advanced biomass. Biomass is a sustainable fuel recognized as beneficial to climate change mitigation.	OPG, 2012 Sustainable Development Report, p. 12.	Coal elimination Facility conversion Advanced biomass Sustainable fuel Climate change mitigation
Ontario has virtually eliminated coal from our electricity system, with the last plant to close in 2014. The phase out of coal is the single largest climate change initiative in North America. Coal use had accounted for $4.4 billion per year in financial, health and environmental costs.	Ontario Ministry of Energy (2013). Long Term Energy Plan, p. 2.	Coal elimination Largest NA climate change initiative
The coal phase-out is the single largest climate change initiative in North America, reducing greenhouse gas emissions and air pollution. Coal use had accounted for $4.4 billion per year in health, environmental, and financial costs.	Ontario Ministry of Energy (2013). Long Term Energy Plan, p. 30.	Coal elimination Reduce GHG

		Reduce air pollution
Ontario is committed to eliminating all coal-fired generation from its energy supply mix by 2014. The initiative is crucial to fighting climate change and protecting the health of Ontarians. Replacing dirty coal-fired generation with conservation, renewables and cleaner sources of supply will reduce Ontario's greenhouse gas emissions by up to 30 megatonnes (Mt) – representing the largest single climate change initiative in Canada.	OME Results-Based Plan (2009-2010), p. 7.	Coal elimination Climate change response Conservation Renewables Cleaner sources Reduce GHG Largest NA climate change initiative
As part of its commitment to a clean energy future and fighting climate change, Ontario announced plans to close four coal-fired generation units - two at Nanticoke Generating Station and two at Lambton Generating Station - by October 2010, which is four years ahead of the 2014 target. These four units represent about 2,000 megawatts of generation capacity.	OME, Results-Based Briefing Book (2010-2011), p. 12.	Clean energy future Coal elimination
After extensive public consultations, the environmental assessment process was completed for the Bruce to Milton Transmission Reinforcement Project, one of several projects Hydro One is undertaking to meet Ontario's needs for the 21st century. The transmission line supports the province's climate change and clean air initiatives by providing an additional 3,000 MW of power from renewable and nuclear sources in the Bruce area to Ontario's electricity consumers. This project is scheduled to be in-service at the end of 2012.	OME, Results-Based Briefing Book (2010-2011), p. 24.	Environmental assessment Transmission Reinforcement Clean air initiatives Renewable energy Nuclear energy
As part of the government's commitment to a clean energy future and fighting climate change, Ontario is committed to eliminating coal-fired electricity generation by the end of 2014.	OME, Results-Based Plan Briefing Book (2011-2012), p. 8.	Clean energy future Coal elimination
Ontario's commitment to phase out coal-fired electricity by the end of 2014 remains the single largest climate change initiative in North America.	OME, Results-Based Plan Briefing Book (2011-2012), p. 25.	Coal elimination Largest NA climate change initiative
As part of the government's commitment to a clean energy future and fighting climate change, Ontario is committed to eliminating coal-fired electricity generation by the end of 2014.	OME, Results-Based Plan Briefing Book (2011-2012), p. 8.	Clean energy future Coal elimination
As part of the Long-Term Energy Plan, the government moved forward on its goal to end coal-fired generation by the end of 2014. On December 31, 2011, the province shut down two more coal-fired power units at Nanticoke. Ontario's commitment to phase out coal-fired electricity by the end of 2014 remains the single largest climate change initiative in North America.	OME, Results-Based Plan Briefing Book (2012-2013), p. 28.	LTEP Coal elimination Largest NA climate change initiative
On January 10, 2013, the Government of Ontario announced it would cease coal-fired generation at the Lambton and Nanticoke plants by the end of 2013, one year earlier than previously planned. Ontario's commitment to phase out coal-fired electricity by the end of 2014 remains the single largest climate change initiative in North America.	OME Results Based Plan Briefing Book (2013-2014), p. 33.	Coal elimination Largest NA climate change initiative
On December 31, 2011, the province shut down two more coal-fired power units at Nanticoke. Ontario's commitment to phase out coal-fired electricity by the end of 2014 remains the single largest climate change initiative in North America.	OME Results Based Plan Briefing Book (2013-2014), p. 33.	Coal elimination Largest NA climate change initiative
Renewable energy facilities connected to the electricity distribution system can not only improve	OPA, 2006 Annual	Renewable energy

the reliability of supply but also contribute to cleaner air and reduced emissions of greenhouse gases that contribute to climate change.	Report, p. 10.	Supply reliability Clean air Reduce emissions
In December, the OPA awarded a 20-year contract to York Energy Centre LP to design, build and operate a simple-cycle natural gas plant in the Township of King. This plant will address the urgent need for clean, reliable and secure power in one of the fastest-growing areas in Ontario. It will also help the province to close down coalfired generation by 2014 – Canada's single biggest climate-change initiative.	OPA, 2008 Annual Report, p. 19.	Natural Gas Coal elimination Largest NA climate change initiative
In addition to encouraging billions of dollars of investment in Ontario's electricity sector, this push for more renewable energy is enabling us to eliminate coal from the province's supply mix – Canada's single largest climate change initiative.	OPA, 2009 Annual Report, p. 2.	Renewable energy investment Coal elimination Largest climate change initiative
Ontario is phasing out coal by the end of 2014. This is the largest climate change initiative in Canada and is expected to reduce the province's carbon dioxide emissions from electricity generation by up to 30 megatonnes – representing a 75-percent reduction from 2003.	OPA, 2009 Annual Report, p. 4.	Coal elimination Largest climate change initiative in Canada Reduce reduction
And the province is eliminating coal-fired generation by the end of 2014, which is the biggest climate change initiative in North America. Ontario is the first jurisdiction on the continent to do so. It will reduce the carbon footprint of Ontario's electricity sector by 75 percent.	OPA, 2012 Annual Report, p. 2.	Coal elimination Largest NA climate change initiative Reduce carbon footprint
When coal-fired generation is eliminated at the end of 2014 – the largest climate-change initiative in North America – Ontario will have reduced its electricity sector's carbon footprint by 75 percent from 2005 levels.	OPA, 2013 Annual Report, p. 1.	Coal elimination Largest NA climate change initiative Reduce carbon footprint

Climate Change Excerpts: Promoting Energy Efficiency and Conservation

Excerpt	Sources	Open Codes
In 2008 Sustainable Waterloo was founded to allow the Waterloo Region business community to be a part of the local solution to global climate change. This not-for-profit has a growing membership dedicated to reducing its carbon footprint through efficiency and waste reduction, with a heavy emphasis on electricity conservation. The CKW Group are supporters of this organization and their local events. Waterloo North Hydro is a Founding Partner. In 2008 Sustainable Waterloo was founded to allow the Waterloo Region business community to be a part of the local solution to global climate change. This not-for-profit has a growing membership dedicated to reducing its carbon footprint through efficiency and waste reduction, with a heavy emphasis on electricity conservation. The CKW Group are supporters of this organization and their local events. Waterloo North Hydro is a Founding Partner.	CDN Hydro, 2011 CDM Strategy, p. 26.	Reduce carbon footprint - Efficiency - Waste reduction - Electricity conservation Local solution Climate change
The Board is committed to promoting conservation in the province. An increased focus on the environment and climate change continues to underpin the importance of, and support for, conservation and energy efficiency. The Board seeks to ensure that its regulation is consistent with the delivery of efficient and effective conservation and demand management (CDM) programs. Key implementation issues are conservation and demand management programs provided by distributors, smart meters and time-of-use pricing.	OEB, Business Plan (2008-2011), p. 12.	OEB promote conservation Focus on conservation Focus on energy efficiency OEB deliver CDM

Energy efficiency is a cornerstone of the province's Long-Term Energy Plan, and an important element of Ontario's climate change strategy. As a result of the government's energy efficiency efforts, Ontario has saved more than 1,700 megawatts of electricity since 2005, equivalent to more than half a million homes being taken off the grid.	OME, Results-Based Plan Briefing Book (2011-2012), p. 10.	LTEP: energy efficiency Ontario climate change strategy: energy efficiency

