SUSTAINABLE ENERGY FUTURES: TOWARD AN INTEGRATED STRATEGIC ENVIRONMENTAL ASSESSMENT PROCESS FOR ENERGY PLANNING

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PERMISSION TO USE STATEMENT

ABSTRACT

Strategic environmental assessment (SEA) and sustainability are inextricably linked. SEA can be used to assess the sustainability impacts of plan, program and policy (PPP) initiatives, inform decision-making with regard to sustainability issues and promote the trickle down of sustainability principles to project level assessment, among others. However, in terms of energy sector practice in particular, SEA application is neither well applied nor understood, there has been insufficient evidence of the operationalization of sustainability in SEA and little research showing how SEA might provide a systematic framework for the integration of sustainability principles. As a result, this thesis examines the relationship between SEA and sustainability, with the goal of understanding how sustainability principles and criteria can be integrated and operationalized in the development of energy futures. The thesis chapters are manuscript based. The first manuscript presents a literature review of ten years of academic research examining how SEA facilitates the integration of sustainability in PPP development decision making, while the second and third manuscripts focus on a 'state of practice' examination of SEA application and sustainability integration in international electricity sector case practice. The fourth manuscript applies a structured SEA framework that operationalizes sustainability principles using an expert-based assessment of alternative future scenarios for electricity development in Saskatchewan, along with an examination of implications for both electricity sector practice and SEA methodology. Finally, the conclusion discusses the major findings from the four manuscripts and identifies challenges for the operationalization of sustainability, the adoption of good-practice SEA elements in practice and makes recommendations for future SEA guidance and academic research.

Overall, the lack of operationalization of sustainability in energy sector SEA suggests the need for improved SEA methodology and guidance that describes the scope of and approaches to sustainability in SEA and outlines how to effectively incorporate sustainability in SEA practice. In order for SEA to deliver on its sustainability mandate, impact assessment methodologies that allow for clarification of both the concept of sustainability and the uncertainty surrounding higher level policy, plan and program (PPP) decision-making need to be developed and more widely adopted. Lessons learned from practice that describe the appropriate use of both quantitative and qualitative methodologies also need to be better disseminated and shared amongst the SEA research and practitioner community. However, results from this research also illustrate that there is still inconsistent application of SEA processes, which likely stems from uncertainty and confusion on behalf of practitioners and decision-makers as to what the role and purpose of SEA is in PPP development. More case-practice evidence of SEA application is needed that demonstrates the purpose and benefits of SEA for sustainability in a variety of decision-making contexts. Evidence from this research also shows that tiering, both upward to higher PPP levels and downward to the project level, is occurring in some electricity sector SEAs. That SEA outcomes are potentially tiering upward to influence the development of legislation is a finding that counters the often-cited notion that tiering in SEA is idealistic. This research indicates the need for additional focus on institutional arrangements that allow for SEA application to effectively inform and influence PPP decision-making in support of sustainability. The need for SEA as a higher order assessment process to capture regional and strategic impacts is becoming increasingly important in light of current federal legislation that eliminates environmental impact assessment requirements for many small-scale projects. However, although SEA emerged, in part, to inform and direct decisions made at the project level, the link between SEA, sustainability and operational decisions still remains elusive in practice.

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LIST OF ABBREVIATIONS

AHP	Analytical Hierarchy Process
CCME	Canadian Council of Ministers of the Environment
CO_2	Carbon Dioxide
CR	Consistency Ratio
DECC	Department of Energy and Climate Change
EA	Environmental Assessment
EDA	Exploratory Data Analysis
ENGO	Environmental Non-governmental Organization
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWh	Gigawatt Hour
kWh	Kilowatt Hour
MCA	Mulit-Criteria Analysis
MW	Megawatt
NGO	Non-governmental Organization
OEER	Offshore Energy Environmental Research Association
OPA	Ontario Power Authority
PSCW	Public Service Commission of Wisconsin
PPP	Policy, plan and program(me)
SEA	Strategic Environmental Assessment
SEOC	Swedish Environmental Objectives Commission
UK	United Kingdom
US	United States
VOC	Volatile Organic Compound

CHAPTER 1: INTRODUCTION - STRATEGIC ENVIRONMENTAL ASSESSMENT AND SUSTAINABILITY IN THE ENERGY SECTOR

1.1 Introduction

Since the second industrial revolution, energy resource development has been the backbone of economic and social growth in the developed world. The world population is set to double by the mid-21st century, with estimates of global primary energy demand increasing by 1.5 to 3 times by the year 2050 (Dincer, 1999). In 2007, Canada was the fifth largest energy producer in the world and ranked third and seventh, respectively, in gas and oil production (Hester, 2007). As a result, Canada is in a prime position to provide energy to an ever-increasing world population with increasing energy needs. However, while Canada is rich in both renewable and non-renewable energy resources, there is a need to also ensure that Canada's energy sector is developed in a more sustainable way (Hofman and Li, 2009). Decisions about energy resource development in Canada, as well as the management of the impacts associated with development, are typically made with the support of Environmental Impact Assessment (EIA). A concern, however, is that although EIA in the energy sector has been ongoing in Canada for many years, it has been narrowly focused on individual energy development projects (e.g., hydroelectric dams) or single sectors (e.g., offshore oil and gas development) and focused on mitigating the potential effects of a proposed development rather than also examining alternative energy options and sustainable energy futures at the strategic level of policies, plans and programs (PPPs) (Hannah, 2009; Marshall and Fischer, 2006; Benson, 2003; Noble and Storey, 2001). Arguably, a more strategic form of environmental assessment is required for energy development assessment and decision making than what can be achieved under current project-driven EIA practices – a more regional and possibly national level assessment, that is more proactive and that integrates and operationalizes sustainability principles in energy policy and planning initiatives.

The Canadian Council of Ministers of the Environment (CCME) defines regionally-based strategic environmental assessment (SEA) as "a process designed to systematically assess the potential environmental effects of alternative strategic initiatives, policies, plans or programs for a particular region" (CCME, 2009, p. 6) so as "to inform the preparation of a preferred development strategy and environmental management framework for a region" (CCME, 2009, p. 7). SEA is a higher order environmental assessment process that facilitates the environmental assessment of PPP initiatives and their alternatives at the early stages of planning and decision making, and is intended to be undertaken while alternative futures and options for development are still open (e.g., CCME, 2009; Marshall and Fischer, 2006; Dalal-Clayton and Sadler, 2005). As such, SEA provides a framework to apply environmental assessment in a more broad-based, conceptual way than at the project level (Noble, 2009) and offers a sound basis for informed decision making with regard to sustainability (Noble and Gunn, 2009). Its main advantages are that by focusing on higher-order PPP initiatives, targeted sustainability principles and criteria can be integrated into the process, potential impacts can be addressed at their source, and the benefits of early consideration of environmental costs and benefits can trickle down and inform project level development and investment decisions (see CCME, 2009).

In principle, SEA applied to the energy sector looks beyond the individual energy development projects and is focused on planning for energy futures. In this regard, SEA has tremendous potential as an assessment tool to facilitate sustainable energy development. The Canadian government's Cabinet Directive for SEA states that "by addressing potential environmental considerations of policy, plan and program proposals, departments and agencies will be better able to...implement sustainable development strategies" (Privy Council Office and Canadian Environmental Assessment Agency, 2004. p 3). Similarly, the purpose of SEA with regard to sustainability as stated under the European Directive is that it must promote sustainable development (Therivel et al., 2009). Under the European Directive, the objective is "to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development" (EC, 2001). Overall, these directives provide the mandate for sustainability considerations to be integrated into the development and evaluation of energy policies, plans and futures.

Academic research also purports that SEA methodology has the ability to implement and promote sustainability principles in the assessment of energy futures and policies. Fischer (2003, p. 162), for example, states that "the main rationale for applying SEA is to help create a better environment through informed and sustainable decision making". Thus, it seems appropriate to integrate sustainability principles into the SEA process. In their assessment of SEA and its applicability to the development of alternative energy futures for Canada, Noble and Storey (2001, p 491) argue that energy policy must balance different interests and priorities, especially sustainability priorities such as environmental, social and economic goals and note that SEA can "identify the most practical and environmentally preferred energy alternative(s) to guide the development of an energy policy."

However, even with SEA mandates that require the consideration of sustainability and academic research that encourages the use of SEA as a sustainable development tool, SEA in the energy sector has not been developed explicitly for sustainability integration and is said to not be living up to its expectations with regard to the incorporation of sustainability principles and objectives in higher-order decision making (Noble, 2009; Gibson, 2006a; Partidário, 2000). One plausible explanation is that there has not been a systematic decision-making methodology with which, first, to operationalize sustainability principles in energy sector PPP development and, second, to provide for accountability in energy decision making whereby industry and government decision-makers explicitly capture the trade-offs made between social, economic and environmental priorities. SEA application in the energy sector is still in its infancy (Fidler and Noble, 2012; Marshall and Fischer, 2006), with inconsistent application of formal SEA and SEA-type models limited largely to single sector development, and there is an overall lack of awareness of how SEA is of value to energy sector development decision making (Noble, 2009; OAG, 2008; Noble 2004). In the face of growing energy demands in Canada and globally, there is both a need and opportunity to advance SEA and its value added to energy PPP decisions (Lyhne, 2011; Jay, 2010; Marshall and Fischer, 2006; Jay and Marshall, 2005), especially in terms of improving the rational models used in energy decision-making.

This research is based on the notion that, amongst the most significant challenges to advancing SEA as a tool for sustainable development in general, and in the energy sector in particular, there is little conceptual and applied research showing how sustainability principles are most effectively integrated and operationalized in SEA methodology (see Pope et al., 2004), and how SEA methodology might provide the structure and support necessary to implement sustainability principles in the development and assessment of energy futures. The opportunity, then, is to demonstrate how to operationalize sustainability in SEA for energy futures and PPP development, where options and alternatives can be developed and a more proactive approach can be taken earlier in the energy decision making process (Dalal-Clayton and Sadler, 2005; Noble and Gunn, 2009). In doing so, decision-makers can identify and evaluate alternative future energy scenarios based on a set of defined goals and objectives, presumably sustainability goals and objectives, and subsequently make an informed, measured choice where trade-offs about sustainability can be made explicit.

1.2 Research Purpose

This thesis examines the relationship between SEA and sustainability in order to determine how sustainability principles and criteria can be integrated and operationalized in the development of energy futures using an SEA methodology. Specific focus is placed on electricity sector development in particular because of its potential environmental impacts resulting from generation activities and large geographical transmission areas. While the specific focus of this research is on the electricity sector, the broader research purpose is to apply a generalized methodology for SEA and sustainability that can be adapted and modified for use in other sectors and for other applications. This is accomplished through the following objectives, to:

i) examine the use of SEA as a tool to support sustainability integration in policy, planning and decision making;

ii) determine how SEA in the electricity sector is currently applied and how sustainability principles are being integrated into the process; and

iii) demonstrate, based on a case study of electricity futures in Saskatchewan, an expert-based SEA process for electricity futures analysis that incorporates sustainability principles and criteria.

1.3 Thesis Structure

This thesis adopts a 'dissertation by manuscript' style, following the guidelines as set out by the College of Graduate Studies and Research. Following the introductory chapter, the thesis is organized into four manuscripts, each of which is presented as a single thesis chapter. The first manuscript (Chapter 2),"Strategic Environmental Assessment for Sustainability: A Review of a Decade of Academic Research" examines the SEA–sustainability relationship over the past decade from 2000 to 2010, focusing in particular on how SEA is said to facilitate sustainability in PPP assessment, development and decision making. A total of 86 research papers that address sustainability in SEA, published in the three leading environmental assessment journals, namely *Environmental Impact Assessment Review*, *Impact Assessment and Project Appraisal* and the *Journal of Environmental Assessment and Policy Management*, were reviewed. The Chapter presents an analytical literature review that examines how SEA supports the integration of sustainability in SEA, and identifies a number of persistent challenges to SEA *for* sustainability.

The second manuscript (Chapter 3), “Strategic Environmental Assessment Best Practice Process Elements and Outcomes in the International Electricity Sector”, and the third manuscript (Chapter 4), “Strategic Environmental Assessment for Sustainability: Best Practices and Lessons Learned from the International Electricity Sector”, focus on the current state of practice of SEA in the electricity sector and how sustainability is integrated in SEA practice. Chapter 3 addresses the need to better understand and advance SEA processes and its value added to energy sector planning and decision making, while Chapter 4 examines sustainability integration in SEA in the electricity sector to assess whether and how SEA can ensure and/or support sustainability. Five SEA and SEA-type cases in the electricity sector that included sustainable development as a goal were analyzed including the Ontario Power Authority’s (OPA) Integrated Power System Plan, Nova Scotia’s Fundy Tidal Project, the UK’s National Policy Statements, the Public Service Commission of Wisconsin’s (PSCW) Strategic Energy Plan, Portugal’s National Transmission Grid plan and Sweden’s Municipal Energy Plan for Finspång. The application of SEA in the electricity sector and the role that it fulfills when it is applied was first examined, and then attention was focused on whether and how sustainability principles are being integrated into SEA methodologies. Emphasis was placed on identifying current SEA approaches and practices that exist within the electricity sector and recognizing best practice and state of the art applications regarding incorporation of sustainability principles into SEA processes. Collectively, the chapters present a ‘state of practice’ examination of SEA application and sustainability integration in SEA in the electricity generation sector.

The fourth manuscript (Chapter 5), “Strategic Environmental Assessment in the Electricity Sector: An Application to Electricity Supply Planning in Saskatchewan, Canada” develops an SEA framework for electricity sector planning and applies the framework to evaluate electricity supply scenarios for the province of Saskatchewan. The chapter demonstrates an SEA process that operationalizes sustainability principles using an expert-based assessment of alternative future scenarios for electricity development in Saskatchewan, including the evaluation and assessment of renewable resource and uranium development futures. The SEA framework, adapted from Noble and Storey (2001), included a reference framework, baseline, identification of electricity supply alternatives, assessment of the alternatives and identification of a preferred electricity supply option. An examination of the potential implications resulting from the preferred electricity supply option, as well as the methodological implications resulting from the application of a structured SEA framework are discussed.

The thesis concludes in Chapter 6, "Integrating Sustainability into SEA Frameworks for Electricity Planning." This chapter discusses the major findings from the four manuscripts, and addresses challenges concerning the operationalization of sustainability, the limited use of quantitative impact assessment methodologies and the inconsistent adoption of good-practice SEA elements observed in SEA practice to date. The Chapter also includes observations regarding tiering in electricity sector SEA, the need for provision of adequate institutional arrangements in support of effective SEA application and implications for future SEA practice in light of recent changes to federal project-level environmental assessment requirements. Finally, recommendations are made for future SEA guidance and academic research, as well as opportunities to apply this research work to other sectors.

1.4 Copyright and Author Permissions

Chapters 2 through 5 of this thesis consist of manuscripts that have been published, accepted for publication or submitted for publication. Consistent with the copyright and author rights of each publisher, the manuscript citations are provided below. Permission to use or author rights from each publisher allowing use of the manuscripts in this thesis are included in Appendix C. For all manuscripts, as per the College of Graduate Studies and Research guidelines for manuscript style theses, the student is the first author and supervisor second author.

Chapter 2: White, L. and Noble, B.F. (2012a). Strategic environmental assessment for sustainability: A review of a decade of academic research. *Environmental Impact Assessment Review.* Article in press. http://dx.doi.org/10.1016/j.eiar.2012.10.003 [Elsevier]

Chapter 3: White, L. and Noble, B.F. (2013). Strategic environmental assessment best practice process elements and outcomes in the international electricity sector. *Journal of Environmental Assessment Policy and Management*. Article accepted for publication [World Scientific]

Chapter 4: White, L., and Noble, B.F. (2013). Strategic environmental assessment for sustainability: Best practices and lessons learned from the international electricity sector. *Energy Policy*. Article submitted for review [Elsevier]

Chapter 5: White, L., and Noble, B.F. (2012b). Strategic environmental assessment in the electricity sector: An application to electricity supply planning in Saskatchewan, Canada. *Impact Assessment and Project Appraisal*, 30(4): 284-295. DOI 10.1080/14615517.2012.746836 [Taylor and Francis]

PREFACE TO CHAPTER 2: STRATEGIC ENVIRONMENTAL ASSESSMENT FOR SUSTAINABILITY: A REVIEW OF A DECADE OF ACADEMIC RESEARCH

The first objective of this thesis was to examine the use of SEA as a tool to support sustainability in policy, planning and decision making. In order to accomplish this objective, Chapter 2 examined the SEA–sustainability relationship over the past decade, from 2000 to 2010, focusing in particular on the incorporation of sustainability in SEA. A total of 86 papers from the academic literature containing the terms ‘sustainability’ or ‘sustainable development’ and ‘strategic environmental assessment’ were identified and reviewed. Several common themes emerged by which SEA can support sustainability, including providing a framework to support decision making for sustainability; setting sustainability objectives, ensuring the consideration of ‘more sustainable’ alternatives, and integrating sustainability criteria in PPP development; and promoting sustainability outcomes through tiering and institutional learning. At the same time, the review identified many underlying barriers that challenge SEA for sustainability, including the variable interpretations of the scope of sustainability in SEA; the limited use of assessment criteria directly linked to sustainability objectives; and challenges for decision-makers in operationalizing sustainability in SEA and adapting PPP development decision-making processes to include sustainability issues. To advance SEA for sustainability there is a need to better define the scope of sustainability in SEA; clarify how to operationalize the different approaches to sustainability in SEA, as opposed to simply describing those approaches; provide guidance on how to operationalize broad sustainability goals through assessment criteria in SEA; and understand better how to facilitate institutional learning regarding sustainability through SEA application.

Chapter 2 has been published in the journal Environmental Impact Assessment Review. See: White, L. and Noble, B.F. (2012a). Strategic environmental assessment for sustainability: A review of a decade of academic research. *Environmental Impact Assessment Review.* Article in press. http://dx.doi.org/10.1016/j.eiar.2012.10.003 [Elsevier]

CHAPTER 2: STRATEGIC ENVIRONMENTAL ASSESSMENT FOR SUSTAINABILITY: A REVIEW OF A DECADE OF ACADEMIC RESEARCH

2.1 Introduction

Strategic environmental assessment (SEA) is argued to provide a sound basis for informed decision making toward sustainability (see Tetlow and Hanusch, 2012; Partidário and Clark, 2000). Presumably, SEA helps ensure that policies, plans and programs (PPPs) are developed in a more environmentally sensitive way; that environmental impacts are taken into account early in PPP decision making; and that individual projects are implemented in a broader sustainability framework (Therivel, 2010; Noble and Gunn, 2009; Morrison-Saunders and Therivel, 2006). This is consistent with various international policies and directives that support SEA. In Canada, for example, SEA is formalized under a Cabinet directive to ensure, among other things, that environmental considerations are fully integrated into the analysis of PPPs in order to "make informed decisions in support of sustainable development" (Privy Council Office and Canadian Environmental Assessment Agency, 2004). The European SEA Directive also identifies SEA as contributing "...to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development" (EC, 2001).