Climate Change Excerpts- Reducing GHG

Excerpt	Sources	Open Codes
One of the company's major initiatives was the adoption of a greenhouse gas management plan, establishing greenhouse gas management strategies for OPG during a transitional period in our generation mix. The plan focuses on: improving the performance of OPG's nuclear and hydro assets; improving the energy efficiency of OPG's generating stations; pursuing the use of biofuels; preparing for "carbon trading;" researching the impact of climate change on our operations; and planting trees through OPG's extensive biodiversity program. OPG planted 320,000 trees in 2007 and has planted a total of 2.8 million native trees and shrubs throughout Ontario since 2000.	OPG, 2007 Annual Report, p. 10.	OPG GHG Management Plan - Generation Mix - improve nuclear performance - improve hydro performance - improve efficiency - bio fuels - prepare carbon trading Biodiversity program Tree planting
OPG's vision is to be a leading clean energy company, powering Ontario to a more sustainable energy future. In 2008, nearly 80 percent of OPG's generation was from our nuclear and hydroelectric stations. These facilities produce virtually no emissions contributing to smog or climate change. We are working to reduce emissions even more by expanding our hydroelectric capability and exploring the possibility of burning carbon-neutral biomass fuel at our coal-fired stations, which have been directed by the Ontario government to stop burning coal by the end of 2014.	OPG, 2008 Annual Report, p. 5.	Goal: clean energy company Sustainable energy Reduce emissions - Nuclear - Hydro electric - Biomass fuel Coal elimination
Our nuclear stations had a strong year in 2008, generating more than 48 TWh of electricity that has virtually no emissions that contribute to smog or climate change.	OPG, 2008 Annual Report, p. 6.	Nuclear generation No emissions
The Darlington nuclear site in Durham Region can accommodate up to four additional nuclear reactors representing a total of 4,800 MW virtually free of emissions contributing to smog and climate change.	OPG, 2008 Annual Report, p. 8.	Nuclear generation No emissions
To achieve further improvements in OPG's GHG emissions, OPG launched its Greenhouse Gas Management Plan in 2007. The plan focuses on: improving the energy efficiency of OPG's facilities, the use of biofuels as a partial replacement for coal, researching the impact of climate change on OPG's operations, expanding the tree planting effort through OPG's extensive biodiversity program, and an education program for employees.	OPG, 2008 Annual Report, p. 24.	OPG GHG Management Plan Generation efficiency Biofuel Coal elimination OPG Biodiversity Program
In 2012, only about four TWh came from coal/ thermal. The remainder - approximately 95 per cent – was from nuclear and hydroelectric sources, which produce virtually no emissions contributing to smog or climate change.	OPG, 2012 Annual Report, p. 6.	Nuclear Generation Hydroelectric generation No emissions
Also in 2011, 96 per cent of the electricity of OPG's generation came from sources that produce virtually no emissions contributing to smog, acid rain, or climate change.	OPG, 2011 Sustainable Development Report, p. 4.	No emissions
Electric vehicles (EVs) are a reliable transportation choice and can play an important part in mitigating climate change. By supporting the widespread adoption of EVs,	OPG, 2011 Sustainable	EVs- CCM

OPG's goal is to maximize the environmental and economic benefits that they bring. Given that Ontario's baseload generation is virtually free of GHG emissions, EVs have the potential to make a significant contribution to Ontario's GHG emission reduction goals.	Development Report, p. 15.	EV- Reliable Transportation EV- economic benefits EV- environmental benefits Emission-free baseline generation Provincial GHG reduction goals
Electrification of the transportation sector and charging on clean generation like nuclear and hydro is a key strategy to reducing Ontario's emissions and mitigating climate change.	OPG, 2011 Sustainable Development Report, p. 15.	Electrification of transportation Charging on clean generation Reduce emissions Climate Change mitigation
OPG uses electric vehicles as part of our fleet and has installed over a dozen charging stations, providing reliable transportation and contributing to reducing Ontario's emissions and mitigating climate change.	OPG, 2012 Sustainable Development Report, p. 13.	OPG EV Fleet Charging stations Reliable Transportation Reduce emissions Climate change mitigation
(Right) Terry Robertson, Veridian's Manager of Metering, is an avid cyclist who commutes to work from Whitby. Terry enjoys the exercise that cycling provides, and is a strong proponent of reducing traffic congestion and taking action on climate change.	Veridian, 2009 Annual Report, p. 13.	Employee Commuter Cycling Reducing Traffic Climate Change Action
The company is a proud member of Smart Commute Durham, whose goal is to reduce traffic congestion and to take action on climate change through transportation efficiency.	Veridian, 2010 Annual Report, p. 44.	Smart Commute Reduce traffic Transportation efficiency
When clean energy from the wind is available, it reduces our need to rely on fossil fuel sources of electricity that contribute to smog, pollution and climate change.	Ontario Ministry of Energy (2013). Long Term Energy Plan, p. 38.	Clean energy Wind Reduce fossil fuel dependency Reduce pollution Reduce smog
Participants also contributed to Ontario's climate change targets, achieving greenhouse gas (GHG) reductions of nearly 600,000 tonnes per year, which is equivalent to taking over 124,000 cars off the road.	OME, Results-Based Plan Briefing Book (2011-2012), p. 26.	Ontario climate change targets GHG reductions

Climate Change Excerpts: Policy Mandates and Regulations

Excerpt	Source	Open Codes
The Federal Government is preparing to announce revisions to its Climate Change Plan, which are expected to include the creation of a technology investment fund and a regulated GHG limit for large point sources, including the thermal electricity sector.	OPG, 2004 Annual Report, p. 32.	Federal Climate Change Plan Technology investment fund Regulated GHG limit

The Kyoto Protocol, to which Canada is a signatory, came into force on February 16, 2005. To meet Canada's international obligations under the Protocol, the federal government's Climate Change Plan includes the provision for regulations to be applied to Large Final Emitters ("LFE") of GHG, including OPG.	OPG, 2005 Annual Report, p. 47.	Kyoto Protocol Federal Climate Change Plan Large Final Emitters GHG Regulations
In June 2007, aggressive targets to reduce greenhouse gas emissions were introduced by the Province as part of the Province's climate change plan. Among other initiatives, the plan identified a target reduction of greenhouse gases to six per cent below 1990 levels by 2014.	OPG, 2007 Annual Report, p. 22.	Provincial GHG Targets Provincial Climate Change Plan
In order to meet the federal and provincial emission targets previously identified under the heading, Recent Developments, Climate Change Plan, there is a risk that OPG will be required to either reduce certain emissions or purchase offsets, which could have a material adverse impact to OPG.	OPG, 2007 Annual Report, p. 53.	Federal emission targets Provincial emission targets Climate change plan OPG risk to operations
Through the GEGEA, the Ontario Government is expecting to deliver on the Province's Climate Change Strategy to create a world-leading clean-tech industry that will help facilitate the achievement of aggressive targets including: • 6000 megawatts (MW) of conservation by 2015 with an additional 2.5% annual (compounding) reduction in energy resource needs as a result of conservation from 2015 onwards • 10,000 MW of new installed renewable energy by 2015, over and above 2003 levels • 25,000 MW of new installed renewable energy by 2025, over and above 2003 levels • 1,500 MW of new installed clean distributed energy by 2015, and 3,000 MW by 2025, as of the introduction of the GEGEA. • Achievement of the approximately 30% reduction in natural gas consumption by 2017.	PowerStream, 2009 Annual Report, p. 21.	GEGEA Provincial Climate change strategy Clean-tech industry Aggressive targets Conservation Renewable energy Consumption reduction
THESL operates in an environmentally responsible manner consistent with Toronto"s Climate Change Action Plan, thus supporting its greenhouse gas (GHG) reduction targets of 30% by 2020 and 80% by 2050. This is reflected in our initiatives aimed at reducing the energy consumption and GHGs associated with our fleet, facilities, line losses and the use of Sulphur Hexafluoride (SF6). Furthermore, our corporate and/or departmental balanced scorecards include indicators that monitor our progress on these projects (e.g., reduced GHGs from fleet and facilities, reduced idling time, reduced office square footage, etc.).	THESL, 2013 Environmental Performance Report, p. 1.	Toronto's CC Action Plan GHG Reduction Targets Adjust corporate operations - Reduce fleet GHG - Reduce idle times - Reduce office footage
Reports on greenhouse gas emissions 58.2 (1) The Environmental Commissioner shall report annually to the Speaker of the Assembly on the progress of activities in Ontario to reduce emissions of greenhouse gases, and the Speaker shall lay the report before the Assembly as soon as reasonably possible. Same (2) Each report under subsection (1) shall include a review of any annual report on greenhouse gas reductions or climate change published by the Government of Ontario during the year covered by the report under subsection (1).	Ontario Ministry of Energy (2009). *Green Energy and Green Economy Act,* p. 32.	ECO GHG monitoring
The proposed IPSP plays a pivotal role in the government's Go Green climate change action plan, by closing the supply gap in a way that reduces Ontario 's carbon footprint.	OME, Results-Based Plan (2008-2009), p. 3.	Reducing carbon footprint

The OPA formed a climate change committee in 2009 to monitor greenhouse gas activities in Ontario and surrounding jurisdictions to determine their impacts on the OPA and the province's electricity sector. Discussions have been held with the Ministry of Energy and Infrastructure, as well as with the Ministry of the Environment, which is taking the lead in developing legislation for a potential cap-and-trade regime and in representing Ontario in various initiatives on greenhouse gases		Climate change committee Cap and Trade regime
As these policies evolve, the OPA is examining options and solutions to incorporate mechanisms to deal with changes to climate change regulation and their impacts on the OPA's procurement processes and contracts.	OPA, 2010 Annual Report, p. 15.	Impact of climate change regulation Impact on OPA Procurement
The Power Authority currently holds the environmental attributes associated with new renewable energy contracts on behalf of Ontario ratepayers. As government policies on climate change and carbon mitigation develop, options for the treatment of environmental attributes will be explored and the necessary contract adjustments will be made.	OPA, Business Plan (2010-2012), p. 19.	Treatment of Environmental attributes
During the business planning period, legal services plans to expand the breadth of knowledge of client activities, assist with the development of the organization's understanding of the legal issues related to climate change and carbon trading, maintain an appropriate balance of internal and external counsel and continue with improvements in the efficiency of its operations.	OPA, Business Plan (2010-2012), p. 27.	Legal issues Climate change Carbon trading
A key initiative taking place during the planning period is policy development with respect to carbon mitigation. At this time, carbon policies are being developed by federal, provincial and regional governments in Canada and the United States. The OPA will monitor developments and assess their impacts on the OPA's mandates and the sector as a whole. Options for the treatment of environmental attributes will be explored as government policies on climate change and carbon mitigation evolve.	OPA Business Plan (2011-2013), p. 23.	Federal carbon policy Provincial carbon policy Regional carbon policy Treatment of environmental attributes

Climate Change Excerpts: Climate Change Impacts

Excerpt	Sources	Open Codes
The water-energy nexus is deeply embedded within the context of climate change, a concern that is front and centre for many Canadians and that the Ontario Government has identified as a priority (Pembina, 2008; Office of the Premier, 2004). Burning fossil fuels to generate electricity and heat for provision of water services creates greenhouse gas emissions, heat trapping gases that contribute to global warming and ultimately to climate change. Climate change will in turn impact water availability, increase water temperature and alter the frequency and duration of rainfall.	Ontario's Water-Energy Nexus:, p. 1 (found in Guelph Hydro, 2011 CDM Strategy).	Water-energy nexus Water availability Water temperature Alter rainfall frequency and duration
Ontario's energy needs are growing and changing. The impact of climate change on the environment has made it clear that the province and its people must take a new approach to energy use and supply management.	Hydro One, 2007 Annual Report, p. 9.	New Approach Energy Use Supply Management
The extent to which OPG can operate its hydroelectric generation facilities depends upon the availability of water. Significant variances in weather or water flows, including climate change, could affect water flows.	OPG, 2012 Annual Report, p. 56.	Climate change impact OPG operations Water availability Weather variances Water flows
The extent to which OPG can operate its hydroelectric generation facilities depends upon the availability of water. Significant variances in weather, including	OPG, 2013 Annual Report, p. 59.	Climate change impact OPG operations

impacts of climate change, could affect water flows. OPG manages this risk by using production forecasting models that incorporate unit efficiency characteristics, water availability conditions, and outage plans."		Water availability Weather variances Water flows OPG Risk management Production forecasting Outage plans
It is recognized that climate change could have far reaching effects on Ontario's watersheds. Energy production is very sensitive to the amount, timing, and geographical pattern of precipitation (supply side), as well as temperature (demand side). Changes in river flows and reservoir levels may have a direct impact on how much and when hydroelectric generation can be produced. The challenge remains to gain understanding of long-term climatic trends in order to understand the potential impacts to our operations, and to assess potential new development. Seasonal variability of precipitation, temperature, evaporation, lake levels and their divergences from normal ranges are the key elements of interest for OPG.	OPG, 2011 Sustainable Development Report, p. 15.	Watershed impacts Energy production impacts: - precipitation amount - precipitation timing - precipitation geographical timing - temperature - river flows - reservoir levels Understand Long-term climatic trends OPG operations - precipitation variability - evaporation - lake levels
Historically the focus on climate change has been on mitigation. While still important, climate scientists have concluded that climate will change and extremes of weather will occur as a result of natural and human activity and there is now an increased focus on adaptation to the impacts.	OPG, 2012 Sustainable Development Report, p. 12.	Climate change mitigation Extreme weather Climate change adaptation
The importance of adapting our operations to meet the needs of our customers is becoming more apparent with the increasing number of extreme weather events resulting from extreme weather due to climate change has become more common in recent years. With Superstorm Sandy in 2012, the July 2013 flood in the Greater Toronto Area, as well as the ice storm in 2013, what used to be a "once every 10 years" storm is now becoming more frequent.	PowerStream, 2013 Annual Report, p. 5.	Adapting operations Extreme weather
The goals of this program are threefold: (1) to manage weather related risks to the THESL system and operations; (2) to enhance system resilience to adapt to climate change and withstand extreme weather events; and (3) improve restoration practices when extreme weather events affect the system	THESL, 2013 Environmental Performance Report, p. 9.	Manage weather risk Enhance system resilience Climate change adaptation Improve restoration
In 2013, THESL initiated multiple programs focused on identifying its assets" vulnerabilities and uncertainties related to climate change.	THESL, 2013 Environmental Performance Report, p. 9.	Vulnerability assessment Manage uncertainty
THESL will conduct the second phase of its Climate Change Risk Assessment of Electrical Distribution Infrastructure in 2014. The first phase of this assessment, done in 2012, identified equipment vulnerabilities in the system based on past	THESL, 2013 Environmental Performance Report, p.	Vulnerability assessment Climate projections

weather. The second phase will focus of system level vulnerabilities based on future weather patterns.	9.	
The second phase of this program will build on information collected in the first phase of the program. Phase two of the program will analyze THESL‟s system and identify its vulnerabilities looking at future weather patterns and map risk scenarios. In preparation for the Phase Two of the program, in 2013, THESL conducted research on publicly available weather prediction papers and model results from sources such as Intergovernmental Panel on Climate Change (IPCC) and Senes Consulting Ltd .	THESL, 2013 Environmental Performance Report, p. 9.	Vulnerability assessment Climate projections
Environmental issues, particularly the need to respond to the climate change challenge, have sharpened the focus on how the province plans its electricity system.	OPA, 2009 Annual Report, p. 2.	Environmental issue impact electricity planning
The OPA does not directly operate any electricity infrastructure. However, it has contractual obligations with power suppliers that could expose the OPA indirectly to operational or system risks caused by climate change issues.	OPA, 2009 Annual Report, p. 35.	Climate change - operational risk - system risk
The impacts of climate change for OPA-contracted facilities include changing precipitation patterns, higher water temperatures, higher average temperatures, changes in cloud cover and changes in wind pressure.1	OPA, 2009 Annual Report, p. 35.	Precipitation changes Water temperature changes Changes in cloud cover Changes in wind pressure
To oversee the management of climate change issues, the OPA has established a climate change committee composed of representatives from each functional business unit. The committee tracks emerging issues and provides strategic input to the OPA's senior executive team on climate-related topics	OPA, 2009 Annual Report, p. 35.	Climate change committee