The academic literature has similarly promoted SEA's sustainability mandate. According to Fischer (2003, p. 162), "the main rationale for applying SEA is to help create a better environment through informed and sustainable decision making." Arce and Gallon (2000) indicate that sustainability is core to SEA, and both Linacre et al. (2006) and Liou and Yu (2004) argue that SEA adds value to the decision-making process by informing decision makers about the sustainability of strategic actions. In their recent review of the state-of-the-art of SEA, Tetlow and Hanusch (2012, p. 16) describe SEA as having evolved into a "...proactive process of developing sustainable solutions as an integral part of strategic planning activities." However, notwithstanding the recognized potential for SEA to contribute to sustainability (Bond et al., 2012), there is a plethora of views on how this may be accomplished (see D'Auria and Cinneide, 2009; Liou et al., 2006; Noble, 2002; Partidário, 2000).

There have been several reviews of SEA over the past decade, including recent reflections on the state-of-the-art of SEA (see Tetlow and Hanusch, 2012), the need for SEA (see

Bina, 2007) and the emergence of sustainability assessment (see Bond et al., 2012). There has been much less critical review of how SEA supports sustainability and the potential tensions between SEA and sustainability. In this paper, the SEA–sustainability relationship is examined based on the past decade of academic research on the subject. The purpose of this paper is to identify and critically examine what the academic literature reports as to how SEA, as an assessment tool or process, can or should support sustainability in PPP development, assessment and decision making. Such a review is timely. It follows the 10-year anniversary of the European SEA Directive and precedes the start of what may be a new era in Canadian environmental assessment, marked by increasing demands on SEA to offset regulatory reforms to streamline project environmental impact assessments (see Gibson, 2012). In the sections that follow, the approach to the review is first described, followed by author perspectives on SEA as a means to support sustainability. A number of observations are then ventured concerning the state-of-the-art of SEA for sustainability and directions for future research.

2.2 Methods

The focus of this review was the academic literature between 2000 and 2010. This is a decade marked by unprecedented growth in the adoption of SEA systems internationally (see Tetlow and Hanusch, 2012). It was also a decade characterized by much debate about the rationale for SEA (see Bina, 2007), criticism about SEA's ability to ensure sustainability (see Noble, 2002), and considerable discussion about the role of SEA alongside emerging interests in sustainability assessment (e.g., Govender et al., 2006; Morrison-Saunders and Therivel, 2006; Morrison-Saunders and Fischer, 2006).

This review is based on a select set of literature in impact assessment, namely *Environmental Impact Assessment Review, Impact Assessment and Project Appraisal and the Journal of Environmental Assessment and Policy Management*. The review was limited to these three journals as their primary focus is on impact assessment and, arguably, contain the largest volume of peer reviewed published research on the subject from leading scholars in the field. It is acknowledged that these are not the only sources of peer reviewed research on SEA and sustainability and that the scope of the journals reviewed does have bearing on the themes emerging from this analysis.

All journal volumes and issues published between 2000 and 2010 were searched using an online search engine database, Engineering Village 2 (EI Engineering Village Compendex and Inspec). The search targeted the key terms ‘sustainability’ or ‘sustainable development’, as well as the term ‘strategic environmental assessment’ appearing in the title, abstract or keywords. A total of 86 papers were identified. Selected book chapters published during the same period were also used for supplemental or background information, including Therivel (2010), Dalal-Clayton and Sadler (2005), and Noble and Gunn (2009). These chapters were chosen as reference material due to their focus on SEA definitions and principles as well as their collective, comprehensive overview of SEA development, processes and methodologies.

All papers were imported in their entirety, organized, coded thematically and analyzed with the assistance of QSR NVivo© v.9, a software program designed to classify and manage qualitative information. A ‘coding-up’ process was adopted (see Lockyear, 2004), whereby an initial review of each paper was undertaken to identify the key terms and concepts that were being discussed in relation to SEA process and sustainability; for example, concepts such as flexibility, sustainability principles and alternatives assessment. Over a series of iterations, similar terms and concepts were then grouped and regrouped into larger concepts (see Corbin and Strauss, 2008), from which nine broad themes were identified addressing how SEA, procedurally, is a means to support sustainability and the different types of sustainability that SEA supports. Each of these themes is discussed in the sections that follow. It is acknowledged that the results that follow are not the only themes identified in the literature and are not comprehensive of all authors or views on the subject – for example, there are broader issues, such as power relations, that are important to the SEA-sustainability relationship. The approach to framing the issue was based on SEA as a process and, based on the review and the sample of literature, it is suggested that these themes capture those lines of argumentation that appear most dominant in terms of SEA for sustainability.

2.3 Perspectives on SEA as a Means to Support Sustainability

Several dominant lines of argumentation emerged from the review as to how SEA supports sustainability in PPP development and decision making. The majority of these were methodological in nature, based on SEA process, while others were more implicit and based on institutional change and learning resulting from SEA application. Each of these is reported briefly below. The views presented are not mutually exclusive.

2.3.1 Providing a Decision Support Framework for Sustainability

First, several authors identify the 'decision support framework' of SEA and its ability to employ a range of assessment tools as core to its ability to facilitate the assessment of, and decisions based on, sustainability (see Browne and Ryan, 2011; Gunn and Noble, 2009b; Noble, 2009; Balfors et al., 2005; Kuo et al. 2005). As noted by Sheate (2009), sustainability is an underlying objective of all environmental assessment tools. Partidário (2000) maintains that "the value of SEA is a function of the extent it influences and adds value to decision making" (p. 647) and that SEA, conceptualized as a framework defined by a set of core elements, can "help achieve sustainable development by changing the way decisions are made" (p. 647). Noble (2002) similarly identifies the importance of the SEA decision support framework, stating that "the effectiveness of SEA in achieving sustainability objectives will only be realized when a structured and systematic methodological assessment framework is adopted" (p. 14). Noble (2009) later goes on to note that a well-defined framework for SEA is one of the most important attributes necessary to ensure SEA's ability to contribute to sustainability. This is consistent with the views of others, such as Therivel (2010) and Fischer (2003), who suggest that SEA, as a structured framework, can readily support sustainable development goals and objectives by, among other things, incorporating sustainability considerations directly into impact assessment tools and decision making processes.

2.3.2 Being Adaptive to the Decision Making Process

Notwithstanding the recognized importance of the decision support structure provided by SEA, the literature also emphasized the adaptive nature of SEA as core to its ability to support sustainability (e.g. Partidário et al., 2008; Retief, 2007a; Nilsson and Dalkmann, 2001). Partidário et al. (2008), for example, note that SEA can be viewed as "a framework of activities" and this enables SEA "to become flexible, diversified and tailor-made to the decision-making processes" (p. 219). In this regard, Nilsson and Dalkmann (2001) note that SEA must also be "sensitive to the real characteristics of the decision making context" (p. 305) and, in doing so, it can "adapt to the way in which sustainability considerations are dealt with in the process" (p.

322). Retief (2007a) explains that "the evolution of SEA debates has shifted in its views of the SEA process as a formal process...to a much more flexible and adaptable approach" (p. 85). Eggenberger and Partidário (2000) suggest that "SEA…can play a significant role in enhancing the integration of sustainability concerns in policy and planning processes" and that in doing so SEA is adaptive to context; it can be "approached through highly structured and rationalised processes; highly regulated; or result more simply from providing principles and informal procedures and changes in the decision-making process (p. 202)".

2.3.3 Incorporating Sustainability Objectives and Principles

Third, several authors reported the opportunity SEA presents to adopt sustainability objectives and principles in the PPP decision making process (e.g. Pope et al., 2004; Stinchombe and Gibson, 2001). Rossouw et al. (2000), for example, report that "the aim of SEA is to deliver the information necessary at the right time to integrate the concept of sustainability into decision-making" (p. 219). They go on to explain that "SEA interacts consistently with the plan and programme procedure in an iterative way, to integrate sustainability into decision-making and introduces sustainability goals at the earliest stage in the plan and programme process, from conceptualisation through to the many stages of decision-making" (p. 220). Pope et al. (2004) similarly indicate that the use of sustainability objectives in SEA helps decision-makers and policy makers "decide what actions they should take and should not take in an attempt to make society more sustainable" (p. 596) and Stinchombe and Gibson (2001) state that SEA "facilitates establishment of a more comprehensive overall system of sustainability application at all levels, from the setting of decision objectives to the monitoring of implementation effects" (p.357).

2.3.4 Considering Relevant Sustainability Issues Early On

Closely related to the above was the notion that SEA allows for the consideration of sustainability issues early on, at the time of PPP formulation (e.g. D'Auria and Cinneide, 2009; Partidário et al., 2008; Liou et al., 2006). Arce and Gullon (2000, p. 394), for example, argue that "the contribution of SEA towards sustainability stems from [the fact that]…SEA ensures the consideration of environmental issues from the beginning of the decision-making process…and can detect potential environmental impacts at an early stage, even before the projects are designed." Liou et al. (2006) also emphasize, as a defining feature of SEA, that the environmental, social and economic impacts of proposed PPPs can be identified at an early stage of the decision-making process. Buckley (2000) similarly indicates that one of SEA's principal aims, within the context of sustainability, is "to encourage consideration of environmental factors at an early stage in planning and policy formulation" (p. 215), and D'Auria and Cinneide (2009) also note that SEA "seeks to ensure that all environmental parameters and issues are integrated, appropriately addressed, and incorporated into the planning system at the earliest appropriate stage of the decision-making process" (p. 309). Arts and Van Lamoen (2005) similarly maintain that SEA is "important for a careful integrated consideration of environmental, economic and social issues before defining the scope of planning developments (p. 75). Partidário et al. (2008) go a step further, identifying SEA as "an instrument to enable integration of environmental and sustainable development issues into early stages of development policy and planning, to help design and assess preferred strategic options" (p. 219). They describe SEA as a "process that offers the capacity to enable the inclusion and integration of environmental and sustainability issues right from the early stages of the preparation of a strategic concept, and throughout the design and implementation stages of subsequent policy, planning or programme development actions (p. 219).

2.3.5 Adopting Sustainability-Based Assessment Criteria

A fifth theme that emerged was the inclusion of assessment criteria in SEA against which the sustainability of PPPs are assessed (see Croal et al., 2010; Desmond, 2009; Pope et al., 2004). Obbard et al. (2002), for example, state that SEA "can be viewed as an integrated system of planning instruments in which sustainability criteria are integrated into the planning process" (p. 289). Kuo et al. (2005) contend that "indicators of sustainability are increasingly viewed as quite instrumental in the process of giving a certain dimension to sustainability" (p. 265), and Pope et al. (2004) note that ''environmental assessment processes…are among the most promising venues for application of sustainability-based criteria" (p. 598). In this regard, SEA has often been promoted as a means to determine the effects or contributions of a PPP based on criteria and indicators developed from sustainability principles and objectives. Marsden (2002) argues that SEA can play a role toward sustainability if "simple (and) pragmatic indicators are used that can assist monitoring of the decisions to determine the actual effects" (p.37). Both Marsden (2002) and Partidário (2000) suggest that sustainability issues can be used as benchmarks against which objectives and criteria for SEA can be evaluated, and Briffet et al. (2003) indicate that it is vital to "identify environment and sustainability benchmarks by which the effects of a PPP can be tested" (p.176). Further, in developing their decision-maker's tools for sustainability-centred SEA, Croal et al. (2010) indicate that sustainability-based criteria can "also function as evaluation criteria in the SEA process for judging the significance of impacts, alternatives, possible enhancement or mitigation measures and for designing follow-up requirements" (p. 13). By using sustainability-focused decision criteria, "all policy and development objectives are considered together and trade-offs are addressed directly such that best options and not just acceptable options are achieved" (Desmond 2009, p.57).

2.3.6 Identifying and Evaluating 'More Sustainable' Alternatives

The identification and evaluation of alternatives in SEA was frequently identified as a defining feature of its ability to identify 'more sustainable' PPP options. In his 2007 study of SEA in South Africa, for example, Retief (2007a) states that "SEA is set within the context of alternative scenarios" (p. 87) and that SEA "facilitates identification of development options and alternative proposals that are more sustainable" (p. 86). Desmond (2009) similarly purports that "the formulation of alternatives is a core activity in the achievement of sustainable development" (2009, p. 52) and that "SEA seeks to inform the decision maker of… the range of plan or program alternatives available" (p. 51). The identification and evaluation of reasonable alternatives is identified by many authors as simply 'best-practice' SEA (see Therivel, 2010; Noble and Gunn, 2009; Partidário, 2000). Therivel (2010), for example, states that the identification and comparison of alternatives "helps to ensure that the strategic action is as good as possible, including as sustainable as possible" (p. 43). In an international review of SEA, Marsden (2002) similarly noted that "it is believed… that SEA can play a role toward sustainability if…credible and feasible alternatives (are considered) that allow evaluation of a decision" (p. 37). Morrison-Saunders and Therivel (2006, p. 289) indicate that it is easier and more appropriate to develop alternatives at higher PPP decision-making levels, thus allowing for "significant sustainability gains (and avoidance of significant sustainability losses)."

2.3.7 Trickling-Down Sustainability

There was a consistent message in the literature that SEA can provide a 'trickle down' of sustainability (see Therivel, 2010; Sinclair et al., 2009; Therivel and Partidário, 1996), thereby supporting more sustainable decisions from the level of PPPs to the individual development project (Kirchoff et al, 2010; Retief et al., 2008; Noble and Gunn, 2009) and ensuring that decisions are made in a broader sustainability context. Stinchombe and Gibson (2001), for example, maintain that "one of the chief attractions of SEA as a tool for promoting sustainability is its potential for incorporating sustainability principles at the policy level, from which it can 'trickle' down through plans and programmes, ultimately to projects and other specific activities" (p. 355). In their study of SEA processes in Ontario, Canada, Kirchoff et al. (2010) determined that "SEA is intended to occur at a stage in the process and a scale that can provide guidance to subsequent, lower-tier strategic undertakings as well as overall project planning" (p. 337). Similarly, in their study of the application of SEA to land use and resource management plans in New Zealand and Scotland, Jackson and Dixon (2006, p. 92) indicate that SEA can be seen as "an integral part of the assessment of individual projects for their sustainability implications" and that the assessment of projects is, ideally, "the end-product of a strategic overview of policy formulation that embraces sustainability." Noble (2002, p. 10) goes a step further and argues that SEA, as a tiered-forward planning process, "allow(s) sustainability objectives to be trickled down from the policy level (and that) higher level SEAs of policies will set the context for plan, program and project development".

2.3.8 Capturing Large Scale and Cumulative Effects

It was also well argued that cumulative effects are best addressed at the strategic tier (e.g. Alshuwaikhat, 2005; Cooper and Sheate, 2004; Rossouw et al., 2000) and, in so doing, SEA can ensure the sustainability of ecological systems and landscapes by managing, if not avoiding cumulative effects at their source (Gunn and Noble, 2009b; Alshuwaikhat, 2005; Treweek et al., 2005). Stinchombe and Gibson (2001) suggest that one of the advantages of SEA for sustainability is that it "facilitates proper attention to cumulative effects" (p. 343). Gunn and Noble (2009) similarly maintain that SEA provides an opportunity to identify issues trends that may be "of regional relevance and cumulatively significant" (p. 285). They go on to state that SEA, particularly when applied at the regional scale, provides the "most appropriate framework within which to address cumulative effects issues, if the primary goal is to influence the nature and pace of development in support of regional sustainable development goals” (p. 287).

2.3.9 Enabling Institutional Change and Transformational Learning

Finally, but perhaps most subtly, several authors argued that SEA enables institutional change and transformative learning in support of sustainability. Sheate and Partidário (2010), Therivel (2010), and Runhaar and Driessen (2007), for example, argue that SEA supports decision makers’ awareness and understanding of environmental and sustainability issues, enhances understanding of PPP issues and sustainability impacts and can change values and attitudes toward the environment. Therivel and Minas (2002) add that “…even when the strategic action remains unchanged after the SEA, the SEA may still be useful because it...may provide a better understanding of sustainability or the environment...” (p. 82). This is consistent with D’Auria and Cinneide’s (2009) review of SEA in Ireland, who found that SEA “led to a considerably enhanced awareness, understanding and appreciation of local environmental issues” and that stakeholders “…arrived at a broad consensus regarding the need to be vigilant with respect to the protection of critical elements of the local environment, which is increasingly perceived by all concerned as underpinning the town’s sustainable development” (p. 318). Based on study of a community based SEA in Costa Rica, Sinclair et al. (2009) similarly note that SEA can accrue many benefits, including “...social learning outcomes, and facilitating a transition towards sustainability” (p. 155).

2.4 Discussion

The past decade of academic literature suggests that the SEA process has the potential to contribute to the development of more sustainable PPPs in various ways. However, some of the literature reviewed suggested that SEA has been less than successful in terms of delivering on this sustainability mandate (e.g., Noble, 2009; Gibson, 2006a; Liou et al., 2006). Based on the analysis of the literature, what are believed to be a number of persistent challenges to SEA for sustainability are identified in the sections that follow, along with observations ventured and recommendations offered for advancing SEA in a sustainability context.

2.4.1 The Meaning and Scope of Environment and Sustainability in SEA

First, what sustainability means within the context of SEA is still not well understood (see Tetlow and Hanusch, 2012; Bina, 2007; Thissen, 2000; Noble, 2000). Various SEA regulations and directives have now been implemented internationally, many with sustainability or sustainable development as a guiding principle, but the scope of sustainability in SEA is often not well defined. This is due, in part, to the variable interpretations of sustainability and 'environment' within both SEA guidance and the academic literature. Section 2.1.1 of the SEA Directive also indicates that by addressing potential environmental considerations of PPP proposals, departments and agencies will be better able to, among other things, implement sustainable development strategies. This implies that SEA is seen as having the potential to make a positive contribution to sustainability; both environmental and socioeconomic (see Noble, 2002). Across Canada, however, the scope of environment is more or less ambitiously defined under provincial and territorial environmental assessment legislation. In the European Union, the term 'environment' is used to refer to the biophysical aspects of the environment (EC, 2001). As a result, amongst practitioners and decision-makers globally, there are varying ideas about the scope of environment in SEA, and thus sustainability.

There is also much discussion regarding the scope of sustainability in SEA. Emerging based on the concept of environmental sustainability, with the specific purpose of ensuring that environmental considerations are taken into account in decision-making processes, several authors argue that SEA should focus primarily on environmental (ecological) sustainability. Several reasons are often suggested, including that economic and social impacts are often considered the most important factors and override environmental ones, as well as that focusing on the sustainability of environmental systems raises environmental awareness, strengthens environmental management and more clearly illustrates the potential environmental impacts of a PPP (Morrison-Saunders and Fischer, 2006; Morrison-Saunders and Therivel, 2006; Treweek et al., 2005; Briffet et al., 2003; Smith and Sheate, 2001). On the other hand, a number of authors suggest that in order to add value to PPP decision-making, the assessment process must take into account all aspects of sustainability, including social, environmental and economic factors (Croal et al., 2010; Gibson, 2006a; Morrison-Saunders and Fischer, 2006; Alshuwaikhat, 2005; Stinchombe and Gibson, 2001; Partidário, 2000; Rossouw et al., 2000). The reasons posed are two-fold: first, in recognition that trade-offs among factors is how real-world decisions are made;

and, second, so as not to undermine the environment in or have it excluded from the decision-making process (Morrison-Saunders and Fischer, 2006).

This paper does not argue one perspective on the scope of sustainability over the other. Rather, it argues that the meaning and scope of both 'environment' and thus 'sustainability' need to first be explicitly defined and agreed upon within each SEA application. Not to do so, which was found to be common in the review, may be sending mixed, or inconsistent messages to the practitioner and decision-maker communities and cause challenges in communicating sustainability in SEA amongst the academic community (see Noble et al., 2012).

2.4.2 Approaches to Sustainability

Second, authors also seem to be referring to different approaches to sustainability and often without explicit acknowledgement. The 'objectives-led' approach, for example, "reflects a desire to achieve defined social, economic and environmental objectives by assessing the extent to which the implementation of a proposal contributes to these objectives when compared with baseline conditions" (Pope et al. 2005, p. 297). Pope et al. characterize the 'impact based' approach as identifying the environmental, social and economic impacts of a proposal and comparing them with the baseline condition to "ensure that impacts are not unacceptably negative overall and therefore prevent things from becoming less sustainable when compared with the baseline" (p. 296). The 'principles-based' approach to sustainability in SEA tends to align more with sustainability assessment literature (see Bond et al., 2012; Morrison-Saunders and Fischer, 2006; Gibson, 2006a); rather than focusing on separate environmental, social and economic aspects, 'bigger picture' sustainability principles are used as the driving consideration in the SEA process.

The sustainability approach adopted at the outset of an SEA is of significant importance as it sets the context for the SEA process and defines the types of objectives and criteria that are likely to be used in the SEA and thus influence the decision taken (see Pope et al, 2004). While, it is 'nice to know' the range of approaches to sustainability in SEA, the myriad of approaches may be creating uncertainty regarding how to approach SEA for sustainability. Research and guidance is needed that not only describes the different approaches to sustainability, but that illustrates how to appropriately choose the approach that is most appropriate for the planning context and decision-making situation at hand.

2.4.3 Operationalizing Sustainability: From Principles to Practice

Third, it is suggested that the use of 'sustainability' in SEA practice often posits little of substance. Many decision-makers and SEA applications adopt the language of sustainability and use 'sustainability' or 'sustainable development' as an overarching and guiding principle, but do not integrate sustainability into PPP assessment, development and implementation. It could be argued (see Sheate, 2009) that sustainability is implicit in all assessment tools; however, others (see Gibson, 2006a) would argue that sustainability in SEA requires adopting and operationalizing explicit sustainability principles and criteria. Part of the challenge, however, is that sustainability is often mentioned as an overall principle in SEA reports (see OEER, 2008; PSCW, 2007; OPA, 2007), but the concept is not integrated beyond that initial statement to inform assessment and decision-making; likely because sustainability is a concept that is difficult to operationalize (Brunner and Starkl, 2004), or perhaps a concept that is simply not treated as having practical application beyond an overarching principle. Many authors agree that SEA can support sustainability by integrating the concept throughout the decision-making process from principles to practice (Partidário et al., 2008; Stinchombe and Gibson, 2001; Rossouw et al., 2000); however, it appears that practitioners and decision-makers may not understand how to apply sustainability to the SEA process (Retief, 2007b) and struggle in advancing sustainability from broad principles to specific criteria for practice. Part of the reason may be attributed to the labeling of broad sustainability 'principles' as 'criteria' (e.g. Gibson et al., 2005) and the need to provide a clearer understanding of the relationship between sustainability principles, criteria and indicators in SEA (see Hacking and Guthrie, 2006). Although nobody is likely to disagree with sustainability as a guiding principle for SEA, it serves little merit in the absence of criteria that can be operationalized and practical guidance on how to do so.

2.4.4 Flexibility and Structure

Fourth, the debate regarding structure versus flexibility in SEA is creating uncertainty and confusion regarding the 'best' type of SEA framework to support of sustainability. Many authors promote the structured decision support framework of SEA as core to sustainability integration in PPP assessment (Browne and Ryan, 2011; Gunn and Noble, 2009b); others emphasize flexibility and being adaptive to context (Partidário et al., 2008; Nilsson and Dalkmann, 2001).

On the surface, these two concepts may seem contradictory, perhaps stifling sustainability integration in practice.

Sustainability is sometimes viewed as a 'fuzzy concept' (Abouelnaga et al., 2010; Phillis and Andriantiatsaholiniaina, 2001). This does not mean that SEA needs to be fuzzy or necessarily 'soft' in approach; however, neither does it mean that SEA need be highly structured and quantitative. In order for SEA to support sustainability, the SEA process must identify the sustainability ramifications of the PPP, suggest changes to make the PPP more sustainable and incorporate those changes in the PPP itself (Therivel and Minas, 2002). Whether a flexible or structured SEA approach is used to accomplish this is of little matter (see Tetlow and Hanusch, 2012). What does matter is that the SEA framework is applied early and effectively and that sustainability principles and criteria are integrated throughout the process. This requires decision-makers and SEA practitioners to cooperate and decide upon an SEA approach that is appropriate to the institutional culture within the organization, including the level of willingness to learn about sustainability issues, adapt current decision-making processes and move beyond simply meeting legislative requirements for SEA. Thus, as a minimum requirement, guidance is needed that adequately describes both structured and flexible SEA approaches and how each can effectively operationalize sustainability from principles to practice. In their review of methods and guidance for SEA, Noble et al. (2012) argue that more attention needs to be given to practical guidance on how to operationalize SEA, versus principles-based guidance focused on generic processes and compliance with directives, such that practitioners are able to make informed choices about the best SEA design set of supporting methods to facilitate sustainability integration.

2.4.5 Institutional Change and Learning for Sustainability

Finally, regardless of the above, achieving sustainability through SEA is often constrained due to the lack of institutional willingness to change. According to Bochman and Kroth (2010, p. 329), "organizational learning hinges on an organization's willingness to change and adapt" and is most often brought about by crisis or major failure. However, it appears that institutional constraints are deeply rooted in a number of factors, including an inability or lack of willingness to examine past failures in decision-making and decision-makers themselves are sometimes unwilling to tackle complex sustainability issues through SEA. For example, decision-makers are sometimes constrained to focusing primarily on satisfying regulatory obligations (Tetlow and Hanusch, 2012), or restricted by higher level policies that prevent them from effective application of sustainability in SEA (see OPA, 2007). Institutional change and learning in organizations are also slow processes (Jha-Thakur et al., 2009). There is often a lengthy time period required to realize the influence of an assessment process for decision on actual environmental outcomes, thus organizations may not see the value of making changes to decision-making practices in the short term (Tetlow and Hanusch, 2012). And, institutional resistance to the consideration of other, sometimes competing priorities can be significant. This is particularly the case when the application of sustainability in SEA, as opposed to its adoption as an overarching principle, may be incompatible with political objectives in PPP development, especially during times of national, regional or local economic recession.

Institutional arrangements, and specifically how organizations learn through SEA, are important to the success of SEA as a tool for sustainability. In agreement with Slootweg and Jones (2011), more emphasis is needed in SEA research on governance and institutions and ways of "learning our way into sustainable futures, rather than planning our way" (p. 269). Specifically, considerably more attention needs to be placed on institutional learning and change through SEA application, and exploring how to facilitate this learning within organizations.

2.5 Conclusion

This paper set out to identify and examine what the academic literature reports as to how SEA, as an assessment tool or process, can or should support sustainability in PPP development, assessment and decision making. The 'value add' of SEA for sustainability, which many authors believe is the ultimate measure of the effectiveness of SEA (Therivel, 2010; Noble, 2002; Partidário, 2000), includes a number of elements, including adding structure and flexibility, allowing for early adoption of sustainability principles and identification of sustainability issues, promoting development and consideration of more sustainable alternatives, delineating and applying impact assessment criteria, allowing for trickle down of sustainability principles and promoting transformational learning regarding sustainability. However, potential is not practice and one might wonder why, with so much potential for SEA, there is not more widespread evidence of it achieving sustainability outcomes. Many barriers still exist that challenge SEA for sustainability, including variable interpretations of the scope of sustainability in SEA, the limited adoption of assessment criteria in SEA that are directly linked to broader sustainability principles and the challenges for decision-makers in adapting PPP development decision-making processes to include sustainability issues. The nature of academic work on the matter may also be stifling progress. Rather than simply adopting and building on current framings of sustainability principles, which seem to have contributed only modestly to SEA practice, it is argued that there is a need to challenge such framings or, at a minimum, focus on how to better operationalize the principles.

Arguably, however, many of these issues are not unique to SEA, and will not be resolved simply by abandoning SEA in support of sustainability assessment or other tools. But, in order to advance SEA for sustainability, there is a need for 1) detailing the nature and scope of sustainability and elucidating the purpose of SEA in a variety of decision-making contexts; 2) describing how to select and operationalize the different approaches to sustainability in SEA frameworks; 3) guiding the adoption of sustainability objectives and the development of assessment criteria linked to sustainability goals; and 4) placing much more attention on how to facilitate institutional learning regarding sustainability through SEA application.

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PREFACE TO CHAPTER 3: STRATEGIC ENVIRONMENTAL ASSESSMENT BEST PRACTICE PROCESS ELEMENTS AND OUTCOMES IN THE INTERNATIONAL ELECTRICITY SECTOR

The second objective of this thesis was to determine how SEA in the electricity sector is currently applied and how sustainability principles are being integrated into the process. Chapter 3 focused on the first part of this objective and examined the contribution of SEA in six International electricity sector planning case studies. All cases showed some 'best practice' evidence such as participation, alternatives consideration and impact assessment; however, considerable variability was found in the types of alternatives considered and the approach to impact assessment and monitoring depending on the timing of SEA application in the PPP process. Regarding substantive contributions, SEA was identified by stakeholders as improving communication during planning and informing lower-level decision making, but fared less well in influencing the nature of the PPP at hand; only two cases clearly incorporated SEA recommendations into the final PPP. Overall, results show considerable potential for SEA to support PPP assessment and decision making in the electricity sector, but also a considerable need for improvements in understanding of the importance of the timing of SEA in the PPP process and how to integrate the results of SEA into PPP development.

Chapter 3 has been published in the Journal of Environmental Assessment Policy and Management. See: White, L. and Noble, B.F. (2013). Strategic environmental assessment best practice process elements and outcomes in the international electricity sector. *Journal of Environmental Assessment Policy and Management.* Article accepted for publication [World Scientific]

CHAPTER 3: STRATEGIC ENVIRONMENTAL ASSESSMENT BEST PRACTICE PROCESS ELEMENTS AND OUTCOMES IN THE INTERNATIONAL ELECTRICITY SECTOR

3.1 Introduction

Decisions about energy resource development have significant implications for sustainability. Such decisions traditionally have been made on a project-by-project basis, using environmental impact assessment (EIA) as the decision support tool. Environmental impact assessment is focused on identifying and mitigating the effects of a proposed energy project, such as a hydroelectric or coal fired generating station, rather than also on assessing alternative energy options and sustainable energy futures (Marshall and Fischer, 2006; Benson, 2003). Although project-based assessment is important for managing the effects of energy projects, "there are questions about the ability of EIA to deal adequately with the challenges now associated with energy supply; …the issues we now face need to be addressed at a higher level of planning, at a regional, national or even super-national scale" (Jay, 2010, p. 3489). In a period of increasing global energy demand, concerns over energy security and the impacts of energy development, there is a need and opportunity to advance environmental assessment to the more strategic level of energy futures and energy sector planning.

Emerging partly in response to the shortcomings of project level environmental assessment, strategic environmental assessment (SEA) is now internationally recognized as a tool for the environmental assessment of policy, plan and program (PPP) initiatives. Strategic environmental assessment is intended to occur early in the PPP process, before irreversible decisions are made and when alternative options for development are still open. In doing so, potential environmental effects can be addressed at their source and sustainability considerations can trickle down and influence project-based development actions (CCME, 2009). The energy sector is an "ideal candidate" for SEA (Jay, 2010, p. 3490); decision-makers need to identify and evaluate alternative energy futures and make informed, measured choices about the longer-term sustainability of PPPs often comprised of competing energy investment initiatives. This is especially the case in the electricity sector, given its large natural resource requirements for electrical generation and the ecological footprint of electrical distribution systems (see Lior, 2010; El-Fadl et al., 2009; Williams and Kahrl, 2008). In principle, SEA can help identify and balance often competing priorities in electricity supply policy and generation and transmission planning; facilitate the integration of sustainable development principles and criteria in electricity sector decision-making; and direct the development of informed and improved electricity PPPs (Noble and Storey, 2001). In practice, the nature of SEA itself remains unclear to many (Noble, 2009; Vicente and Partidário, 2006), and its role and value in electricity sector PPP assessment and decision making for sustainability are neither well developed nor understood (see Jay, 2010; Marshall and Fischer, 2006).

There is substantial SEA knowledge in the transportation and land use planning sectors (Marshall and Fischer, 2006; Dalal-Clayton and Sadler, 2005), but SEA has been slow to evolve in the energy sector (Fidler and Noble, 2012) and in particular in the electricity sector (Marshall and Fischer, 2006). Part of the challenge may have to do with "the relatively fragmented nature of the industry which makes strategic planning itself more difficult" (Jay, 2010, p. 3489). There is some evidence in recent years of SEA and SEA-like processes being used in several countries for a range of energy applications, including energy policy development, offshore energy assessment, and electricity sector planning (e.g., Fidler and Noble, 2012; Jay, 2010; Partidário et al., 2010; DECC, 2009; OPA, 2007); however, SEA in the electricity sector is still novel when compared to other sectors. There is a need and opportunity to advance SEA and its value added to energy PPP decisions (Lyhne, 2011; Jay, 2010; Jay and Marshall, 2005), but this first requires understanding how SEA is currently applied in the sector and whether it is a meaningful and worthwhile component of energy PPPs.

This paper examines the role and contributions of SEA in energy sector planning, both in terms of its process elements and PPP outcomes. Specifically, we examine six SEA and SEA-type applications in the international electricity sector, the nature of SEA application and its influence or value added to electricity PPP development and decision making. The six international electricity sector SEAs are briefly described below, followed by an analysis of SEA process elements and the substantive outcomes achieved. The broader implications for advancing SEA in electricity sector PPP processes are then discussed.

3.2 International Electricity Sector SEA

There is a growing interest in energy sector SEA (e.g., Fidler and Noble, 2012), and specifically SEA for electricity sector planning (e.g., Jay, 2010; Marshall and Fischer, 2006). The electricity transmission and distribution sector, by its very nature, operates in a strategic manner due to its spatial scale, potential for environmental impacts, long-term shifts in generation type, and changes in electricity demand (Jay, 2010). Thus, "it might be expected…that this industry would be well-placed to incorporate SEA into its planning and to benefit from it" (Jay, 2010, p. 3492). The six international electricity sector SEAs introduced below were selected to capture a diversity of SEA and electricity PPP contexts, including: formal SEA practices based on SEA Directives or policy requirements, and SEA-like practices guided by sector-based regulations and the mandates of corporations; different timing in SEA application, from early application to inform PPP development to later applications focused on an existing PPP or prescribed alternative; and different electricity PPP levels and spatial scales of application including national electricity policy, and regional and municipal planning applications. The cases are summarized in Table 3-1 and were identified based on a review of the limited cases reported in the peer reviewed literature, and with the input of key informants from the electricity sector and scholars in the field.

Table 3-1. Overview of electricity sector SEA cases

SEA Case	Application	Type[1]	Purpose	Timing	Requirements
Ontario Power Authority Integrated Power System Plan, Canada	Provincial plan	Informal	To prioritize how electricity is developed in the province	During development of the plan	Ontario Regulation 424/04; Ontario Electricity Act Sec. 25.30
Nova Scotia Tidal Fundy Initiative, Canada	Regional program	Formal	To direct the development of regional tidal energy projects and technology	Prior to development of the program	Federal SEA Cabinet Directive
UK Draft National Policy Statements for Overarching Energy	National policy	Formal	To control how energy infrastructure is developed	During review and revision of the policy	Planning Act 2008 Sec. 5(5); EU SEA Directive 2001/42/CE
Finspång Municipal Energy Plan, Sweden	Local plan	Formal	To strengthen municipal energy planning and evaluate the SEA process	During development of the plan	EU SEA Directive 2001/42/CE; National Environmental Objectives
Portugal National Transmission Grid Plan	National plan	Formal	To guide the development of the National Transmission Grid	During development of the plan	EU SEA Directive 2001/42/CE; National Decree Law 232/2007
Wisconsin Strategic Energy Assessment, US	State policy	Informal	To identify projects and address adequacy and reliability issues	During review and revision of the policy	State Statutes 196.491(2); 196.377; 196.378; and 1.12

[1]Formal SEA refers to SEAs required by and conducted in accordance with SEA directive or legislation; informal SEA refers to SEA-like or ad hoc applications that reflect SEA principles and methodologies but are neither required by directive or legislation nor carry the SEA label (see Noble, 2009).