Climate Change Excerpts: Consumer Education and Public Awareness

Excerpt	Source	Open Codes
Over the past two years, 100 schools, 500 teachers and student teachers and more than 6,000 children have learned about energy sources, climate change and energy conservation through these educational programs. No other utility in Ontario has undertaken such an ambitious children's educational program on energy conservation.	Horizon Utilities, 2008 Annual Report, p. 19.	School Education programs Energy conservation Environmental messages
We continued our support of external and internal events that promoted environmental causes and messaging including Earth Hour and the company's own Environment Awareness Week. The Barrie Earth Hour Music Festival and Woodbridge Earth Hour Lantern Walk were two events held in March 2010 that PowerStream sponsored to encourage customers to help fight climate change by reducing their electricity consumption.	PowerStream, 2010 Annual Report, p. 22.	Earth Hour Environmental Awareness Week Barrie Earth Hour Music Festival Woodbridge Earth Hour Lantern Walk Fight climate change Encourage Conservation
In the early years of Earth Hour, an annual global grass-roots movement building awareness for climate change, residents of the City of Barrie participated in the event just like everyone else in the world did – by simply turning their lights off.	PowerStream, 2011 Annual Report, p. 20.	Earth Hour Grassroots movement

		Climate change awareness Lights off
Earth Hour was established by the World Wildlife Fund to bring attention to the issue of climate change. The idea is that simply turning off the lights for an hour, when done collectively worldwide, could have a noticeable impact.	PowerStream, 2011 Annual Report, p. 20.	Earth Hour Climate change awareness Global impact Lights off
Other events such as Earth Hour engage our staff, but are also promoted through the community for their participation and involvement. You can always find PowerStream represented at community events marking this worldwide stand, shedding light on climate change.	PowerStream, 2013 Annual Report, p. 32.	Earth Hour Community engagement Climate change education
Also, the marketing of the PeaksaverPLUS program does not highlight the connection to climate change that may motivate greater participation in the program as well as providing public education.	Woodstock Hydro, 2012 CDM Report, p. 39.	PeaksaverPLUS Marketing No connection to climate change

Appendix F: Latent Content Analysis Open Codes

The following table shows every individual open code identified within the SG and climate change excerpts chosen for latent content analysis. As shown below, open codes identified from the SG excerpts are found in the left column, while open codes identified from the climate change excerpts are found in column on the right.

Smart Grid Excerpts- Open Codes	Climate Change Excerpts- Open Codes
Green economy	Landfill Gas Collection and conversion
CDM-SG Complementary	Environmental benefit
GEGEA	Green energy
SG enable renewable	Reduce GHGs
SG enable Conservation	Coal elimination
Individual customer energy intensity	No emission
Communication networks	Coal elimination
SG enable renewable	Biggest NA climate change initiative
SG enable distributed generation	Coal elimination
SG enable renewables	Wood pellets generation
Upgrade system to SG	Climate change response
Leverage smart meter	Wood biomass
Enable Distributed generation	Climate change benefits
Conservation mandate	No food crops for fuel
Pressure from regulators	Renewable energy
Integrate distributed generation	Sustainable fuel
Safe and reliable system	Climate change mitigation
OEB Programs	Coal elimination
Renewable Generation Facilities	Facility conversion
Enable Renewable	Advanced biomass
SG Investments	Sustainable fuel
SG enable conservation	Climate change mitigation
Energy saving targets	Coal elimination
SG Enable Conservation	Largest NA climate change initiative
Zero emission mobility	Coal elimination
SG Enable EV	Reduce GHG
SG technology	Reduce air pollution
EV charging	Coal elimination
Vehicle-to-home power	Climate change response
Solar PV Projects	Conservation
SG Assets	Renewables
Renewable generation distribution assets	Cleaner sources
EV Charging	Reduce GHG
SG enable EV	Largest NA climate change initiative
Off-Peak Charging	Clean energy future
SG to optimize grid	Coal elimination
SG enable renewable	Environmental assessment
SG enable conservation	Transmission Reinforcement
SG enable renewable	Clean air initiatives
SG enable conservation	Renewable energy
Consumer benefits	Nuclear energy
System benefits	Clean energy future
Integrate	Coal elimination
Renewables	Coal elimination
Energy storage, smart meters, EV	Largest NA climate change initiative
Flexibility to market	Clean energy future
SG consumer benefit	Coal elimination
Coal elimination	LTEP
Culture of conservation	Coal elimination
Reduce environmental footprint	Largest NA climate change initiative
Renewable generation	Coal elimination
Future demand	Largest NA climate change initiative

Provincial initiatives - Conservation - Renewable generation - Smart meters SG required for: - Off-Peak Charging - avoid increasing peak - EV batteries/ storage Culture of conservation Renewable commitment SG enable conservation SG enable renewable Communication technology • Pervasive • Rapid • Robust • Scalable • Secure Communication standards Interoperability of devices Communication to accommodate smart meters Scalable communication Adaptable communication devices SG communications Open standards Accommodate devices SG Enable EV EV Charging Avoid adverse impacts Electricity infrastructure Customer service SG Technology EV charging Adverse impacts Distribution equipment Customer service SG enable EV Flexible EV Charging SG Enable EV Avoid Grid Impacts Renewable resources SG development Demand-side involvement Coal elimination Variable generation Resource procurement SG enable DSM resources Carbon pricing Increase in EV FiT Program microFIT SG-Enabled DSM SG-Enabled CDM OEB responsibilities - Conservation Grid upgrades to accommodate - Renewable - SG technology Role of data analytics SG Enable Societal Obj: - coal elimination - renewable energy - economic development - load shifting SG enable conservation	Coal elimination Largest NA climate change initiative Renewable energy Supply reliability Clean air Reduce emissions Natural Gas Coal elimination Largest NA climate change initiative Renewable energy investment Coal elimination Largest climate change initiative Coal elimination Largest climate change initiative in Canada Reduce reduction Coal elimination Largest NA climate change initiative Reduce carbon footprint Coal elimination Largest NA climate change initiative Reduce carbon footprint Reduce carbon footprint - Efficiency - Waste reduction - Electricity conservation Local solution Climate change OEB promote conservation Focus on conservation Focus on energy efficiency OEB deliver CDM LTEP: energy efficiency Ontario climate change strategy: energy efficiency OPG GHG Management Plan - Generation Mix - improve nuclear performance - improve hydro performance - improve efficiency - bio fuels - prepare carbon trading Biodiversity program Tree planting Goal: clean energy company Sustainable energy Reduce emissions - Nuclear - Hydro electric - Biomass fuel Coal elimination Nuclear generation No emissions OPG GHG Management Plan Generation efficiency Biofuel Coal elimination OPG Biodiversity Program Nuclear Generation Hydroelectric generation No emissions No emissions EVs- CCM EV- Reliable Transportation EV- economic benefits EV- environmental benefits Emission-free baseline generation Provincial GHG reduction goals