3.2.1 Ontario Power Authority Integrated Power System Plan

In 2005, the Government of Ontario, Canada, requested that the Ontario Power Authority develop a long-term integrated power system plan for the province into 2027. The Ontario Power Authority evaluated several supply mix scenarios. The Minister of Energy and Infrastructure then selected a preferred supply mix, and set a Supply Mix Directive (OPA, 2007) prioritizing how electricity was to be developed and transmitted. The Ontario Power Authority used the Directive to develop an Integrated Power System Plan that prioritized how electricity resources should be developed to meet the needs of the province and to "incorporate considerations of environmental sustainability" (OPA, 2007, p. 3). The purpose of the Integrated Power System Plan was to assist, through the management of supply, transmission and demand, achievement of the Supply Mix Directive. Included in the Integrated Power System Plan is wind, solar and biomass investment to meet renewable electricity generation capacity requirements of 15,700 MW by 2025, as set out by the Directive (OPA, 2008). The Integrated Power System Plan was exempt from impact assessment; however, Ontario Regulation 424-04 required that environmental protection and sustainability be considered when developing the plan, as well as the impact of electricity projects recommended by the plan, and an analysis of the impacts of a reasonable range of alternatives (Stratos, 2007). Under the *Electricity Act*, the Integrated Power System Plan was also required to consider supply adequacy, safety, sustainability and reliability issues.

3.2.2 Nova Scotia Tidal Fundy Initiative

The Offshore Energy Environmental Research Association's SEA of the Fundy Tidal Initiative, Nova Scotia, Canada, was completed in 2008 as a response, in part, to the province's Renewable Energy Standards that call for 500 MW of additional renewable electricity generation capacity by 2013. The purpose of the SEA was "to assess social, economic and environmental effects and factors associated with potential development of renewable energy resources in the Bay of Fundy, with an emphasis on in-stream tidal" (OEER, 2008, p. 3). The SEA was intended "to inform decisions on whether, when and under what conditions to allow pilot and commercial projects" in the Bay of Fundy, "and under what conditions renewable energy developments are in the public interest over the long term" (OEER, 2008, p. 3). The SEA generated 29 recommendations for the Province to "guide a strategic approach to the development of marine renewable energy in the Bay of Fundy" (OEER, 2008, p. 1) and recommended the use of sustainability principles for incorporation into future planning and approval processes for the testing and development of marine renewable energy technologies (OEER, 2008). The SEA was regional in scope, focused on a particular energy program and was carried out under the Canadian federal SEA Directive (see Government of Canada, 2004).

3.2.3 UK Draft Policy Statement for Overarching Energy Infrastructure

In 2008 the Department of Energy and Climate Change developed a National Policy Statement for energy infrastructure initiatives in England and Wales "to reflect and clarify existing policy and practice…in consenting (to) nationally significant energy infrastructure" (DECC, 2009, p. viii). The purpose was to control energy infrastructure development "so that decisions are taken consistently and will increase certainty (and efficiency) for investors" and to make decision-making more transparent (DECC, 2009, p. xi). A sustainability assessment was required under the *Planning Act* (DECC, 2009) to "identify, describe and evaluate the likely significant social and economic effects of implementing the National Policy Statement", and to recommend mitigation measures (DECC, 2009, p. v). An SEA was required by the EU SEA directive (2001/42/EC) to consider: the current state of the environment and change in absence of the plan or program; environmental characteristics of areas that are likely to be significantly affected; existing environmental problems relevant to the plan or program; and measures concerning how the effects of implementing the National Policy Statement will be monitored (see DECC, 2009). The EU renewable energy capacity target of 15% of gross energy consumption by 2020 was adopted for the National Policy Statement, although it was not specified how this target was to be met (DECC, 2009).

3.2.4 Finspång Municipal Energy Plan

In 2006, an academic-led SEA was initiated for an energy plan for the municipality of Finspång, Sweden. The objective was "to strengthen municipal decision-making by applying, evaluating and developing tools for SEA in energy planning" (Martensson et al., 2006, p. 61). The research project proposed new tools for SEA in municipal energy planning and then applied an SEA process using those tools to evaluate Finspång's energy plan. The SEA was conducted during the plan's development. Part of the stated purpose was to determine how effective the SEA was in improving the municipal energy plan in terms of adopting renewable energy systems at the local level (Martensson et al., 2006). The municipal plan falls under legislation set out by the Swedish government, which requires each municipality to issue an up-to-date energy plan, as well as EU regulations requiring assessment of the effects of certain plans and programmes (2001/42/CE). National Swedish environmental objectives also require that such assessments incorporate considerations of biodiversity, human health, water, climate and cultural heritage and landscape, among others (Martensson et al., 2006).

3.2.5 Portugal's National Transmission Grid Plan

Portugal's National Transmission Grid development plan was undertaken by Rede Electrica Nacional in 2007. This was a national level plan SEA for the purpose of "assisting and facilitating the planning concept and design by integrating the environment and sustainability issues at an early stage in the planning and programming cycle" (Partidário et al., 2010, p. 3). The SEA was "to identify, describe and assess the relevant environmental and sustainability issues necessary to help, and sometimes guide, the technical strategic options that could support decisions on the solutions for the National Transmission Grid evolution" (Partidário et al., 2010, p. 1). National requirements for renewable electricity production capacity of 11 GW of wind and hydropower by 2018 were identified in the SEA, and 'increased renewables use' was adopted as a criterion for assessment. The SEA reviewed and assessed strategic options for expanding the National Transmission Grid and determined a preferred option, along with providing a governance framework and guidelines for follow-up of planning, management and monitoring. The SEA was completed in accordance with the SEA directive (2001/42/EC) and in accordance Portugal's National Decree Law 232/2007, which requires plans that set a framework for the development of projects undergo environmental assessment.

3.2.6 Wisconsin's Strategic Energy Plan Assessment

In 2005, the Public Service Commission of Wisconsin, US, undertook a strategic energy assessment for the development of State electricity supply options from 2006 to 2012. The assessment was fourth in a biennial series of reports to illustrate the State's past and future energy needs and supply. The assessment focused on sustainable energy alternatives, an improved energy planning process, utility workforce planning and accountability in the regional market (PSCW, 2007). The purposes were to identify planned electricity generation and transmission projects, address electricity supply and reliability issues, project demand, identify activities to discourage inefficient and excessive consumption, determine whether sufficient electrical capacity will be available at a reasonable price and assess existing and planned renewable energy facilities (PSCW, 2007). The assessment included plans to meet State renewable generation capacity requirements of 10% of the total electricity mix by 2015, namely through utility initiatives and small scale on-site customer generated projects. The assessment was conducted at the State policy level during the process of reviewing and revising the existing policy. Wisconsin Statute 196.491(2) requires assessment of the adequacy and reliability of the state's electrical supply and purchased generation capacity, as well as the economic and environmental impacts of electricity production (PSCW, 2007). Although not an SEA by name, the Wisconsin case was 'SEA-like', reflecting broad SEA principles and methodology.

3.3 Methods

Several researchers have proposed SEA review criteria based on various system, process, and results components (see Noble, 2009; Soderman and Kallio, 2009; Cashmore et al., 2008; Runhaar and Driessen, 2007). Adopting a standard set of criteria for SEA review "provides an opportunity to identify the 'state-of-practice' across SEA systems based on a common set of principles and criteria" and "enables identification of common SEA constraints and opportunities for improvement" in the particular PPP decision-making context (Noble, 2009, p. 67). The criteria used in this research to examine the nature and influence of SEA in international electricity PPP development and decision making, and to identify lessons and 'best practices', were derived from the above referenced literature and are presented below in Table 3-2. This is not an exhaustive list; rather, the criteria were identified as generally accepted SEA principle and design evaluation criteria. In the context of the electricity sector, they provide a means to compare practice and examine whether and how SEA is helping to identify and balance often competing priorities in electricity PPPs, facilitate the integration of sustainable development principles, and direct the development of informed and improved electricity PPPs. In doing so, strengths, limitations and opportunities for improving practice can be identified.

Table 3-2. SEA review criteria

Criteria	Description
SYSTEM CRITERIA	
Provisions	Clear provisions, standards or requirements to undertake the SEA, or equivalent, process
Integration	Application is early enough to address deliberation on purpose and alternatives, or to guide initial conception of review for an existing PPP
PROCESS CRITERIA	
Purpose and objectives	Assessment purpose and objectives are clearly defined
Alternatives consideration	Comparative evaluation of reasonable alternatives or scenarios
Impact evaluation	Identification of potential impacts or outcomes resulting from each option or scenario under consideration
Participation and engagement	Opportunity for meaningful participation and deliberations
Monitoring program	Procedures to support monitoring and follow-up of process outcomes and decisions for corrective action
OUTCOME and INFLUENCE CRITERIA	
Knowledge and understanding	Identification of key issues and areas of concern for decision makers Identification of additional options or alternatives for consideration in the PPP
Decision-making	Identification and/or adoption of a 'best' option or alternative Influence on the final decision or the decision making process and incorporation of recommendations into the final PPP
Tiering	Adoption of a formal approach to tiering that demonstrates a defined linkage between the current PPP and: i) the goals and objectives set by higher-order PPPs, and ii) the review or approval of any anticipated lower-tier PPPs or initiatives
Communication and learning	Opportunity for institutional learning, improved collaboration and communication Increased transparency in decision-making process and increased public awareness and education

The criteria were used to review each of the six SEAs. Attention was focused on SEA process and outcome or influence on the PPP and decision making process. A review of the SEAs or relevant electricity sector PPP documents was undertaken to identify the SEA context, including its purpose, institutional setting and specific tier or type of application (see Table 3-3). This was followed by an examination of fundamental phases of SEA (see Therivel, 2010; CCME, 2009; Noble and Gunn, 2009), namely the consideration of alternatives, impact assessment, monitoring and participation. The document review was supplemented with semi-structured interviews with key informants from each of the respective cases. Key informants were identified from the SEA or PPP documentation, or recommended by others. All interviewees were either directly involved with the respective SEA or intimately involved in planning and decision-making processes for the electricity PPP. A total of 14 people were interviewed. Interview results were organized, coded thematically and analyzed using QSR NVivo© v9 software designed to classify and manage qualitative information. Interviews focused on two themes. The first theme was ‘knowledge and learning,’ including: 1) identifying options and key areas of concern; and 2) institutional learning, including transparency and increasing public awareness. The second theme was ‘influence and tiering,’ including: 1) incorporating SEA alternatives, recommendations and stakeholder input in the final PPP; and 2) informing and influencing lower tier decision making, legislating the PPP into lower level decisions and considering higher level initiatives.

Table 3-3. Case study documents and interviewees

Case	Documents Reviewed	Interview Participants
Ontario Power Authority Integrated Power System Plan, Canada	Development of the Integrated Power System Plan; The Integrated Power System Plan for the Period 2008-2027; Supplementary Environmental Impacts Report for the Integrated Power System Plan Final Report; Ontario Power Authority Sustainable Due Diligence Assessment Final Report	Power system planner, OPA; Transmission integration planner, OPA
Nova Scotia Tidal Fundy Initiative, Canada	Fundy Tidal Energy Strategic Environmental Assessment, Final Report; The Role of Strategic Environmental Assessments (SEAs) in Energy Governance: A Case Study of Tidal Energy in Nova Scotia's Bay of Fundy; Chapter 6: Environmental Issues, Jacques-Whitford Background Report for the Fundy Tidal SEA; Bay of Fundy Tidal Energy: A Response to the SEA	Environmental planner; Nova Scotia Environment; Nova Scotia Department of Energy
UK Draft National Policy Statements for Overarching Energy	Appraisal of Sustainability for the draft National Policy Statements for Overarching Energy (EN-1); Appraisals of Sustainability of the revised draft energy National Policy Statements: Draft Monitoring Strategy; Consultation on draft National Policy Statements for Energy Infrastructure	Energy development unit manager, DECC
Finspång Municipal Energy Plan, Sweden	Strategic Environmental Assessment in Energy Planning - Exploring New Tools in a Swedish Municipality; Do decision-making tools lead to better energy planning: Working Paper; Energy planning with decision-making tools: experiences from an energy-planning project; New tools in local energy planning: experimenting with scenarios, public participation and environmental assessment; Sweden's Environmental Objectives in Brief; Valuation of environmentally assessed measures, basis for energy plan (translated from Swedish)	Researcher, Linkoping University; Researcher, Blekinge Institute of Technology
Portugal National Transmission Grid Plan	First Transmission Grid Plan with Strategic Environmental Assessment in Portugal: Added Value to the Electric System; Plan of Development and Investment National Network of Transportation of Electricity 2009-2014, Report of Public Consultation Plan and Their Strategic Environmental Assessment (translated from Portuguese); Strategic Environmental Assessment of the Plan of Development and Investment National Network of Transportation of Electricity 2009-2014, Non-technical summary (translated from Portuguese); Sustainability Report for the Rede Electrica Nacional Group	SEA team leader; Rede Electrica Nacional Planning Division; Rede Electrica Nacional Equipment Division
Wisconsin Strategic Energy Assessment, US	Strategic Energy Assessment, Energy 2012, Final Report; EA of the Strategic Energy Assessment 2006-2012, Docket 05-ES-103; State Energy Policy 1.12; State Renewable Energy Sources Policy 196.377	Public utility financial analyst, PSCW (x 2); Administrator, Gas and Energy, PSCW

3.4 Results

Results are summarized below in Table 3-4 and Table 3-5 and presented in the sections that follow. Section 3.2 above speaks broadly to the 'system criteria' and to the specific purpose and objective of each of the SEA applications. Attention here is limited to select process criteria and, in particular, to the outcome and influence of the SEA on the electricity PPPs.

Table 3-4. Overview of SEA process elements for the six electricity sector cases

SEA	Alternatives Considered	Impact Assessment	Participation and Engagement	Monitoring Proposed
Ontario Power Authority Integrated Power System Plan, Canada	No. Supply Mix Directive outlined electricity mix	Qualitative social and economic impacts; Quantitative environmental impacts	Workshops with and written comments from public, government and interest groups; consultations with Aboriginal & Métis groups	Environmental impacts, such as greenhouse gas emissions, land and water use, waste production
Nova Scotia Tidal Fundy Initiative, Canada	No. Focus was on tidal technology	Qualitative social, economic and environmental impacts; Cumulative impacts	Forums, roundtable discussions and advisory board meetings with public, industry, government, environmental and Aboriginal groups	Social, economic and environmental impacts, such as biophysical, tourism and recreation, economic development
UK Draft National Policy Statements for Overarching Energy	Yes. Four alternatives including a 'do nothing' option	Qualitative social, economic and environmental impacts; Cumulative impacts	Scoping workshops with government; online and written comments from public; consultations with public, government and environmental & interest groups	Social, economic and environmental impacts, such as ecology, climate change, resources and raw materials, economy and skills
Finspång Municipal Energy Plan, Sweden	Yes. Numerous actions and strategies, including a 'do nothing' option	Quantitative and qualitative environmental impacts	Workshops and panels with public, industry and government	SEA processes, such as scope and quality of EIA, goal setting and system boundaries
Portugal National Transmission Grid Plan	Yes. Five alternatives including new option proposed by SEA team	Qualitative social, economic and environmental impacts; Cumulative impacts	Presentations for and debate sessions with public; workshops with government, environmental groups and NGOs	Planning processes, such as implementation of the National Transmission Grid plan
Wisconsin Strategic Energy Assessment, US	No. Focus was on revision of current policy	Quantitative social, economic and environmental impacts	Public meetings with and online comments from public and interest groups	Planning aspects, such as energy demand, electricity rates, renewables use

Table 3-5. Reported SEA outcomes and influence[1]

Reported SEA Outcome and Influence	Ontario	NS	UK	Sweden	Portugal	Wisconsin
Understanding and knowledge:						
▪ Identified areas of concern and key issues	✓	✓		✓	✓	✓
Communication and learning:						
▪ Improved collaboration and communication	✓	✓	✓	✓	✓	✓
▪ Improved institutional learning and transparency	✓			✓	✓	
▪ Increased public awareness		✓		✓	✓	
PPP decision making:						
▪ Best option identified			✓	✓	✓	
▪ SEA recommendations included in PPP		✓	✓			
▪ SEA options incorporated into PPP				✓	✓	
▪ Stakeholder input incorporated into PPP	✓	✓	✓			
Tiering:						
▪ Influenced lower level decision making	✓	✓	✓	✓	✓	✓
▪ PPP legislated into lower level decisions			✓	✓	✓	✓
▪ Considered higher level initiatives			✓	✓	✓	✓

[1]As reported by interview participants and evidenced in SEA or PPP documentation.

3.4.1 SEA Process

Development and consideration of alternatives

Three of the six cases developed or considered alternatives (Table 3-4). In the UK, the Department of Energy and Climate Change considered several alternatives for its overarching policy on energy infrastructure, ranging from a 'do nothing' alternative to an National Policy Statement that would set out a high level government energy policy; define types of locations suitable for energy developments; and set guidance on how impacts of energy development could be managed (see DECC, 2009). The Portugal SEA considered four alternatives, including consideration of requirements for supply, reception of energy produced by nuclear, conventional or renewable sources, and ensuring appropriate levels of exchange between the Iberian grids (Partidário et al., 2010). In the Swedish case, a backcasting approach was used whereby a panel of municipal government, energy sector representatives, the public and researchers developed a vision for the future of the municipality based on long-term energy sustainability (Martensson et al., 2006). Several alternatives were then developed, including a "current state" scenario, a "no-action" scenario, and several alternative strategies that may influence a sustainable energy system. Amongst those SEA that did not consider alternatives, Ontario's higher-tiered Supply Mix Directive set out the resource mix for electricity provision; the Integrated Power System Plan focused only on how the mix was to be developed and transmitted (OPA, 2007). In Nova Scotia, a background report to the SEA described, in brief, different types of marine renewable energy technologies, but the SEA itself focused on the proposed tidal in-stream energy conversion plan (OEER, 2008). According to an interviewee from the Department of Energy, "the SEA wasn't really about alternatives, it was about identifying issues that need to be addressed later on (with tidal in-stream technology)…we found that it was very successful (in that) we were able to identify a research agenda."

Impact assessment

All cases assessed the potential impacts of the PPP, but practice was variable. In Nova Scotia, UK, Wisconsin, Portugal and Ontario, impacts (including cumulative effects in the UK and Nova Scotia case) were assessed based on social, economic and environmental factors. In the Swedish case, assessment focused on environmental impacts only. In the UK case, the National Policy Statement was "appraised" qualitatively against sustainability objectives (see DECC, 2009); cumulative effects were also addressed at the policy level, qualitatively, as required by the EU SEA Directive. In the Portugal case, based on country trends and drivers and Rede Electrica Nacional's sustainability policy, a set of assessment criteria were developed (see Partidário et al., 2010) and the impacts of each PPP alternative evaluated qualitatively based on its potential for positive gains or the risk of adverse outcomes. In the Ontario case, impact assessment was carried out only on the prescribed electricity mix to determine the priority order of development of resources. The Ontario Power Authority developed "sustainability planning criteria" to rank and prioritize electricity development based on such factors as feasibility, reliability, and environmental performance (OPA, 2007). The Tidal Fundy SEA similarly assessed, qualitatively, potential interactions between tidal in-stream technologies and the biophysical and socio-economic environment, as well as cumulative effects (see OEER, 2008), including the effects of energy extraction, the effects of other developments and the effects of other ecosystem changes (OEER, 2008). Wisconsin was the only case that used a predominately quantitative assessment, focused on assessing the impacts of the policy based on electricity reliability and adequacy of supply (see PSCW, 2007).

Participation and engagement

All SEAs included some form of participation and engagement. Engagement ranged from simple information dissemination to more interactive participation through roundtable discussions, workshops and public panels. In Portugal, for example, the National Transmission Grid plan and the SEA were subject to public consultation sessions, workshops with environmental authorities and NGOs and public debate sessions. In Wisconsin, public meetings regarding transmission line siting and new electricity generation projects took place as part of the strategic energy planning process and documents were made available online for public comment (PSCW, 2007). In the UK, a five-week consultation process during the scoping phase of the assessment included government agencies (DECC, 2009) and the assessment report was available publically for comment. In Nova Scotia and Ontario, participation processes also included relevant Aboriginal communities potentially affected by the proposed PPP.

Monitoring

All PPPs proposed monitoring of some form. In Ontario, Nova Scotia, and the UK proposed monitoring focused on environmental, social or economic impacts; other cases focused on the monitoring of planning processes. In Ontario, for example, the Integrated Power System Plan set electricity development priorities by tracking and assessing environmental performance parameters, such as GHG emissions, land and water use and waste production that indicate "the extent to which the future electricity system may cause adverse environmental effects" (OPA, 2007, p. 24). In the UK, the Department of Energy and Climate Change focused on effects that could give rise to irreversible damage and identified areas "where monitoring would enable preventative or mitigation measures to be undertaken" (DECC, 2009, p. xxi). Proposed monitoring parameters included GHG emissions, flora and fauna condition, waste production and water use and employment (DECC, 2010). That being said, in the Ontario and UK cases, the PPPs have either been sent back to the drawing board or have yet to be implemented. In Nova Scotia, monitoring was proposed for a number of social, economic and environmental topics;

although the only monitoring being implemented is that of the physical environment and at the project level.

In contrast, monitoring in the Portugal, Sweden and Wisconsin SEAs focused primarily on monitoring of planning and assessment processes, rather than the environmental impacts of the PPP per se. In Wisconsin, for example, reliability and adequacy parameters, including energy demand, electricity rates, electrical generation by fuel type and renewables use and transmission capacity are monitored to improve future energy planning (PSCW, 2007). Direct environmental impacts are not included in monitoring at the plan level. In Portugal, the SEA team leader noted that a number of indicators were developed in the SEA for such things as whether certain conservation areas were avoided or whether there would be major changes to the plan itself, and if those major changes had undergone environmental assessments. She went on to note that "last year we went back to those indicators and tried to see whether certain guidelines were actually fulfilled in implementation of the plan and how much the decisions have changed with respect to the plan that had been approved." In the Swedish SEA, monitoring was also designed to evaluate the SEA process, specifically "the effectiveness of the tested process and tools in terms of their ability to provide a plan which would be efficient in controlling the development of the local energy systems in a direction towards improved environmental performance" (Martensson et al., 2006, p. 63).

3.4.2 SEA Outcomes

Increased knowledge and understanding

In all but one of the six cases (see Table 3-5), interviewees indicated that the SEA resulted in the identification of new issues or areas of concern. In the Ontario case, for example, the assessment identified significant electricity supply and reliability issues; in Portugal the SEA led to increased understanding of the environmental issues associated with the PPP. As explained by one interviewee, there was "a big change in…environmental perception and environmental interest, and the level at which everybody put the environmental issues in the technical decision improved a lot, and so (the planning team) is now much more conscious of the environmental issues than before." In Sweden the SEA highlighted the issue of "problem shifting" in the PPP. For example, as explained by one interviewee, the SEA led to the realization that heat production from biomass in individual households could be replaced with electric heat pumps, which would reduce local air pollution, including VOCs and particulate matter; but this shift would create additional regional emissions since the heat pumps use electricity from burning coal. In Ontario, increased communication with the public was reported by to have prompted the Ontario Power Authority to revise certain aspects of their Integrated Power System Plan, including removal of a wind generation option (Stratos, 2007). According to one interviewee, the SEA was “very helpful for uncovering things that we might not have thought of (and) identifying different options that we might not have considered, whether they be transmission or distribution or certain problem areas that we have.”

Improved communication and institutional learning

Improved communication and collaboration was identified as an SEA outcome in all six cases, albeit among different stakeholders. In Nova Scotia, for example, one interviewee stated that “one of the great things about (the SEA) was the extent to which they (government) consulted with the public... they had a really good sense of what the stakeholder concerns were”. In Portugal, public consultation on the National Transmission Grid plan and the SEA created “a platform that enabled and strengthened dialogue between Rede Electrica Nacional and its planning process stakeholders, including private companies, sectoral administration, environmental authorities, NGOs and the public” (Partidário et al., 2010, p. 7). The SEA also aided technical dialogue between the SEA and National Transmission Grid planning teams, as well as between private and public authorities (Partidário et al., 2010). One interviewee stated that in “in the room traditionally would be engineers (only); now we have engineers, politicians, biologists and very important(ly), we have our top administration responsible also for taking (on) the public commitment for the plan and the environmental solutions”.

In several cases, namely Portugal, Ontario and Sweden, learning on behalf of the planners was reported as having emerged from interactions with stakeholders during the SEA. In Ontario, one provincial government interviewee noted that there was consultation with the environmental community “...that we wouldn’t normally be doing if we weren’t involved with this process.” The participant went on to explain that there was much organizational learning through the SEA “…because we’re generally utility planner types, not necessarily environmental scientist types; so there is a lot of learning going on…” In Sweden, learning also resulted from improved communication between planners and stakeholders. According to one researcher involved in the case, “the cooperation with the panel was also something that they (the planners) had never been into before...they created discussions that were very open from the start…one thing they learned was that ordinary people have a lot of good and interesting things to add to, for example, planning processes”. In these same three cases, participants also identified improved transparency as a result of collaboration with stakeholders during the SEA process. In Sweden, for example, one researcher indicated that there was improved transparency because “the municipality decided right at the start of the project that they would publish everything…on the internet and that they hadn’t done that before; it was kind of a novelty for them”. In the Ontario case, one interviewee suggested both improved transparency and accountability in the decision-making process as a result of the SEA. The participant explained that an Integrated Power System Plan is thousands of pages of information, but the consultations provided an opportunity to present the information “…in a much more concise way... people can submit questions and they can ask for all of the backup for why a certain decision was made; what that does is it will also identify for them whether or not we’ve given something proper consideration.”

A final point identified by participants was that the SEA contributed to increased public or stakeholder awareness about the PPP. In the Swedish case, one interviewee explained that “...public officials and representatives from the local energy company were forced to work together” and that this “has led to many new ways of communication and much better cooperation. The participant went on to explain that “public officials and the politicians learned that a process that takes time can be very beneficial because the outcome…is very legitimate now and anchored among the actors”. In the Nova Scotia case, one interviewee noted that involvement in the SEA process demonstrably increased public awareness such that “...there’s been requests from environmental organizations and members of the public to do SEAs on other types of development in the province”.

Influenced PPP decision making

In five of the cases, the SEA was said to have influenced PPP decision-making, with two cases reporting more than one type of improvement (Table 3-5). In Portugal, the SEA lead commented that one option developed by the SEA team was “a better option that would fit much better the kind of risks and opportunities that have been identified” and was subsequently determined to be the final preferred option for the National Transmission Grid plan. The SEA showed “clear signs of influence in the technical design of the National Transmission Grid" (Partidário et al., 2010, p. 7). As explained by one interview participant, the SEA was "built in" to the plan decision-making process. Similarly, in Sweden, one interviewee explained that "the alternatives or suggestions for actions were generated as a part of the SEA process", which resulted in more robust strategies or actions being included and subsequently adopted in the plan. In Nova Scotia two interviewees reported that SEA resulted in improved decision-making, one of whom noted that it was due to the incorporation of SEA recommendations into the program. According one interviewee, the SEA influenced the final decision because "the Government decided to only allow demonstration scale (projects)...that was a recommendation in the SEA". In the UK case, the Department of Energy and Climate Change addressed certain recommendations for mitigation emerging from the SEA and incorporated them into the National Policy Statement. Interestingly, though, one interviewee commented that the SEA resulted in little change to the policy's initial overall direction. This was in sharp contrast to the Nova Scotia case, where, as one government interviewee explained, "one of the outcomes of the SEA was a recommendation to create new legislation that would embed a whole series of processes, licenses and mechanisms that would enhance public confidence that (development of tidal technology) was being done properly".

Promoted tiering

For all SEAs participants identified some form of influence through tiering (Table 3-5); however, three different types of tiering relationships were identified. First, and in all six cases, SEA was reported to have promoted tiering to lower level decision making, including pre-screening projects, streamlining the project approval process and setting a context for potential future projects. However, only in two cases was there demonstrable evidence of the influence of SEA on lower-level decision making, namely that of Wisconsin and Nova Scotia. In the Nova Scotia case, stemming from the completion of the SEA, a proposed Fundy Tidal Energy Demonstration Project was approved in 2009 under the *Environmental Assessment Act.* As explained by one interviewee, there was an environmental assessment for the facility that is permitted to generate 5 MW of tidal energy and "we would not have been able to get the project approval without having the SEA done in advance….we were able to (get) through the SEA a great deal of public input, which made the regulators quite comfortable with the level of environmental assessment that they had to undertake at a project level." In the Wisconsin case, the assessment influenced the number and types of programs that were funded in the State, such as on-site, customer-produced renewable energy projects, as well as energy efficiency programs (PSCW, 2007). The assessment also helped in identifying and describing planned electricity generation and transmission construction projects.

Second, in four of the cases, the PPP was legislated as part of a lower tiered initiative (Table 3-5). For example, in Portugal, one interviewee explained that the final report resulting from the SEA was a starting mandatory framework for projects defined in the plan. The interviewee explained that "when we consult for an environmental impact study for a new project, they have to take into account the SEA of the plan...so the influence is direct and mandatory." Similarly, for the UK, developers proposing energy infrastructure projects must ensure that their applications are consistent with the National Policy Statement requirements. In Ontario, Regulation 424/04 requires project level environmental assessments on electricity projects recommended by the Integrated Power System Plan, as well as an analysis of the impact on the environment of a reasonable range of alternatives to the electricity project (Stratos, 2007).

Third, these same four cases were also tiered or nested within the context of higher-level PPPs. In the case of Wisconsin, federal regulations and other State regulations influenced the policy, including the *Federal Energy Policy Act* of 2005 Wisconsin Statute 196.378, which requires retail electric companies to provide a portion of sales from renewable resources (PSCW, 2007). In the UK case, the Department of Energy and Climate Change evaluated "how the National Policy Statement could be affected by other policies or how it could contribute to or hinder the achievement of any environmental or sustainability targets set out in those policies" (DECC, 2009, p. vii). As such, national regulations influenced the National Policy Statement development, including the *Planning Act* of 2008, which sets out the size and types of development that are appropriate and the criteria to be applied in locating infrastructure projects.

3.5 Discussion

Regardless of whether the electricity sector PPP adopted formal SEA or simply an SEA-like approach, all demonstrated some evidence of 'good' SEA process and PPP influence as a result of the SEA application. This suggests that there are benefits to be derived from adopting SEA in the development and assessment electricity sector PPPs, regardless of whether SEA is formally required or not as part of the electricity policy and planning process. This is confirmed by SEA reviews in other sectors, which also suggest that some of the better SEA applications have been outside the umbrella of formal SEA requirements (see Noble, 2009). However, there were certain patterns that emerged across the six cases with regard to both SEA process and outcomes.

3.5.1 Generation and Consideration of Alternatives

First, notwithstanding evidence of good-practice SEA process elements, performance was relatively weak in terms of alternatives assessment – a component of the process identified as fundamental in the SEA literature (e.g., Therivel, 2010; Desmond, 2009; Retief, 2007a) and, arguably, core to the development of improved electricity sector PPPs (see Noble and Storey, 2001). Only half of the electricity sector SEAs considered alternatives. Interestingly, these were the three were the more ‘formal’ SEAs, implemented under legislative or directive-based requirements, and in those cases the consideration of alternatives had a significant impact on electricity PPP development. In the Swedish and UK cases, the alternatives were reported to have improved the final PPP and in the Portugal case, a new electricity plan alternative identified during the SEA was ultimately adopted. In those cases where there were no alternatives, the SEA consisted of determining the impacts of a prescribed option. This is less than ideal in the electricity sector, often resulting in the justification of a pre-ordained PPP and perhaps less consideration of more sustainable electricity supply options – particularly in those cases where the electricity supply mix and targets for renewables are already established. Results indicate the need for a better consideration of alternatives in SEA in the electricity sector and at higher levels of PPP assessment, as currently the process is rather restrictive (see Jay, 2010). However, ensuring that alternatives are considered in SEA, particularly for addressing alternative supply mixes, seems to favour more formal SEA requirements. The benefits from alternatives consideration in SEA in electricity sector policy and planning practices need to be better demonstrated and documented if SEA is to be adopted as common in ‘informal’ SEA, outside the scope of legislation or directive-based requirements, where many SEA applications in the electricity sector seem to occur.

3.5.2 Impact Assessment Methodology

There appears to be a dominance of qualitative impact assessment in electricity sector SEA. Three of the cases examined, Portugal, Nova Scotia and the UK, used strictly qualitative approaches; Ontario and Sweden used a combination of quantitative and qualitative approaches. Wisconsin was the only case that used a strictly quantitative approach. Several authors (e.g., Browne and Ryan, 2011; Song et al., 2011; Zhu et al., 2011; Therivel, 2010) support the use of qualitative methods, particularly for impacts that are subjective or when quantification may not be needed for comparing alternatives, but also because qualitative approaches are often seen as easier for decision makers to understand. While the prevalence of qualitative approaches may be a reflection of the small number of cases examined, reviews of international practice in other sectors by Noble et al. (2012) confirm the results found in this work. Qualitative impact assessment is useful; however, it may be overused in practice and pose challenges for SEA process in the electricity sector, particularly when the focus of attention is on electricity futures, modeling of supply and distribution systems, and in scenario-based approaches to grid infrastructure planning. While appropriate for use in some cases, qualitative methods may also prove problematic in SEA follow-up where the focus is on monitoring actual impacts of electricity plans or infrastructure as opposed to broader influence on decisions.

That said, in the Sweden case, which did adopt a quantitative approach, there were still methodological challenges. For example, the quantitative life cycle analysis was not considered to be the most successful approach by the SEA practitioners involved due to difficulty integrating the approach with tools for public participation and scenario planning (see Bjorklund, 2012). The methods used were also deemed too complicated for the municipality to use on their own. It may be that practitioners are not sufficiently aware of the range of available methods for use in SEA (see Liou et al., 2006), or simply that more operational guidance is needed at the practitioner level on how to select the best available methods for the SEA tier and context at hand (Noble et al., 2012). Arguably, in order to advance SEA in the electricity sector there needs to be more attention to the range of both quantitative and qualitative methods available for use and on how to select the most appropriate methods in SEA to support decision making and post-PPP implementation follow-up and monitoring.

3.5.3 Timing

Early application of SEA in PPP formulation is vital to ensure the integration and consideration of all relevant issues in the design and assessment of strategic options throughout the preparation and implementation of a PPP (Therivel, 2010; D'Auria and Cinneide, 2009; Gunn and Noble, 2009a). Several cases initiated SEA early on in the electricity PPP development stage and in those cases, the SEAs was reported to have had a significant influence on decision-making; however, several interviewees noted that when SEA is fully integrated with the PPP process, it can be difficult to quantify the direct influence of the SEA on electricity policies and plans because it is so well-integrated. In the three cases where SEA was initiated during the review and revision of an existing PPP, namely the UK, Wisconsin and Ontario cases, the SEA was reported to have had less influence on PPP decision-making.

The UK SEA, for example, was an 'appraisal' of an existing electricity policy and served primarily to clarify policy goals and objectives; in Ontario, the assessment was conducted after a Supply Mix Directive had already been established, thus limiting the scope and influence of the SEA for examining alternative electricity mix options at the plan level. Consistent with recent literature on the timing of SEA (e.g., Therivel, 2010; Desmond, 2009; Therivel and Walsh, 2006), earlier application tends to result in more influential SEA; however, at the same time our results show that the influence of fully integrated SEA in the electricity sector can be difficult to trace. There is a need to establish clear indicators of SEA influence or success at the outset of the process, such that its influence and benefits as an integrated part of PPP development can be clearly measured and understood.

3.5.4 Participation and Learning

Participation in SEA provides an opportunity for stakeholders to inform and influence the direction of and decisions about PPP developments (see Sinclair et al., 2009). Consistent with recent literature, results show value-added to PPP development and decisions as a result of public and stakeholder engagement in electricity PPP processes. Improved collaboration and communication was deemed a major outcome in all six cases reviewed, and in some cases it was identified as amongst the most important. However, we also observed an important link between participation and learning, more so than direct or immediate influence of participation on the PPP itself. In four of the cases, participation was said to have resulted in, firstly, increased transparency and public awareness of electricity plans and, secondly, institutional learning on behalf of the decision-makers and planners. This suggests that, in many instances, the influence of participation may not always be direct or immediate, but rather indirect and even subtle - changing values and attitudes about SEA through learning and clarifying the responsibilities of decision makers and the roles of SEA itself (see Sheate and Partidário, 2010; Runhaar and Driessen, 2007; Fitzpatrick, 2006). In the Nova Scotia case, for example, one of the important outcomes of stakeholder engagement was recognition of the added value of the SEA, resulting in subsequent requests for the province to undertake additional SEAs in the region.