SG enable efficiency	Electrification of transportation
Provincial conservation and efficiency measures	Charging on clean generation
Long-term CDM targets	Reduce emissions
SG enable CDM progress	Climate Change mitigation
SG policy parallel renewable generation development	OPG EV Fleet
Integrate SG policy	Charging stations
SG enable conservation	Reliable Transportation
OPA support conservation	Reduce emissions
OPA support SG	Climate change mitigation
SG enable distributed generation	Employee Commuter Cycling
SG evaluation	Reducing Traffic
SG enable distributed generation	Climate Change Action
SG enable conservation	Smart Commute
OPA on SG Forum	Reduce traffic
SG Results in Reliable Electricity	Transportation efficiency
SG-enabled distributed generation	Clean energy
SG-enabled efficiency	
SG-enabled demand management	Wind
Consumer adoption SG	Reduce fossil fuel dependency
THESL SG Roadmap	Reduce pollution
SG- Goal Climate Protection	Reduce smog
SG-Goal energy security	Ontario climate change targets
SG-Goal customer satisfaction	GHG reductions
SG-enabled CDM	Federal Climate Change Plan
SG-enabled grid automation	Technology investment fund
SG-enabled home energy management	Regulated GHG limit
Ensure Privacy with SG	Kyoto Protocol
Ensure Conservation with Privacy	Federal Climate Change Plan
THESL SG Roadmap	Large Final Emitters
SG-goal climate protection	GHG Regulations
SG-goal energy security	Provincial GHG Targets
SG-goal customer satisfaction	Provincial Climate Change Plan
Electric transportation	Federal emission targets
SG-Enable demand management	Provincial emission targets
Carbon-Pricing	Climate change plan OPG risk to operations
Environmental Cost Regimes	GEGEA
SG Integrate System	Provincial Climate change strategy
SG Impact: efficient system	Clean-tech industry
SG Impact: reliable system	Aggressive targets
SG Impact: Responsive system	Conservation
SG Impact: environmental benefits	Renewable energy
SG Enable consumer renewable generation	Consumption reduction
Efficient and effective production	Toronto's CC Action Plan
Efficient and effective consumptions	GHG Reduction Targets
SG consumption data	Adjust corporate operations
SG system automation	- Reduce fleet GHG
SG-enabled reliability	- Reduce idle times
SG-enabled reroute	- Reduce office footage
GEGEA-enable distributed renewables	ECO GHG monitoring
GEGEA-enable grid upgrades	Reducing carbon footprint
SG-enabled home management	Climate change committee
Energy monitoring tools	Cap and Trade regime
SG-enabled reliability	Impact of climate change regulation
SG-enabled alternative energy	Impact on OPA Procurement
SG-enabled renewable	Treatment of Environmental attributes
SG-enabled small scale renewable	Legal issues
Smart appliances	Climate change
TOU-energy management	Carbon trading
SG-enabled demand response	Federal carbon policy
Faster restoration	Provincial carbon policy
SG-enabled renewables	Regional carbon policy
SG-enabled outage management	Treatment of environmental attributes
Changing billing practices	Water-energy nexus
Changing systems	Water availability
SG-enabled small scale renewable	Water temperature
Reduce demand central generation	Alter rainfall frequency and duration

SG-reduce outages SG to improve system performance Smart meter Efficient delivery Outage management TOU Load shifting Consumer benefit Home energy management Manage consumption Manage costs Environmental benefit Home energy management market Innovation SG maximize generation Service quality SG-enabled demand response SG to enhance security Remote monitoring technology Smart meter generated Consumption data SG Integrated System SG integrating system SG-enabled distributed generation SG-enabled EV charging Improve system operation Consumer benefits Environmental benefits SG economic benefits SG environmental benefits Improved operating performance Outage management Rapid restoration Self-healing Improve power quality System automation Increase productivity Managing complexity Improved system performance Improve safety Remote operation Equipment automation SG-enabled reliability Faster service restoration SG enhanced maintenance SG planning Automatic reconfiguration Minimize faults Modify business practice New information SG enable detailed planning Precise information available SG enhanced service SG enhanced reliability Transmission impacts Safety impacts Accommodate resource mix SG-enabled storage SG-enabled demand response Coal elimination Nuclear generation SG enhanced reliability SG enhanced flexibility SG-enabled efficiency SG enhanced control of transmission SG-enhanced coordination Evolving supply mix	New Approach Energy Use Supply Management Climate change impact OPG operations Water availability Weather variances Water flows Climate change impact OPG operations Water availability Weather variances Water flows OPG Risk management Production forecasting Outage plans Watershed impacts Energy production impacts: - precipitation amount - precipitation timing - precipitation geographical timing - temperature - river flows - reservoir levels Understand Long-term climatic trends OPG operations - precipitation variability - evaporation - lake levels Climate change mitigation Extreme weather Climate change adaptation Adapting operations Extreme weather Manage weather risk Enhance system resilience Climate change adaptation Improve restoration Vulnerability assessment Manage uncertainty Vulnerability assessment Climate projections Vulnerability assessment Climate projections Environmental issue impact electricity planning Climate change - operational risk - system risk Precipitation changes Water temperature changes Changes in cloud cover Changes in wind pressure Climate change committee School Education programs Energy conservation Environmental messages Earth Hour Environmental Awareness Week Barrie Earth Hour Music Festival Woodbridge Earth Hour Lantern Walk Fight climate change Encourage Conservation Earth Hour Grassroots movement Climate change awareness Lights off Earth Hour Climate change awareness

SG address transmission congestion SG complicate security SG-enabled storage SG-enabled vehicle battery storage SG-enabled efficiency SG-enabled reliability SG-enabled flexibility Use of Existing infrastructure Consumer benefits Environmental benefits SG improve asset management Mitigate system costs Mitigate customer costs SG-enabled efficiency SG-enabled storage SG-enabled EV SG-enabled clean energy to remote communities Public participation Private sector participation SG economic development Export opportunities Smart grid Convenience New jobs Green electricity Consumer data Security risks Privacy risks SG- Customer Value Customer confidence SG-enabled reliability SG-enabled security SG-enabled privacy SG benefits SG-enabled storage Storage-enabled flexibility Storage enabled reliability Storage enabled predictability Environmental benefit Reduce fossil fuel dependency Enhance system efficiency SG-enabled renewables SG long-term economic value SG-enabled distributed generation SG affect future electricity investments SG- economic return Job creation Economic development LDCs research investments Consumer benefits SG- rapid error response SG- consumer control SG- consumer market participation Smart meter TOU SG- enabled CDM Smart home - internet access - smart meter - smart appliances - distributed generation - consumers="prosumers" SG-enabled emission reduction - Peak load energy savings - Energy efficient programs - Reduced system losses	Global impact Lights off Earth Hour Community engagement Climate change education PeaksaverPLUS Marketing No connection to climate change

- Renewable integration - EV deployment Job creation SG –enabled net zero house SG progress SG-enabled renewables SG-enabled- ancillary services SG-enabled – market liquidity SG-enabled transmission and distribution asset deferral SG-enabled reduced economic costs SG- enabled market efficiency gains SG- enabled renewable integration SG- enabled consumer participation SG- enabled demand management SG- enabled conservation SG- enabled distributed generation SG-enabled renewables SG-enabled EV charging SG-enabled storage Storage-enabled supply reliability SG-enabled distributed generation SG-enabled renewables Access to consumer data - Changing utility roles Access to consumer data - Changing utility roles SG- enabled home energy management SG-enabled DSM SG-enabled DSM Enhanced price signal SG-enabled automatic home energy management SG-enabled consumer control SG-enabled renewables SG-enabled self healing networks - Re-route power - Outage management GEGEA- enable SG GEGEA- enable renewables Gov mandate: culture of conservation Smart meter roll out TOU pricing GEGEA- enable renewables GEGEA- enable CDM GEGEA- enable SG OEB set CDM targets Green economy CDM strategies Smart grid Infrastructure upgrades- SG Infrastructure upgrades- distributed generation GEGEA OEB mandate OEB deferral accounts - renewable generation - SG development GEGEA- enabled SG LDCs- consumers reduce peak demand LDCs- consumers conserve Provincial conservation targets LDC- SG implementation LDCs- enable renewables GEGEA- enabled renewables GEGEA- enabled SG GEGEA- enabled renewables GEGEA- enabled SG Privacy principles OEB evaluation criteria	