3.5.5 Tiering and Influence

Tiering is alive and well in SEA. Various authors note the importance of tiering in SEA (Kirchhoff et al., 2011; Therivel, 2010); some say it is too 'idealistic' (Fischer 2010; Nitz and Brown, 2001) and others have reported a lack of tiering in practice (Song and Glasson, 2010; Noble, 2009). Results of our research speak to the ability of SEA in the electricity sector to influence outcomes through tiering at three levels: 1) tiering down, informally, to lower level electricity development plans and projects; 2) tiering up, to higher level electricity plans and policies, with changes being legislated into subsequent lower level actions; and 3) the SEA itself occurring within the context of a higher tiered PPP initiative. All six SEAs examined reported some degree of tiering toward lower level decision making; two cases were reported to have had a demonstrable influence on a lower level decision, including helping to streamline project level assessment and influencing the delivery of electricity supply programs and projects. In one case, namely Nova Scotia, there was evidence that also indicated SEA 'tiering-up' and influencing higher levels of policy in the electricity sector. The SEA recommended the development of marine renewable energy legislation to guide development of tidal technology in the region, and such legislation is currently being considered as part of the province's "*Renewed Energy Strategy*". Typically, SEA is thought of as influencing lower, project-level development at best (Kirchhoff et al., 2011; Partidário, 2000; Fischer, 1999); results here show not only tiering-down in the electricity sector but that SEA can have a much broader influence, potentially affecting higher-level policy and legislation.

3.6 Conclusion

The role and potential value of SEA in energy sector PPPs is neither well developed nor understood. Based on SEA experiences in the international electricity sector, this paper set out to examine the role and contributions of SEA in energy sector planning, both in terms of its process elements and PPP outcomes. Results show that SEA can and does contribute to improved PPPs in the energy sector. Participation of decision-makers and stakeholders in the SEA process led to awareness of new environmental issues and preferable PPP options and to public awareness of the benefits of SEA. There was also institutional learning exhibited and demonstrated accountability and public confidence in PPP decisions. Early adoption of SEA processes in PPP development, specifically those that also included the consideration of alternatives, demonstrably improved the development several PPPs. In some cases the SEA tiered to other levels decision-making, including the streamlining of project level assessment, shaping program delivery and influencing the creation of higher level legislation.

That said, there remain many barriers to SEA realizing its full potential. For example, not all cases showed substantive influence on the PPP due to the late application of SEA, the lack of alternatives considered in some cases, or the restrictions set on the scope of SEA by ‘higher-level’ policies. Arguably, this is mainly due to a lack of awareness on behalf of planners and decision-makers regarding the role of SEA and the importance of its timing in the PPP process. In moving forward, more guidance is needed so that planners and decision-makers are better aware of when and how to apply SEA frameworks in order to maximize its impact and value added in the PPP development process.

PREFACE TO CHAPTER 4: STRATEGIC ENVIRONMENTAL ASSESSMENT FOR SUSTAINABILITY: BEST PRACTICES AND LESSONS LEARNED FROM THE INTERNATIONAL ELECTRICITY SECTOR

Chapter 4 addressed the second part of the second objective of this thesis, to examine how sustainability principles are being integrated into the SEA process in the electricity sector. Six international electricity sector policy, plan and program SEAs were examined to assess the operationalization of sustainability and sustainable development in SEA practice and to assess whether and how SEA can ensure sustainability in the electricity sector. The cases showed some ability for SEA to operationalize sustainability, including: setting a sustainability approach and objectives; evaluating alternatives based on assessment criteria developed from sustainability objectives; and promoting sustainability outcomes, such as tiered forward-planning and institutional learning. The cases also illustrated that decision-makers are still unclear regarding how sustainability principles and objectives can be explicitly linked to SEA practice, and SEA methodology itself was sometimes poorly applied. That said, results did show potential for SEA to contribute to sustainability-centred decision making in the electricity sector, by identifying sustainability goals and principles and providing the necessary framework for the integration of sustainability criteria in electricity sector policy, plan and program development.

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CHAPTER 4: STRATEGIC ENVIRONMENTAL ASSESSMENT FOR SUSTAINABILITY: BEST PRACTICES AND LESSONS LEARNED FROM THE INTERNATIONAL ELECTRICITY SECTOR

4.1 Introduction

Energy sector sustainability and energy systems planning are inextricably linked. This is particularly the case for the electricity sector because of its resource requirements and the ecological footprint of electrical distribution systems (Lior, 2010; El-Fadl et al., 2009; Williams and Kahrl, 2008; Schenler et al., 2002). For the most part, however, the electricity sector has been characterized by only limited integration of sustainability in planning and assessment processes, even though "there are increasing concerns about the sustainability of the electricity sector, ranging from impacts of current operation(s) to the choice of future options for system development" (Schenler et al., 2002, p. 9). Schenler et al. (2002, p. 8) note that there is a demonstrated need for a "planning methodology framework that will assist the decision-making process consistently with the long-term sustainable development of the electricity sector." A key challenge is thus how to incorporate sustainability principles into electricity sector planning and development decisions (Unsihuay-Vila et al., 2011; Lior, 2010; Tsai, 2010; Pereira et al., 2008; Afgan et al., 1998)

Strategic environmental assessment (SEA) in the energy sector, that is the environmental assessment of energy policies, plans and programs (PPPs), is focused on planning for energy futures before individual project development decisions are made and when alternative futures and options for development are still open (see Dalal-Clayton and Sadler, 2005; Noble and Gunn, 2009). In doing so, SEA allows energy system planners and policy and decision makers to identify the most practical and environmentally preferred energy alternative(s) to guide the development of an energy policy (Noble and Storey, 2001). That being said, and notwithstanding the many benefits of and opportunities for SEA, in practice there are several challenges that limit planning for sustainable futures in the electricity sector in particular (see Jay, 2010; OPA, 2008; PSCW, 2007; Jay and Marshall, 2005). Amongst the most significant challenges is the limited empirical research showing how sustainability principles are effectively integrated and operationalized in SEA for electricity sector planning (see Noble, 2002). A significant need and opportunity exists to advance SEA in the electricity sector (see Jay, 2010; Marshall and Fischer, 2006), but it remains unclear as to how sustainability principles are best operationalized in SEA (Pope et al., 2004). As a result, there has been limited opportunity to observe how SEA can contribute to sustainable electricity sector planning and improved PPP evaluation processes.

The purpose of this paper is to examine how sustainability is integrated and operationalized in SEA practice in the electricity sector. In order to accomplish this attention is focused on six cases of SEA and SEA-type processes in the international electricity sector. In the sections that follow, each of the six electricity sector SEAs is introduced, followed by an analysis of whether and how sustainability and sustainability-focussed assessment criteria are integrated in the SEA practice. The paper concludes with a number of lessons and observations about how SEA can better ensure the consideration of sustainability principles in electricity sector planning.

4.2 International Electricity Case Studies

Six international cases in the electricity sector were identified for review (Table 4-1). The cases were identified based on the limited academic literature on energy sector SEA and recommendations from several scholars in the field. The small number of cases covering a large geographical area was reflective of the relatively limited application of SEA in the electricity sector to date. The cases capture a spectrum of recent SEA or SEA-like application in the electricity sector, including broad policy and regional SEAs. Each of the cases demonstrates some attempt to incorporate sustainability principles in the SEA process and include sustainable development as a guiding principle or overall goal. Each case also considered ‘sustainability’ or ‘sustainable development’ as part of, or in addition to, the SEA process. Sustainability requirements ranged from regulatory or directive-based requirements to consider the sustainability impacts of electricity projects and plans, to mandates that include the electricity provider’s own sustainability objectives in the SEA process.

Table 4-1. International electricity sector SEAs

SEA Case	Application	Type[1]	Purpose	Sustainability Mandate
Ontario Power Authority Integrated Power System Plan, Canada	Provincial Plan	Informal	To prioritize how electricity is developed in the province	Ontario Reg. 424/04; Ontario Electricity Act Sec. 25.30
Nova Scotia Tidal Fundy Initiative, Canada	Regional Program	Formal	To direct the development of regional tidal energy projects and technology	Federal Cabinet SEA Directive 2004
UK Draft National Policy Statements for Overarching Energy	National Policy	Formal	To control how energy infrastructure is developed in the country	EU SEA Directive 2001/42/CE; Planning Act 2008 Sec. 5(5);
Finspång Municipal Energy Plan, Sweden	Local Plan	Formal	To strengthen municipal decision making and evaluate the SEA process	EU SEA Directive 2001/42/CE; Swedish Environmental Objectives
Portugal National Transmission Grid Plan	National Plan	Formal	To guide the development of the National Transmission Grid	EU SEA Directive 2001/42/CE.; National Decree Law 232/2007; National Sustainable Development strategy (2005); Rede Electrica Nacional's sustainability mandate
Wisconsin Strategic Energy Assessment, US	State Policy	Informal	To identify projects and address adequacy and reliability issues	Wisconsin Statutes 1.12; 196.377; and 196.491(2)

[1]Formal SEA refers to SEAs required by and conducted in accordance with SEA directive or legislation; informal SEA refers to SEA-like or ad hoc applications that reflect SEA principles and methodologies but are neither required by directive or legislation nor carry the SEA label (see Noble, 2009).

In the case of Ontario Power Authority, a provincial Crown Corporation, a long-term Integrated Power System Plan was initiated in 2005 to prioritize the development of electricity resources and to "incorporate considerations of environmental sustainability" (OPA, 2007, p. 3). Ontario Regulation 424-04 required environmental protection and sustainability to be considered when developing the plan, as well as the impact on the environment of recommended electricity projects and alternatives (Stratos, 2007). Under the Ontario *Electricity Act*, the Integrated Power System Plan was also required "to ensure the adequacy, safety, sustainability and reliability of electricity supply in Ontario", and "to promote the use of cleaner energy sources and technologies and promote economic efficiency and sustainability in the generation, transmission and distribution and sale of electricity" (Stratos, 2007, Appendix A).

The second case, an SEA of the Fundy Tidal Initiative, Nova Scotia (OEER, 2008), set out "to assess social, economic and environmental effects and factors associated with potential development of…in-stream tidal" (OEER, 2008, p. 3) and direct subsequent project level development decisions. The SEA was carried out under the Canadian federal SEA Directive (Privy Council Office and Canadian Environmental Assessment Agency, 2004). The Directive aims to ensure the consideration of environmental issues in policy, plan and program decisions consistent with federal sustainable development goals and objectives.

The third case, carried out by the UK Department of Energy and Climate Change, concerned the development of a National Policy Statement for overarching energy infrastructure initiatives in England and Wales, 2008. A sustainability assessment was required in accordance with the *Planning Act* (DECC, 2009). The policy assessment was required to "identify, describe and evaluate the likely significant social and economic effects of implementing the National Policy Statement", as well as to recommend measures to mitigate effects (DECC, 2009, p. v). An SEA was also required under European SEA directive (2001/42/EC).

The fourth case was an SEA research initiative for the local municipality of Finspång, Sweden. Led by an academic research team, the overall aim was "to strengthen municipal decision-making by applying, evaluating and developing tools for SEA in energy planning" (Martensson et al., 2006, p. 61). A suite of tools for SEA in municipal energy planning were first developed and then applied to evaluate the municipal energy plan. The municipal plan itself falls under the European SEA Directive (2001/42/CE), as well as Swedish national environmental objectives that require incorporation of issues such as biodiversity, human health, water, climatic factors, material assets and cultural heritage and landscape into the planning and assessment process (Martensson et al., 2006).

The fifth case is Portugal's National Electricity Transmission Grid development plan, undertaken by Rede Electrica Nacional in 2007. The purpose of the SEA was "to identify, describe and assess the relevant environmental and sustainability issues necessary to help, and sometimes guide, the technical strategic options that could support decisions on the solutions for the National Transmission Grid evolution" (Partidário et al., 2010, p. 1). The National Transmission Grid SEA was completed in accordance with the European SEA directive (2001/42/EC) and Portugal's National Decree Law 232/2007 (see Partidário et al., 2010, p. 1), as well as Rede Electrica Nacional's own self-stated sustainability mandate: "to conduct its business in accordance with financial, social and environmental principles of sustainable development, with social responsibility and a commitment to research and human resources development" (Rede Electrica Nacional, 2009).

The final case was the 2005 Public Service Commission of Wisconsin strategic energy assessment for the development of electricity supply options for the State from 2006 to 2012. The purposes of the assessment were to identify electricity projects, address electricity supply and reliability issues, project demand and cost, identify conservation and efficiency opportunities and assess renewable energy facilities (PSCW, 2007). The assessment was carried out under three separate State statutes requiring the assessment of the environmental impact of electricity production; the consideration of options based on energy conservation and efficiency, use of renewable energy sources and use of non-renewable energy sources; and consideration of the development and use of renewable energy sources (see PSCW, 2009a, 2009b).

4.3 Methods

Research methods consisted of a review of each of the electricity SEAs and associated planning documents, supplemented by semi-structured interviews (see Table 4-2). A total of 14 key informants were interviewed. These were individuals either directly involved with the respective SEA or intimately involved in planning and decision-making processes for the electricity PPP. Key informants were identified in the respective SEA or electricity planning reports, or on the websites of the respective agency responsible for the SEA, or recommended by other study participants. All interviews were administered over the telephone and each lasted between 30 and 110 minutes. Results were transcribed, organized, coded thematically and analyzed with the assistance of QSR NVivo© v.9, a software program designed to classify and manage qualitative information.

Table 4-2. SEA documents reviewed and key informant interviewees

Case	Key documents reviewed	Interview participants
Ontario Power Authority Integrated Power System Plan, Canada	Development of the Integrated Power System Plan; The Integrated Power System Plan for the Period 2008-2027; Supplementary Environmental Impacts Report for the Integrated Power System Plan Final Report; Ontario Power Authority Sustainable Due Diligence Assessment Final Report	Power system planner, OPA; Transmission integration planner, OPA
Nova Scotia Tidal Fundy Initiative, Canada	Fundy Tidal Energy Strategic Environmental Assessment, Final Report; The Role of Strategic Environmental Assessments (SEAs) in Energy Governance: A Case Study of Tidal Energy in Nova Scotia's Bay of Fundy; Chapter 6: Environmental Issues, Jacques-Whitford Background Report for the Fundy Tidal SEA; Bay of Fundy Tidal Energy: A Response to the SEA	Environmental planner; Nova Scotia, Environment; Nova Scotia Department of Energy
UK Draft National Policy Statements for Overarching Energy	Appraisal of Sustainability for the draft National Policy Statements for Overarching Energy (EN-1); Appraisals of Sustainability of the revised draft energy National Policy Statements: Draft Monitoring Strategy; Consultation on draft National Policy Statements for Energy Infrastructure	Energy development unit manager, DECC
Finspång Municipal Energy Plan, Sweden	Strategic Environmental Assessment in Energy Planning - Exploring New Tools in a Swedish Municipality; Do decision-making tools lead to better energy planning: Working Paper; Energy planning with decision-making tools: experiences from an energy-planning project; New tools in local energy planning: experimenting with scenarios, public participation and environmental assessment; Sweden’s Environmental Objectives in Brief; Valuation of environmentally assessed measures, basis for energy plan (translated from Swedish)	Researcher, Linkoping University ; Researcher, Blekinge Institute of Technology
Portugal National Transmission Grid Plan	First Transmission Grid Plan with Strategic Environmental Assessment in Portugal: Added Value to the Electric System; Plan of Development and Investment National Network of Transportation of Electricity 2009-2014, Report of Public Consultation Plan and Their Strategic Environmental Assessment (translated from Portuguese); Strategic Environmental Assessment of the Plan of Development and Investment National Network of Transportation of Electricity 2009-2014, Non-technical summary (translated from Portuguese); Sustainability Report for the Rede Electrica Nacional Group	SEA team leader; Rede Electrica Nacional Planning Division; Rede Electrica Nacional Equipment Division
Wisconsin Strategic Energy Assessment, US	Strategic Energy Assessment, Energy 2012, Final Report; EA of the Strategic Energy Assessment 2006-2012, Docket 05-ES-103; State Energy Policy 1.12; Renewable Energy Sources Policy 196.377	Public utility financial analyst, PSCW (x 2); Administrator, Gas and Energy, PSCW

Numerous researchers have studied sustainability in SEA (e.g., Sheate and Partidário, 2010; Noble, 2009; Soderman and Kallio, 2009; Cashmore et al., 2008). Based on the available literature, a set of three ‘sustainability themes’ were developed to guide the document analysis and interview process, including ‘sustainability context’, ‘sustainability operationalization’ and ‘sustainability outcomes’ (Table 4-3). The first theme, the sustainability context of the SEA, focused on identifying whether sustainability was explicitly or implicitly used as a guiding principle and the approach adopted toward assessing sustainability. The second theme, sustainability operationalization, focused on how sustainability principles and objectives were operationalized in the SEA and evidence of the use of sustainability-based assessment criteria and indicators. The third theme, sustainability outcomes, focused on identifying key sustainability issues that emerged from the SEA, whether participants deemed ‘more sustainable PPPs’ to have resulted, the nature of trade-offs made and whether and how the SEA increased sustainability awareness and understanding.

Table 4-3. Sustainability themes for document analysis and interviews

Sustainability theme	**Description**
Context	
Institutional requirement	Adoption of a sustainable development framework or sustainability strategy and/or regulations (from government, environmental authorities, etc)
Guiding principle	Use of sustainability or sustainable development as a guiding principle of the PPP (stated explicitly or implicitly)
Approach	Use of a triple bottom line, strictly environmental, other approach
Operationalization	
Principles and objectives	Use of sustainability principles and objectives, including how they were developed and where they came from (government, researchers, etc.)
Criteria and indicators	Use of sustainability criteria and indicators, including types of criteria used (triple bottom line, other), level (broad and general or specific and detailed) and measurability
Outcomes	
Identifying and addressing issues	Identifying and addressing key sustainability issues
PPP development	Development of a more sustainable and/or more environmentally benign PPP and/or development of more sustainable alternatives for consideration
Awareness and understanding	Opportunity for changing decision-makers’ awareness and understanding of environmental and sustainability issues (increased awareness and concern for environment, attitude and value changes, paradigm shifts, etc)
Trade offs	Opportunity to help identify trade offs

4.4 Results

Results are presented thematically in Table 4-4 for each of the six electricity sector SEAs, and summarized in the sections that follow based on each of the three themes: sustainability context, operationalization and outcomes.

Table 4-4. Overview of sustainability themes across SEA cases[1]

	Ontario	Nova Scotia	UK	Sweden	Portugal	Wisconsin
Context						
▪ Sustainability explicitly used as a guiding principle[2]	✓	✓	✓	✓	✓	✓
▪ Approach to sustainability[3]	PB	PB	TBL	ENV	TBL	TBL
Operationalization						
▪ Adopted sustainability principles and objectives	✓	✓	✓	✓	✓	✓
▪ Used assessment criteria developed from sustainability objectives to evaluate PPP alternatives			✓	✓	✓	
Outcomes						
▪ Identified and addressed key sustainability issues	✓	✓	✓	✓	✓	✓
▪ Produced more sustainable PPPs	✓	✓		✓	✓	
▪ Helped identify trade offs					✓	
▪ Increased awareness and understanding of sustainability issues		✓	✓	✓	✓	✓

[1]As reported by interview participants and evidenced in SEA or PPP documentation.
[2]Explicit: sustainable development or sustainability was clearly stated in SEA documents as a goal and/or guiding principle.
[3]Approach: TBL = triple bottom line, focused on inclusion of social, environmental and economic aspects; ENV = environmental only, focused on the biophysical environment; PB = principles-based approach, focused on the interconnections between human and ecological systems.

4.4.1 Sustainability Context

Sustainability as a guiding principle

Sustainability was identified in the SEA or electricity PPP as a guiding principle, key foundation or overarching goal in all six cases. In Portugal, the three people interviewed who were involved with the SEA application reported that sustainability was explicitly considered in practice. The SEA team leader indicated that "...SEA does not make sense outside of (a) sustainability context…if it's not within a framework of sustainability, (it) does not contribute to decision making in a(n) effective way." The participant went on to note that "the only way SEA will influence decision making is to recognize the needs and dynamics and urgencies in decision making and you can only do that in a sustainability context." In the Nova Scotia and Ontario cases, however, interview participants disagreed as to whether sustainability was an explicit goal of the SEA, versus an implied idea and not overtly shaping the electricity SEA process. In Nova Scotia case, for example, even though the SEA report explicitly stated sustainability to be a guiding principle, only one of the three interviewees said that it was an explicit consideration in practice. For the Ontario Integrated Power System Plan, one interviewee stated that "we tried to make (sustainability) explicit through planning criteria we developed…by reviewing some sustainability principles and trying to apply them to the context". Conversely, in the same case, when asked if sustainability was a guiding principle in the development of the Integrated Power System Plan, another interviewee indicated that "we're not using sustainability as part of the decision making process at all…we have the directive that outlines for us what we need to build (and) what the supply mix should be going forward. …we didn't look at it through the lens of sustainability." In a similar fashion, interviewees in the Wisconsin case indicated that sustainable development was used more implicitly "as an indirect, long term, large vision", even though the electricity plan assessment documents identify sustainability as an explicit goal.

Approach to sustainability

Half of the cases adopted a triple bottom line approach to sustainability; while two cases adopted a principles-based approach and the other a strictly environmental approach focused on the biophysical environment only. In the UK, Wisconsin and Portugal cases, interviewees reported that a triple bottom line approach was adopted in the assessment, which incorporated social, environmental and economic factors into decision making. In the UK case, for example, one interviewee said that "clean, secure and affordable energy...(are) the three pillars of sustainability for energy policy...(which) matches up quite neatly with the environmental, social and economic requirements of typical sustainability". In the Portugal case, a triple bottom line approach was also adopted. The Portugal National Transmission Grid plan addressed several social (e.g., land use), economic (e.g., energy use), and environmental (e.g. fauna impacts) factors. The SEA team leader noted that the methodology was:

> …built upon sustainability principles and the way critical decision factors are built are based on an integration of various dimensions which are typically identified as pillars of sustainability. So if you wish, sustainability is intrinsic to the methodology and the fact that we have looked at fauna, land use planning, including health and social issues, (as well as) energy and economic issues, has shown that there is a strong interest in looking at (a number of sustainability issues).

In the case of Nova Scotia and Ontario, a principles-based approach was adopted, whereby the SEA used principles that concentrated attention on the interdependencies between human and ecological well-being, rather than the three separate (triple bottom line) social, ecological and economic pillars (see Gibson, 2006a). These principles included socio-ecological system integrity, livelihood sufficiency and opportunity, intra-generational equity, intergenerational equity, resource maintenance and efficiency, socio-ecological civility and democratic governance, precaution and adaptation and immediate and long-term integration. Sweden was the only case that used a strictly environmental approach to sustainability in their SEA. In this case, the two interviewees agreed that while they recognized the need for a social, economic and environmental approach to sustainability, they focused only on environmental sustainability due to the expertise of the researchers participating in the SEA process. In this case, though, an environment-only approach was not considered to be the best approach. One interviewee indicated that "if you want to include the other two parts (social and economic aspects), you have to do that from the start and give them equal weight. We didn't do that, so that's why we failed I think".

4.4.2 Sustainability Operationalization

Adoption of sustainability objectives

All six SEAs adopted some form of sustainability objectives and principles based on established academic principles, available legislation and regulations, or based on a combination of the two. The Ontario case, for example, used Gibson's (2006) sustainability principles to guide the development of the Integrated Power System Plan. In the Nova Scotia case, Gibson's principles were used to develop ten case-specific sustainability objectives, which included ensuring that commercial application of marine renewable electricity developments do not go ahead unless a proponent can demonstrate no significant adverse effects on the Bay of Fundy region, as well as ensuring that development is planned and managed in order to provide socio-economic benefits to present and future generations, among others (OEER, 2008, p. 26). However, in both of these cases, even though sustainability principles were identified in documentation, several interviewees indicated that they were not explicitly applied in practice.

In the UK, the Department of Energy and Climate Change used key issues from the baseline information collected, as well as SEA Directive target areas to develop 14 sustainability objectives related to various environmental and socio-economic factors, including climate change, flora and fauna, raw materials, economy, water and air quality, transport, landscape, cultural heritage, and health and well-being among others (DECC, 2009). In Sweden, legislation involving national environmental objectives in such areas as clean air, the built environment, groundwater quality, zero eutrophication and reduced climate impact, among others, were adopted as sustainability objectives (SEOC, 2008). In the Wisconsin case, one participant indicated that the objectives upon which they developed their state policy were based on several state Statues, none of which explicitly mention sustainability. Wisconsin's Energy Priority Statute 1.12 states that "you should do conservation first, energy efficiency second and then do cogeneration third" and the State's Renewable Energy Sources Statute 196.377 sets minimum capacity requirements from renewable sources. As a result, their objectives included: reducing the impacts of fossil fuels on the environment in order to meet energy independence goals; ensuring that electricity ratepayers see the benefits of regional wholesale electric markets; and assuring future reliability and energy independence through effective, more comprehensive planning (PSCW, 2007).

Portugal was the only case that used both principles developed by the SEA team as well as national regulations and the electricity company's own sustainability policy to develop a framework to aid in decision making for the National Transmission Grid plan. According to one participant, "…we have not only a national sustainable development strategy published in 2005, but many private companies (and) Rede Electrica Nacional in particular, has a sustainability strategy in place. So one of the things we tried to do...was to marry the SEA with the sustainability indicators...in their sustainability report".

Use of assessment criteria and indicators

All of the cases used some form of quantitative and/or qualitative assessment criteria to assess the sustainability impacts of either the proposed or existing electricity PPP or of a set of PPP alternatives. Three cases that adopted a triple bottom line approach to sustainability (UK, Wisconsin, Portugal), as well as two cases that used a principles-based approach (Nova Scotia and Ontario), developed environmental, social and economic (triple bottom line) assessment criteria. Consistent with their sustainability approach, Sweden used environmental criteria alone. The Ontario case was the only SEA to specifically use the term "sustainability" criteria;

however, the SEA team leader in the Portugal case stated that the SEA "methodology is uniquely (designed) for sustainability and so the selection of criteria are defined to meet sustainability interconnections. Sustainability is the purpose and the assessment criteria were created with sustainability in mind." Even though assessment criteria were used in all six cases, they were used to evaluate and compare PPP alternatives and options, a noted characteristic of 'good SEA', in only three cases, namely UK, Portugal and Sweden. The other cases used assessment criteria to evaluate the potential impacts of only the prescribed PPP. The cases that used assessment criteria to evaluate PPP alternatives were also the only cases where interviewees considered the assessment criteria to be clearly developed from and/or linked to the sustainability objectives adopted at the outset of the SEA process.

The Portugal National Transmission Grid plan used criteria to evaluate five alternative electricity development scenarios. Qualitative criteria were developed in the areas of energy, fauna and land use, and included energy efficiency (management and reduction of losses in the network); fragmentation of protected areas; crossing of sensitive areas to fauna and bird species; and minimizing cumulative impacts and interference with current and potential areas of strong human presence and infrastructure, among others (Partidário et al., 2010). In the UK, criteria were also used to evaluate the National Policy Statement alternatives. Qualitative indicators were adopted in the area of climate change, for example, to determine if "the National Policy Statement will promote long term adaptation to the effects of climate change" and if "the National Policy Statement will significantly change the direct or indirect emission of carbon dioxide and other greenhouse gases" (DECC, 2009, p. 20). Sweden used criteria to evaluate alternative actions and strategies in order to determine which ones should be adopted in the municipal plan. In this case, the quantitative and some qualitative indicators included CO_2, NO_x, SO_x, CO, particle VOCs, CH_4, NH_3 and N_2O and a good built environment (Eriksson, 2004).

Amongst those cases that used criteria to evaluate only the impacts of a given PPP, Ontario assessed the Integrated Power System Plan prescribed electricity mix in terms of numerous qualitative and quantitative criteria, including feasibility, reliability, flexibility, cost, environmental performance and societal acceptance (OPA, 2007, p. 12). Nova Scotia assessed the potential impact of tidal technology on numerous qualitative biophysical and socio-economic factors, including marine birds and mammals, fish, and fish habitat, marine transportation, tourism and recreation and economic development (Jacques-Whitford, 2008). Wisconsin assessed the impact of their electricity policy using numerous quantitative criteria in the areas of reliability, adequacy, cost to consumers, environmental impact, adoption of efficiency measures, use of renewable resources and public health and safety (PSCW, 2007). Environmental impact criteria included greenhouse gas emissions, other air emissions and waste, as well as potential environmental and health impacts of transmission lines (PSCW, 2006).

4.4.3 Sustainability Outcomes

Identifying and addressing key sustainability issues

In all six cases, interviews revealed that the SEA identified and addressed key sustainability issues to varying degrees at both higher and lower levels of electricity sector decision making. In terms of higher level decision-making, one interviewee in the UK case explained that "the National Policy Statements themselves certainly address a wide range of environmental, social and economic issues…the appraisal of sustainability, I'm not really sure if it optimized the plan, but it elaborated on what the key sustainability issues were around energy policy." In regard to addressing sustainability issues at the lower tiers of decision-making, one interviewee in Nova Scotia commented that the SEA was a "method of gathering a whole lot of information that helps in sustainable development decision-making." The participant went on to explain that the project specific EA process is then "a sustainable development tool and it did help with our ability to do project specific EA for these types of projects."

In one case, that of Sweden, while interviewees indicated that there was evidence of the SEA process identifying key sustainability issues, it was less clear if those issues had been addressed as a result of the SEA process, mainly because the planning process and the SEA processes were undertaken jointly. As explained by one interviewee:

> "That is very hard to say, how (the plan) would have been without this (SEA) process. Probably worse in some sense, but (there is) still the awareness of the climate issues and (because) we have these national energy policy goals, I think that maybe the contents (of the plan) would have been similar, but the decisions in this case were much more well informed and as I said, the plan was accepted (by the municipality)."

Developing more sustainable PPPs

In four of the six cases, namely Portugal, Sweden, Nova Scotia and Ontario, interviewees indicated that the PPP was, in their opinion, 'more sustainable' after completion of the SEA. In Ontario, one interviewee stated that the PPP was more sustainable "because our plan got rid of coal, so coal was all gone, and greenhouse gases were reduced by close to 90% in the short term in the first five years of the plan". In Portugal, the plan was more sustainable on a number of different levels, including both the environment and planning processes. One interviewee noted that:

> "…I have other cases that are just as interesting, but not as successful in terms of the range of achievement…such as institutional achievement, linkage with the sustainability management framework of the company and all the embedding of the environmental as well as the sustainability issues throughout the various (planning) activities. I think this is, in fact, one of the success cases."

In the UK case, however, the opposite appeared to be true. It was reported that sustainability was used as an explicit guiding principle throughout the planning process for the National Policy Statement, but stated that "I think sustainability (was) inherent within policy already" and went on to add that "I'm not really sure what the appraisal of sustainability really added to (the National Policy Statement)...As I say, it already was sustainable, give or take…".

Helping to identify trade offs

The use of sustainability-based assessment criteria was reported to have helped in the identification of trade-offs in only one case. In Portugal, an interviewee noted that "...you very seldom have a strategy that is appropriate for all of the factors in the evaluation. Sometimes if you include one factor, you have to pay a price by adding a lasting impact on another factor. So you have to balance the best possible ends to achieve an optimal strategy...". The participant went on to add that:

> "We did not choose the most powerful alternative...from the point of view of electrical performance. We chose an alternative which seemed to us to be the best balance alternative, taking into consideration all the objectives, including sustainability and

environment. So I would say that the final outcome was to get the best balance between all of those competing objectives."

One interviewee in the Ontario case noted that, while not undertaken as part of the SEA process, the weighting of sustainability criteria would have important trade-off implications for future assessments, indicating that trade-offs are "something that we're going to have to look at in the future" but that it comes down to "the weights that we want to use." The participant explained that "one of the options might be quite expensive, but there's zero CO_2 attached to it" so the question is "are you willing to trade off the expense for it."

Increasing decision-makers' awareness and understanding of sustainability issues

The SEA process was reported to have increased decision-makers' awareness and understanding of sustainability issues in all but one case, that of Ontario. In Sweden in particular, increased awareness and understanding on behalf of decision-makers was reported as one of the main benefits of the SEA. In Portugal, an attitude shift relating to sustainability was said to have resulted due, in large part, to the SEA process. The team leader noted that "for example, the (former) director of planning, he is the guy that I have seen the most change in his attitude…(between) the first time that I met him three or four years ago and now he is a different person regarding environmental issues". In Wisconsin, awareness of sustainability issues was said to have changed the decision making context for project level decision makers. One interviewee explained that:

> "…it certainly makes the commissioners aware (and) informs (them). Unlike a construction project where someone comes in and wants to build a power plant, the commissioners are going to think back about what was written in the strategic energy assessment so that they don't look at an individual project out of context."

In Ontario, however, there appeared to be a lack of increased understanding and awareness. One interviewee noted that "people (in OPA) still consider sustainability to be a bit of a fluffy thing and they don't take it seriously…they have a certain way of doing things and environmental considerations are not top of mind". Echoing this concern, another interviewee in the case further noted that:

> "…right now we're focusing on building internal resource capability and in this business it seems that a lot of people, particularly people that have been around a while, are kind of illiterate when it comes to sustainability and perhaps a even bit fearful of the stuff. It's just a mindset…I see getting around that as being a long incremental education process, basically, but you can't go to quickly too fast...it's (about) trying to bridge the gap between those who are very much zealots for the environment and sustainability and those who think that the stuff is a waste of time (and) there's a lot of work that goes in (to)…merging somehow step by step those views together (into) our organizational awareness."

4.5 Discussion

All six cases examined demonstrated some evidence of the ability for SEA to operationalize sustainability in PPP decision-making in the electricity sector. Although some cases showed more evidence of SEA informing and influencing PPP decision-making regarding sustainability than others, several common issues emerged as important to ensuring the integration of sustainability in PPP development in the electricity sector. Each of these is addressed below along with the implications for improving sustainability in PPP development through SEA application in the electricity sector.

4.5.1 Sustainability Principles in Practice

First, the adoption of explicit sustainability goals and objectives does not necessarily mean that sustainability is actually operationalized or applied in the SEA process. In all six cases, there was a mandate to consider sustainability, of some form, in the electricity PPP and assessment process. The SEA documentation also indicated that sustainability was identified as an explicit goal in all cases and sustainability principles and objectives were identified for use in the SEA process. However, in several cases interviewees disagreed as to whether sustainability was an explicit goal of the process; other cases show that the sustainability objectives adopted at the outset of the SEA were not explicitly linked to the development of assessment criteria for the electricity PPP, which is considered by many to be one of the best ways to operationalize sustainability in SEA (Croal et al., 2010; Kuo et al., 2005; Pope et al., 2004). Thus, it appears that even though sustainability was identified in the SEA documentation as a guiding principle and sustainability objectives were set out for the SEA process, not all interviewees saw it as translating directly to practice. This suggests that, in addition to having to deal with a number of contextually specific issues and realities, planners and decision-makers may still be unclear as to how sustainability, both as an overall goal and in terms of specific objectives and criteria, can and should be operationalized in the SEA process in the electricity sector.

Although some cases suggested that practitioners struggle with how to advance sustainability in SEA from ‘good idea’ to ‘influential practice,’ others seemed to suggest that sustainability could be, and was, operationalized in the SEA process. Several cases showed that the SEA was informed by sustainability, with the purpose of the SEA process and sustainability objectives stemming from either researcher or practitioner values or higher level sustainability guidance in legislation, or both, being well-embedded in the process. The Portugal case was particularly illustrative of this, as the SEA methodology was designed for sustainability and the express purpose was to support sustainability goals in the electricity PPP assessment. Results indicate that sustainability in electricity PPP development can be supported through SEA, if decision-makers and planners understand how to integrate and operationalize sustainability goals and principles in practice. This requires better guidance on sustainability that specifies how to operationalize sustainability and advance from broad principles and objectives to direct incorporation of sustainability into SEA process steps.

4.5.2 Timing and Alternatives

Second, early SEA application that includes the generation of alternatives allows for sustainability principles and objectives to be adopted early on in the PPP decision making process and used as a basis to develop criteria with which to assess alternatives. Only three of the six electricity sector cases examined applied formal SEA frameworks early on in the PPP development process, thus allowing for the adoption of sustainability principles that were used to inform actions from the outset regarding sustainability and thus influence PPP development. Many authors have argued that the early application of SEA can lead to improved PPPs (see Therivel, 2010; D’Auria and Cinneide, 2009; Gunn and Noble, 2009b) and, additionally, that early SEA application facilitates the adoption of sustainability objectives that inform decision-making, including the identification and consideration of relevant sustainability issues (Gunn and Noble, 2009b; Liou et al., 2006; Stinchombe and Gibson, 2001).