OEB SG guidance OEB evaluation criteria OEB SG guidance GEGEA- enabled SG GEGEA-enabled SG GEGEA- enabled SG SG privacy principles GEGEA-enabled SG OEB SG Guidance Renewed Regulatory Framework for Electricity OEB SG Guidance OEB SG Guidance LDC- SG implementation OEB SG Guidance OEB SG Guidance OEB SG Guidance GEGEA-enabled conservation GEGEA- enabled efficiency GEGEA-enabled renewables OEB SG Evaluation Criteria OEB SG Deployment OEB Statutory Objective OEB SG Guidance OEB SG Evaluation OEB SG guidance OEB-enable SG OEB SG Guidance OEB SG Evaluation Criteria OEB SG Guidance OEB SG Guidance OEB SG Evaluation Criteria GEGEA-enabled SG OEB Statutory Objective OEB SG Guidance SG-Objective Customer control SG-Objective Power System Flexibility SG-Objective Adaptive Infrastructure OEB SG Guidance - capital planning - innovation - coordination Flexible regulatory framework Data access OEB SG Evaluation Criteria - operational efficiencies - asset management OEB SG Guidance OEB SG Evaluation Criteria GEGEA- enabled SG SG-enabled renewables SG-enabled smart meters SG-enabled TOU SG-enabled EVs GEGEA- SG Objectives OEB SG Guidance LDC- SG Implementation OEB SG Guidance OEB SG Evaluation Criteria OEB SG Guidance OEB SG Evaluation Criteria LDC- SG Implementation OEB SG Evaluation Criteria OEB SG Evaluation Criteria SG Objectives Interoperability Standards Renewed Regulatory Framework for Electricity	

SG Forum monitor SG investment Renewed Regulatory Framework for Electricity SG Investments SG Objectives LDC Evaluation Guidelines - Customer focus - Operational effectiveness - Public policy responsiveness - Financial performance SG Evaluation Criteria SG-related legislation SG-related regulatory instruments SG-related public investments Renewed Regulatory Framework for Electricity SG Principles OEB SG Guidance OEB SG Evaluation Criteria Privacy principles Security standards OEB SG Guidance GEGEA- enable SG SG-enable change in consumer behavior SG-enabled renewable connections OEB-enabled SG OEB-enable distributed generation SG- impacts on distributed generation - contracting - pricing Privacy principles Privacy principles Consumer data storage Consumer data management Privacy principles Privacy principles Privacy principles Privacy principles Privacy principles Privacy principles Privacy principles Privacy principles Privacy principles OEB Statutory Objective OEB facilitate SG OEB promote renewables OEB SG Guidance LDC- SG Implementation GEGEA- enabled renewable generation GEGEA- enabled SG SG-enabled reliability OEB facilitate SG OEB- SG Guidance OEB Evaluation criteria Government Policy Objectives Security standards Efficient SG development Consumer Data SG-enhanced consumer control SG-enabled consumer control SG-support environmental awareness SG-enable small-scale generation SG-enable renewable technologies SG-objective grid efficiency SG-objective grid reliability SG- objective flexibility SG Principles Ontario SG Forum SG principles and objectives	

- inform policy - inform selection of technologies SG Forum SG Principles: - Efficiency - Customer Value - Coordination - Interoperability - Security - Privacy - Safety - Economic Development - Environmental benefits - Reliability Specific Objectives - customer control - power system flexibility - adaptive infrastructure SG Principles SG Objectives SG Foundations SG Principles SG Objectives OEB SG Guidance SG Principle: Privacy Privacy principles SG Principle: Security SG Principle: customer value SG Principle: Environmental benefits - EV SG Principles: coordination SG principles: interoperability Continental standards OEB SG Guidance Policy Objectives - operational efficiency - customer value - regional coordination - interoperability - security - privacy - safety - economic development - environmental benefits - reliability Electricity Objectives: - economic efficiency - cost effectiveness - smart grid implementation - renewables OEB SG Guidance SG Policy Objectives - customer control - power system flexibility - adaptive infrastructure objectives SG policy objectives - efficiency - customer value - interoperability - privacy Renewed regulatory framework objectives SG Obj- consumer control - authorized access to data - consumer control consumption - prosumer OEB SG Guidance	

Policy Objectives - consumer control - flexibility - adaptive infrastructure SG Obj: Adaptive Infrastructure SGWG to advise OEB on SG technologies OEB SG Guidance OEB Evaluation Criteria OEB SG Evaluation Policy Objectives Efficiency - Operation efficiency - Cost effective Customer value - SG benefits Coordination - Regional Smart Grid Plans - Economies of scale Interoperability - Recognized industry standards - Common operation protocol - Develop standards Security - Cybersecurity - Physical security - Protect data - Unauthorized access - Malicious attacks Privacy - Protect and Respect - Consumers privacy - Privacy impact assessments Safety Economic development - Growth - Job creation - Ontario Based Sourcing Environmental benefits - Clean technology - Conservation - Efficient use of existing tech Reliability - Maintain and improve - Outage management Consumer Education - generation involvement - conservation involvement - SG benefits Flexibility - support applications Forward Compatibility - modularity - scalability - extensibility Encourage Innovation Maintain Pulse on Innovation - information sharing - best practice SG-goal: grid efficiency SG-goal: grid reliability SG-goal: grid flexibility Privacy principles Privacy principles Smart meter SCADA to Facilitate SG technology	

Real-time interface: - Smart meter - SCADA - OMS SG-enable micro-grid Infrastructure investments: - system reliability - customer care - growth SG Investments: - Integrated operating model - Smart meter Integrated Operating Model (IOM) - distribution system intelligence - operating performance - reliability - customer outage - responsiveness - public safety System automation Real-time information Smart meter rollout Smart meters 1.8–1.83 GHz spectrum for Smart Grid applications. SG Applications- ADS project SCADA Real time monitoring Archive interruption data System Integration - smart meter - smart grid - OMS Communication system upgrades Additional with bandwidth- grid operation Redundant Service- grid operation Advanced monitoring technology Advanced control technology Self-healing technology FIDR Advanced Metering Infrastructure Fibre Optics Communications - data collection - data control - meter data transmission - video Smart protective relays: Reduce outage impacts AMI- OMS-GIS Interface Smart meter rollout LDC Smart grid strategy Smart meter rollout TOU rates SG demo- micro-grid - renewable energy - storage SG Demo- Micro-grid - consumer awareness - leverage SG technology Micro-grid demo SG Initiatives: - Transformer loading analytical tool - EV mapping project - Green button initiative - High speed breaker - Smart grid success metric OMS	

Automated switching Smart meter OMS System automation - reliability - efficiency Network monitoring Intelligent switches - automatic power reroute TOU Ontario SG leader TOU System Transition Communication spectrum Distribution monitors Transformer monitors System automation Smart meter TOU LDC SG demonstrations SG-enabled distributed generation SG Data management technologies SG-enabled small scale generation SG-enabled reactive power Communication protocol for home energy management Web-based tool to control energy use Detection and isolation of system faults SG-enabled storage SG-enabled renewables SG-enabled increased grid capacity SG-enabled distributed generation SG-impact consumer visibility SG-impact consumer control EV deployment Smart appliances Energy management services Distributed generation Renewables Smart homes Smart appliances EV Distributed generation Self-healing grid EV Charging Impacts EV Demo SG-enable EV Smart grid technology - HVAC - Automation systems Old batteries for SG applications SG-enabled energy storage SG-enabled distributed generation SG-enabled energy management SG-enabled electric transportation SG Development and Implementation Advanced Technology Systems and Equipment Fault Detection Isolation and Restoration system (FDIR) - outage reduction Smart appliances Biomass industrial cogeneration system Web-based commercial lighting field control demo System integration technologies - monitor - control - remediate faults - OMS	

- restoration systems - GIS - Storage Smart grid projects - Customer display integration - Web energy portal - OMS integration - Network monitoring integration - Integration architecture - Network readiness - SG network security Consumer data Smart meters Intelligent Electronic Devices (IEDs) SG consumer value SG consumer engagement Customer awareness Smart Grid Benefits Social media campaign Public awareness SG impressions Online Ads Social media Customer awareness SG campaign Utility service In-person promotion Renewable energy education Health and safety education Conservation education Contest Consumer education SG benefits Little awareness of SG (2012) SG benefits SG benefits Simple language Consumers receptive Customer communication Contest SG awareness SG benefits Social media Contest Social media SG benefits TV advertising Contest SG impressions Geo-targeted online ads Newspaper websites SG impressions Contest Blog posts - Community relations - Conservation - Power outages - Smart grid - Solar generation Home energy management demo Students Hands on leaning - EV - Renewable - SG	

Demo trailer - SG use - SG benefits Student environmental committee - Conservation - Recognition of SG technology Internet web-page Smart meter development Micro-FIT SG innovation Personal benefit Community benefit Educate and train employees Modern electricity system Benefits Ontario SG change service Consumer on-side SG leadership conference Interactive website Consumer education SG roadmap Stakeholder consultation SG public education materials Text materials - Smart meters - TOU rates - In-home devices - Smart appliances - SG technologies SG benefits Consumer value Operational benefits Educational regulatory requirement Informed consumers Customers embrace SG Consumer expenditures Smart homes Consumer impact on electricity system Building trust Benefits of SG Smart Meters Consumer and Generator Demands GEGEA Smart Meters Aging Infrastructure Growing Demands GEGEA Smart Grid Upgrades Aging Infrastructure Grid Modernization Aging Infrastructure Grid Modernization Smart Meters Grid Modernization Paradigm shift SG Required for Renewable SG to accommodate system upgrades Aging Infrastructure Grid Modernization Market Demand Redevelopment and new development opportunities GEGEA GEGEA Modernize Grid LTEP Complementary Goals	

Grid Modernization Long-Term Benefits Market Demand Aging Infrastructure Grid Modernization	

Appendix G: Latent Content Analysis Open Codes By Theme

The following table shows all of the open codes identified in the SG and climate change excerpts arranged by theme. To avoid redundancy in content, duplicated open codes (shown in Appendix E) were eliminated. The far left column is the theme to which the open codes correspond with (many directly correspond with CCIEF indicators). The open codes identified in the SG excerpts are found in the middle column, while open codes identified in the climate change excerpts are found in the right column.

	SG Excerpts: Open Codes	**Climate Change Excerpts: Open Codes**
Non-Carbon Energy	SG enable renewables SG enable distributed generation OEB Programs to facilitate R.G. Integrate renewables Solar PV Projects Renewable generation distribution assets Coal elimination Meet Future demand Variable generation Resource procurement FiT Program microFIT Grid upgrades to accommodate SG policy parallel renewable generation initiatives SG Enable consumer renewable generation SG-enabled alternative energy SG-enabled small scale renewable Reduce demand central generation Nuclear generation Evolving supply mix SG-enabled clean energy to remote communities SG-enabled emission reduction - Renewables SG-enable small-scale generation Reduce fossil fuel dependency Environmental Beneifts	Renewable energy Reducing carbon footprint OPG GHG Management Plan - Generation Mix - Improve nuclear performance - Improve hydro performance - Improve efficiency - Bio fuels - Prepare carbon trading Sustainable energy Reduce emissions - Nuclear - Hydro electric - Biomass fuel Coal elimination Emission-free baseline generation Clean energy Wind Reduce fossil fuel dependency Reduce pollution Reduce smog Landfill Gas Collection and conversion Environmental benefit Green energy Wood pellets generation Wood biomass No food crops for fuel Sustainable fuel Facility conversion Reduce air pollution Supply reliability Largest NA climate change initiative
Conservation and Efficiency	SG-CDM Complement SG Enable conservation Conservation mandate Energy saving targets Culture of conservation Demand-side involvement SG enable DSM resources OEB responsibilities SG enable efficiency SG enable CDM progress Consumer adoption SG Ensure Conservation with Privacy	Consumption reduction Generation efficiency Transportation efficiency Reduce carbon footprint - Efficiency - Waste reduction - Electricity conservation Focus on conservation Focus on energy efficiency LTEP: energy efficiency Ontario climate change strategy: energy efficiency

	Efficient, effective production Efficient, effective consumption Energy monitoring tools Smart appliances TOU-energy management Efficient delivery TOU pricing Load shifting Consumer benefit Home energy management Manage consumption Manage costs SG-enabled emission reduction - Peak load energy savings - Energy efficient programs Enhanced price signal SG-enabled automatic home energy management Efficient SG development	
Electrification	Zero emission mobility SG enable EV EV charging Vehicle-to-home power Off-Peak Charging SG to optimize grid SG required for: • Off-Peak Charging • Avoid increasing peak • Avoid adverse • EV batteries/ storage Increase in EV SG-enabled vehicle battery storage SG-enabled emission reduction - EV deployment	EVs- CCM EV- economic benefits EV- environmental benefits Electrification of transportation Charging on clean generation Reduce emissions Climate Change mitigation OPG EV Fleet Charging stations Reliable Transportation
Micro-Grid	SG-enable micro-grid SG demo- micro-grid - renewable energy - storage Micro-grid demo	
Flexibility and Redundancy	Flexibility to market Flexible EV Charging SG system automation SG-enabled reliability SG-enabled reroute during outage SG enhanced flexibility Enhance system efficiency SG- rapid error response SG-enabled emissions reduction - Reduced system losses SG-enabled self healing networks - Re-route power - Outage management Flexible regulatory framework SG-objective: flexibility	Supply reliability EV- reliable transportation
Education and Awareness	SG consumer value SG consumer engagement Customer awareness Smart Grid Benefits Social media campaign Public awareness SG impressions Online Ads SG campaign Utility service In-person education and promotion In person renewable energy education	Earth Hour Community engagement Climate change education Climate change awareness Global impact Lights off Environmental Awareness Week Barrie Earth Hour Music Festival Woodbridge Earth Hour Lantern Walk Fight climate change Encourage Conservation School Education programs

	In person health and safety education Conservation education Contest Building trust Consumer impact on electricity system Little awareness of SG (2012) Simple language Consumers receptive Customer communication TV advertising Geo-targeted online ads Newspaper websites Blog posts - Community relations - Conservation - Power outages - Smart grid Solar generation Customers embrace SG Consumer expenditures Smart homes Informed consumers Educational regulatory requirement Text materials - Smart meters - TOU rates - In-home devices - Smart appliances - SG technologies Consumer value Operational benefits SG public education materials Home energy management demo Students Hands on leaning - EV - Renewable - SG Demo trailer - SG use - SG benefits Interactive website Consumer on-side SG leadership conference Educate and train employees Student environmental committee - Conservation - Recognition of SG technology Internet webpage Customer confidence SG-enabled storage Storage-enabled flexibility Storage enabled reliability Storage enabled predictability SG Demo- Micro-grid - consumer awareness - leverage SG technology Micro-grid demo EV Demo SG training EV charging demonstration	Environmental messages
Objectives	SG- Customer value Privacy principles SG-Objective Customer control SG-Objective Power System Flexibility	

	- support applications SG-Objective Adaptive Infrastructure GEGEA- SG Objectives Security Standards SG-goal: grid efficiency SG-goal: grid reliability SG-goal: grid flexibility Maintain Pulse on Innovation - information sharing - best practice Encourage Innovation Forward Compatibility - modularity - scalability - extensibility Consumer Education - generation involvement - conservation involvement - SG benefits Efficiency - Operation efficiency - Cost effective Customer value - SG benefits Coordination - Regional Smart Grid Plans - Economies of scale Interoperability - Recognized industry standards - Common operation protocol - Develop standards Security - Cybersecurity - Physical security - Protect data - Unauthorized access - Malicious attacks Privacy - Protect and Respect - Consumers privacy - Privacy impact assessments Safety Economic development - Growth - Job creation - Ontario Based Sourcing Environmental benefits - Clean technology - Conservation - Efficient use of existing tech Reliability - Maintain and improve - Outage management Government Policy Objectives SG-enabled consumer control SG-support environmental awareness SG Obj- consumer control - authorized access to data - consumer control consumption - prosumer Ontario SG Forum SG principles and objectives - inform policy - inform selection of technologies SG Forum SG Principles: - Efficiency	

	- Customer Value - Coordination - Interoperability - Security - Privacy - Safety - Economic Development - Environmental benefits - Relilability Specific Objectives - customer control - power system flexibility - adaptive infrastructure Electricity Objectives: - economic efficiency - cost effectiveness - smart grid implementation - renewables Continental interoperability standards	
Climate Change Response		New Approach for Energy Use Supply Management OPG Risk management Production forecasting Outage plans Understand Long-term climatic trends OPG operations - precipitation variability - evaporation - lake levels Climate change adaptation Climate change mitigation Adapting operations Manage weather risk Enhance resilience Improve restoration Vulnerability assessment Manage uncertainty Climate projections Cap and Trade regime Biodiversity program Tree planting Employee Commuter Cycling Reducing Traffic Climate Change Action Smart Commute Local solution Biggest NA climate change initiative Coal elimination
Drivers and Enablers	GEGEA Green Economy Pressure from regulators OEB Programs for SG investment Provincial initiatives: • Conservation • Renewable generation • Smart meters Provincial conservation and efficiency measures Long-term CDM targets Integrate SG policy GEGEA-enable distributed renewables GEGEA-enable grid upgrades GEGEA- enable CDM GEGEA- enabled efficiency	Federal Climate Change Plan Technology investment fund Kyoto Protocol Regulated GHG limit Large Final Emitters GHG Regulations Provincial GHG Targets Provincial Climate Change Plan Climate change plan OPG risk to operations GEGEA Clean-tech industry Toronto's Climate Change Action Plan Federal carbon policy Provincial carbon policy

	OEB Statutory Objective Aging Infrastructure Growing Demands Market Demands Consumer and generator demands Grid Modernization Grid Redevelopment and new development opportunities	Regional carbon policy Goal: clean energy company Provincial GHG reduction goals Transmission Reinforcement LTEP GEGEA- enable renewables Gov mandate: culture of conservation
Impacts	Upgrade system to SG Enable distributed generation Consumer benefits System Benefits Reduce environmental footprint SG Enable Societal Obj: - coal elimination - renewable energy - economic development - load shifting SG Results in Reliable Electricity SG- Goal Climate Protection SG-Goal energy security SG-Goal customer satisfaction SG-enabled grid automation SG-enabled home energy management Carbon-Pricing Environmental Cost Regimes SG Integrate System SG Impact: efficient system SG Impact: reliable system SG Impact: Responsive system SG Impact: environmental benefits SG-enabled reliability Faster restoration SG-enabled outage management SG to improve system performance Home energy management market Innovation SG maximize generation Service quality SG to enhance security SG economic benefits Rapid restoration Improve power quality Increase productivity Managing complexity Improve safety SG enhanced maintenance Minimize faults Transmission impacts SG enhanced control of transmission SG-enhanced coordination SG address transmission congestion SG complicate security SG-enabled storage SG improve asset management Mitigate system costs Mitigate customer costs Public participation Private sector participation SG economic development Export opportunities Convenience New jobs Consumer data available Security risks	Water-energy nexus Water availability Water temperature Alter rainfall frequency and duration Weather variances Water flows Watershed impacts Energy production impacts: - precipitation amount - precipitation timing - precipitation geographical timing - temperature - river flows - reservoir levels Extreme weather Changes in cloud cover Changes in wind pressure

	Privacy risks Personal benefit Community benefit SG –enabled net zero house Storage-enabled supply reliability SG- impacts on distributed generation - contracting - pricing SG-enable change in consumer behavior SG-impact consumer visibility SG-impact consumer control SG-enabled increased grid capacity Long-term economic value	
Smart Grid Technology and Support	Communication networks Communication system upgrades Additional with bandwidth- grid operation Redundant Service- grid operation Leverage smart meter SG Assets Communication technology • Pervasive • Rapid • Robust • Scalable • Secure • Accommodate smart meters • Accommodate devices • Open standards Interoperability Adaptable communication devices Grid upgrades to accommodate Role of data analytics Ensure Privacy with SG Remote monitoring technology Smart meter generated Consumption data Self-healing System automation Automatic reconfiguration Smart meter development Micro-FIT Smart home - internet access - smart meter - smart appliances - distributed generation - consumers=”prosumers” Smart meter roll out TOU pricing Consumer data storage Consumer data management Interoperability Standards SCADA to facilitate SG technology Real-time interface: - Smart meter - SCADA - OMS Infrastructure investments: - system reliability - customer care - growth SG Investments: - Integrated operating model - Smart meter Integrated Operating Model (IOM)	

	- distribution system intelligence - operating performance - reliability - customer outage - responsiveness - public safety Intelligent Electronic Devices (IEDs) Smart grid projects - Customer display integration - Web energy portal - OMS integration - Network monitoring integration - Integration architecture - Network readiness - SG network security System integration technologies - monitor - control - remediate faults - OMS - Resoration systems - GIS - Energy Storage Smart appliances Biomass industrial cogeneration system Web-based commercial lighting field control demo Real-time information 1.8–1.83 GHz spectrum for Smart Grid applications. SG Applications- ADS project Archive interruption data Fault Detection Isolation and Restoration system (FDIR) Advanced monitoring technology Advanced control technology Advanced Metering Infrastructure Fibre Optics Communications - data collection - data control - meter data transmission - video Smart protective relays: Reduce outage impacts AMI- OMS-GIS Interface Old batteries for SG applications SG Initiatives: - Transformer loading analytical tool - EV mapping project - Green button initiative - High speed breaker - Smart grid success metric Smart grid technology - HVAC - Automation systems SG-enabled reactive power Communication protocol for home energy management Web-based tool to control energy use Detection and isolation of system faults SG Data management technologies Communication spectrum Distribution monitors Transformer monitors Enterprise resource planning information system	
Stakeholder Role	OPA support conservation	ECO GHG monitoring

	OPA support SG OPA on SG Forum THESL SG Roadmap OEB SG Guidance - Capital planning - Innovation - Coordination SG Forum monitor SG investment SGWG to advise OEB on SG technologies LDC SG strategy OEB set CDM targets OEB evaluation criteria OEB SG guidance LDC- SG implementation LDCs- enable renewables LDCs- consumers reduce peak demand LDCs- consumers conserve	OEB promote conservation
Impact on Stakeholders	Changing billing practice Changing systems Modify business practice New information available SG enable detailed planning Use of Existing infrastructure SG affect future electricity investments LDCs research investments SG- consumer control SG- consumer market participation SG-enabled- ancillary services SG-enabled – market liquidity SG-enabled transmission and distribution asset deferral SG-enabled reduced economic costs SG- enabled market efficiency gains Access to consumer data - Changing utility roles Infrastructure upgrades- SG Infrastructure upgrades- distributed generation GEGEA OEB mandate OEB deferral accounts - Renewable generation - SG development Renewed Regulatory Framework for Electricity OEB SG Evaluation Criteria - Operational efficiencies - Asset management SG-related legislation SG-related regulatory instruments SG-related public investments LDC Evaluation Guidelines - Customer focus - Operational effectiveness - Public policy responsiveness - Financial performance	Climate change impact OPG operations Environmental issues impact electricity planning Climate change - Operational risk - System risk Climate change committee Adjust corporate operations - Reduce fleet GHG - Reduce idle times - Reduce office footage Impact of climate change regulation Impact on OPA Procurement Treatment of Environmental attributes Legal issues Climate change Carbon trading