Three of the cases examined applied assessment criteria in their SEA process to evaluate the sustainability impacts of PPP alternatives. Several authors suggest that the evaluation of alternatives based on a set of identified criteria can inform and influence PPP decision making regarding sustainability (Croal et al., 2010; Singh et al., 2009; Kuo et al., 2005; Pope et al., 2004). By developing assessment criteria based on sustainability principles and evaluating PPP alternatives against those criteria, a number of PPP options can be systematically evaluated and, presumably, a more sustainable PPP solution determined. The results of this research showed that the influence of SEA on electricity PPP sustainability was most evident in those cases that both applied SEA early on and developed alternatives for consideration in their PPP decision-making processes. The Portugal, Sweden and Nova Scotia cases, for example, demonstrated the greatest sustainability outcomes including identifying and addressing key sustainability issues, producing more sustainable PPPs, helping to identify trade-offs and increasing awareness and understanding of sustainability issues. This indicates the need for early application of SEA frameworks that allow for consideration of PPP alternatives and timely adoption of sustainability principles in order to operationalize sustainability in PPP decision-making processes in the future.

The type of assessment criteria used in the SEA process also appears to be important in terms of supporting sustainability in PPP development. In one case where an environmental approach to sustainability was adopted and ‘environment-only’ assessment criteria used, interviewees deemed it to be less than successful, or at least missing an opportunity to ensure sustainability because social and economic factors were not included. In addition, two cases that adopted a principles-based approach to sustainability used a combination of social, economic and environmental criteria to assess the impacts of their PPPs. It appears that assessment criteria used to evaluate the sustainability impacts of PPPs that include a combination of social, economic and environmental criteria provide for a more comprehensive view of sustainability in electricity PPP development.

4.5.3 Tiering and Trickle Down of Sustainability

Third, in all six cases SEA was seen as promoting some form of tiered-forward planning, where the SEA influences and sets the context for lower level assessment, thus allowing for the trickle down of strategic objectives and benefits to lower level decision-making (Sinclair et al., 2009;

Noble, 2000; Therivel and Partidário, 1996). In the Portugal and UK cases, the tiered approach adopted provided for the trickling down of sustainability from the PPP in question to the next level of planning, assessment or decision making. The SEA process was undertaken within a context of explicit sustainability; with sustainability principles and objectives developed from a triple bottom line approach; and with criteria developed from sustainability principles used to evaluate PPP alternatives. On the other hand, the Wisconsin, Nova Scotia and Ontario cases did show some evidence of tiering to lower level decision-making, including pre-screening of projects, streamlining the project approval process and setting the context and framework for potential future electricity projects, but it was not clear whether sustainability integration trickled-down. The problems was not so much the lack of tiered-forward planning, but none of the cases evaluated PPP alternatives, nor did they clearly link assessment criteria to sustainability objectives, and in two cases, SEA was applied late in the PPP development process.

That SEA is a means to support tiered-forward planning and thus the trickle-down of sustainability principles from higher to lower levels of planning, assessment and decision-making is one of its most widely discussed benefits in the academic literature (Kirchhoff et al., 2011; Stinchombe and Gibson, 2001; Therivel and Partidário, 1996); but at the same time tiering is also criticized for being over-idealistic and not reflecting real-world PPP contexts (Fischer, 2010; Nitz and Brown, 2001). The results of this research, however, indicate that tiered-forward planning does exist in some electricity sector SEAs and that when those SEAs are based on sustainability, there is evidence of, and the opportunity for, trickling-down of the benefits of sustainability integration from higher to lower tiers of planning.

4.5.4 Knowledge and Understanding of Sustainability Issues

Finally, increased awareness and understanding of sustainability issues in electricity PPPs was a major outcome identified from the SEA process. In the Sweden municipal energy plan, for example, this was identified as one of the most important aspects of the SEA process; in Portugal increased awareness led to major attitude shifts regarding sustainability. As noted by several authors, SEA can increase awareness and understanding of sustainability issues and enable transformative learning (D'Auria and Cinneide, 2009; Sinclair et al., 2009; Therivel and Minas, 2002). Results from the international electricity sector confirms that SEA can communicate environmental and sustainability problems effectively to decision makers (Vicente and

Partidário, 2006). As a result, SEA can ensure that environment and sustainability issues are identified and considered effectively in all stages of the PPP decision making process. However, it was unclear in the Sweden case as to whether the sustainability issues highlighted in the plan development process were as a result of the SEA per se. One interviewee in this case was unsure as to how effective the SEA process really was in bringing sustainability issues to light because the SEA was so well-embedded in the PPP process, thus illustrating the difficulty in determining the sustainability outcomes of fully-integrated SEA. In order to advance SEA in support of sustainability in the electricity sector, clear indicators of SEA's ability to identify sustainability issues in the PPP development process need to be established so that the benefits of SEA as an integrated part of decision-making in support of sustainability can be clearly seen and measured.

In Ontario the influence of SEA on sustainability awareness was less clear and several interviewees reported that increased understanding of sustainability issues on behalf of decision-makers was demonstrably lacking. While it appears that the SEA did highlight sustainability issues in the electricity plan, SEA was applied late in the PPP development process, alternatives to the prescribed electricity mix were not considered and assessment criteria were not clearly linked to sustainability objectives. As a result, there was little opportunity for decision-makers to consider sustainability issues and to understand the sustainability implications of alternatives to the plan. This indicates not only the need for more emphasis on early application of SEA that includes consideration of alternatives, but also research and follow-up in practice to understand better how SEA can facilitate decision-makers' understanding of sustainability issues in order to ensure sustainability integration in electricity sector planning.

4.6 Conclusion

Strategic environmental assessment is widely recognized as a tool to support sustainability in PPP development and decision making. However, the cases examined show mixed results in this regard. There was some demonstrated ability for SEA to improve the sustainability of electricity PPPs, specifically where there was early application that allowed for timely adoption of sustainability principles and consideration of PPP alternatives. There was also evidence that SEA promotes tiering of sustainability to the project level, can communicate sustainability issues effectively to decision-makers and can transform their attitudes toward sustainability. However, results also indicate a lack of 'good practice' SEA in some cases and limited evidence showing how sustainability is linked to practice, including the development of assessment criteria that are explicitly linked to sustainability objectives. Better SEA guidance is required in the electricity sector that directs 'on-the-ground' application, specifically guidance on the operationalization of sustainability from broad goals and objectives to specific criteria for electricity PPP assessment.

PREFACE TO CHAPTER 5: STRATEGIC ENVIRONMENTAL ASSESSMENT IN THE ELECTRICITY SECTOR: AN APPLICATION TO ELECTRICITY SUPPLY PLANNING IN SASKATCHEWAN, CANADA

Chapter 5 addressed the third objective of this thesis, to demonstrate, based on a case study of electricity futures in Saskatchewan, an expert-based SEA process for electricity futures analysis that incorporates sustainability principles and criteria. In this chapter, an SEA framework for electricity sector planning was developed and applied to evaluate electricity supply scenarios for Saskatchewan, Canada. The overall goal of the SEA application was to identify a preferred future electricity production path; demonstrate the application of a quantitative SEA process that operationalizes sustainability principles through the use of assessment criteria; and examine the methodological implications resulting from the application of a structured SEA framework. Results of the application identified a renewables-focused electricity supply preference, but with several implications for electricity sector investment and sustainability, including increased infrastructure requirements and increased cost of electricity. Results also demonstrate a practical approach to the operationalization of sustainability through the application of assessment criteria that are linked to higher level principles. The use of structure in the SEA process provided for replicability, transparency and the ability to quantify issues of uncertainty in PPP decision-making, while at the same time maintaining flexibility to tailor the SEA framework to the electricity sector context.

Chapter 5 has been published in the journal Impact Assessment and Project Appraisal. See: White, L., and Noble, B.F. (2012b). Strategic environmental assessment in the electricity sector: An application to electricity supply planning in Saskatchewan, Canada. *Impact Assessment and Project Appraisal*, 30(4): 284-295. DOI 10.1080/14615517.2012.746836 [Taylor and Francis]

CHAPTER 5: STRATEGIC ENVIRONMENTAL ASSESSMENT IN THE ELECTRICITY SECTOR: AN APPLICATION TO ELECTRICITY SUPPLY PLANNING IN SASKATCHEWAN, CANADA

5.1 Introduction

Strategic environmental assessment (SEA) methodology has advanced considerably over the past decade. Some have argued that good SEA methodology is flexible to context (Partidário et al., 2008; Retief, 2007a; Nilsson and Dalkmann, 2001); others have cautioned that in being flexible to context, both structure and consistency must be maintained (Browne and Ryan, 2011; Therivel, 2010; Gunn and Noble, 2009a). Flexibility is a defining principle of SEA, if not one of its strengths; however, methodological flexibility can pose significant challenges to both the practitioner and decision maker (see Noble et al., 2012; Liou et al., 2006).

The aim to ensure flexibility in SEA has resulted in guidance that is often too generic, leading to criticisms of SEA as ad hoc, vague or inconsistent (see Retief, 2007a; Auditor General, 2004), treating SEA simply as a less detailed and less structured form of impact assessment. The result has often been criticism by decision makers of the uncertain results emerging from SEA due, in part, to the unverifiable nature of the approach and methods used (Noble et al., 2012). Part of the issue is that, in an attempt to be flexible, the range of methods and approaches used in SEA practice and recommended in guidance is restrictive and limited to a number of common, qualitative based methods with more analytical-based and quantitative approaches being underutilized and under promoted (Noble et al., 2012). Quantitative-based approaches to SEA have been criticized for leading to "fictitious precision" due to the "fuzziness" of PPP issues (Sommer, 2005, p. 60). Arguably, structured and systematic methodology characterized by quantitative design does not diminish SEA's ability to be flexible or sensitive to context; and there are quantitative approaches to capture the fuzziness of PPP issues and to ensure a more systematic and verifiable approach to assessment and decision making. Such approaches have received relatively little attention in the SEA literature and there are few examples demonstrating how a systematic and quantitative SEA design can be sensitive to context and to the fuzziness of PPP issues – particularly sustainability, which itself has proven difficult to operationalize (see Bina, 2007; Brunner and Starkl, 2004).

This paper demonstrates a structured, quantitative approach to SEA in the context of electricity sector planning in Saskatchewan, Canada. The purpose is to present a structured SEA methodology for addressing complex and often fuzzy PPP issues, with the aim to operationalize sustainability considerations in the assessment process. The transportation and land use planning sectors have amassed substantial SEA knowledge (see Marshall and Fischer, 2006; Dalal-Clayton and Sadler, 2005), but SEA has yet to be applied on a similar scale in the electricity sector (Jay, 2010). Jay and Marshall (2005) cite several concerns with SEA in the electricity sector, including the limited scope of application (supply and conservation, rather than networks), as well as application on too broad (at a policy level) or too narrow (specific energy sectors) a scale to be useful. As Schenler et al. (2002, p. 8) note, there is a demonstrated need for a "planning methodology framework that will assist decision-making process consistently with the long-term sustainable development of the electricity sector." In the sections that follow the context for the SEA application is introduced, followed by the SEA design, methods and results. Attention then turns to lessons emerging for electricity sector planning and SEA methodology more broadly.

5.2 Electricity Sector Planning in Saskatchewan, Canada

Electricity generation and distribution in Canada fall under provincial jurisdiction. In each province, rules are set which regulate the operation of electricity suppliers in the region and retail level. In Saskatchewan, wholesale electric power is supplied and purchased by the Saskatchewan Power Corporation (SaskPower), a provincial crown corporation which it distributes directly to retail customers in most of the province, with the exception of two municipal franchises in Saskatoon and Swift Current. The municipal franchises have no generation capacity and in the past few decades have only purchased electricity from SaskPower.

Saskatchewan, a western prairie province, is about 650,000 km^2, with a population of just over 1 million. Between 2006 and 2011, the province experienced a 6.7% population increase, mainly due to growth in the large-scale industrial and commercial sectors. Saskatchewan's economy is based primarily on the agricultural, mining (uranium potash, coal) and petroleum and natural gas sectors and has led Canada in growth of real GDP per capita in recent years (Richards et al., 2012). Saskatchewan's net electricity generation capacity for 2009 was 3,840 MW, including 43.8% conventional coal, 29.5% natural gas (including 21.2% single cycle and 8.3% combined cycle natural gas), 22.2% hydro and 4.5% wind (SaskPower, 2010). Provincial electricity demand has grown, on average, 1.3% per year over the past ten years and is expected to grow by up to 3% per year in the next decade (SaskPower, 2010). Increased demand will require a projected new and replacement generation capacity of 4,100 MW by 2030, which is greater than the total generation capacity in 2009 (SaskPower, 2010).

There is a significant need for long-term strategic planning and assessment to guide the development of Saskatchewan's electricity sector (see Bigland-Pritchard and Prebble, 2010). However, there is no formal SEA system in Saskatchewan and no strategic framework to guide the development and evaluation of alternative electricity production options. Environmental assessment in Saskatchewan is project-based under *The Saskatchewan Environmental Assessment Act*. There is some provision under the Act for the environmental assessment of plans, but this provision is limited to the forestry sector (see Gachechiladze et al., 2009).

5.3 Strategic Environmental Assessment Framework

The sections that follow present the SEA framework and methods developed and applied to the Saskatchewan electricity sector. The SEA was undertaken by the authors as part of a research program to provide guidance to electricity planning in Saskatchewan, and not as a formal initiative of the provincial government. The overall assessment framework was informed by conceptual guidance on SEA methodology (e.g. Croal et al., 2012; Gunn and Noble, 2009a), drawing also on analytical and decision support tools for SEA application (e.g. Schetke et al., 2012; Noble and Storey, 2001). After establishing the context of and need for SEA, in section 5.2, the framework consisted of the following:

i) identifying SEA participants;
ii) developing assessment criteria;
iii) identifying PPP alternatives;
iv) assessing alternatives against the criteria;
v) examining potential trade-offs and identifying a preferred alternative(s); and
vi) determining the sensitivity of the assessment results to uncertainties and changing PPP conditions.

5.3.1 Expert-based Assessment Panel

An expert panel was assembled for the assessment; a combination of expert knowledge and practical experience is the typical approach to SEA application (Bao et al., 2004). Potential participants were sampled from stakeholders with expertise in electricity planning, energy development or environmental assessment, including environmental non-government organizations (E-NGOs), provincial energy crown corporations, regulators, industry and environmental consulting organizations. A few initial informants were contacted and asked to identify other potential participants. A total of 173 individuals were invited, of which 44 people (25.4%) agreed to participate: 17 (38.6%) from government, including municipal and provincial ministries involved in electricity planning and environmental assessment; 15 (34.1%) private sector, including business and industry; and 12 (27.3%) E-NGOs.

5.3.2 Assessment Criteria

The criteria against which to assess electricity alternatives were identified before the development of alternatives, ensuring that criteria selection was not biased by the alternatives (see van Huylenbrock and Coppens, 1995). A preliminary list of criteria was derived from a review of recent plans and assessments in the international electricity sector, so as to ensure context appropriate criteria (see Partidário et al., 2010; DECC, 2009; OPA, 2008; OEER, 2008; PSCW, 2007; Martensson et al., 2006), and drawing also on impact assessment and sustainability literature in energy sector planning (see Jay, 2010; LaRovere et al., 2010; Kowalski et al., 2009; Wang et al., 2009). The preliminary criteria were reviewed by a subset of the expert panel, who were asked whether criteria were missing and, if so, to include them in the list and then rank the criteria based on importance for consideration in electricity planning. Responses were compiled into a final set of criteria (see Table 5-1) that attempted to operationalize a number of high-level sustainability principles (see Gibson, 2006b) within the context of applied SEA for electricity sector planning, namely: inter- and intra-generational equity (e.g. C5, C8); resource maintenance and efficiency (e.g. C6); socio-ecological system integrity (e.g. C2, C4); livelihood and sufficiency of opportunity (e.g. C3, C7); precaution and adaptation (e.g. C1); and socio-ecological civility and governance (e.g. C7).

Table 5-1. SEA sustainability criteria for the electricity sector

Criteria	Descriptions
C1: Adaptive capacity	maximizes the ability to accommodate projected, as well as unanticipated future demand growth
C2: Emissions management	minimizes emissions to air and water during electricity production, distribution and use over the life cycle of the system
C3: Employment and income sufficiency	maximizes short and long-term income and employment opportunities
C4: Ecological integrity	ensures biodiversity conservation and ecological resiliency by minimizing use and disturbance of land & water resources
C5: Security of supply	ensures secure and affordable access to electricity supply for current & future generations
C6: Electricity production and transmission efficiency	meets electricity demands while minimizing energy use, raw material use and generation of waste during production and energy loss during transmission
C7: Aboriginal rights	minimizes infringement on culture, traditional land use practices and Treaty Rights
C8: Public health and safety	minimizes risk to public health and safety during electricity production and transmission

5.3.3 Electricity Alternatives

Five policy-level electricity alternatives were developed, each describing an electricity mix for Saskatchewan over the next 30 years (Fig. 5-1). An energy futures focus group of five individuals assisted in the development of scenarios. Focus group members were identified from among energy experts and provincial energy crown corporations based on their expertise and knowledge of the electricity sector. Draft scenarios were developed based on an analysis of SaskPower's assessment of electricity supply and demand in the province (SaskPower, 2010), and presented to the group for comment. The five alternatives are as follows:

Alternative 1 (A1): A continuation of the current electricity production mix over the next 30 years. This could occur if there is a lack of substantial climate change policy, as well as limited research and development of new and renewable technologies. New conventional coal, single and combined cycle natural gas, hydro and wind facilities would likely be built.

Alternative 2 (A2): An increased focus on nuclear electricity production, while still including other traditional means of production. This could occur if climate change policy were to be adopted that restricts or places heavy penalties on carbon emissions from coal produced electricity. New small-scale nuclear, combined cycle natural gas, hydro and wind facilities would likely be built. No new conventional coal facilities or single-cycle natural gas facilities would be built. Several new small scale nuclear power units with capacity no larger than that of current coal facilities (300 to 500 MW) would likely be built. It is assumed that reactors are built in areas with a sufficient workforce, access to cooling water and access to power markets.

Alternative 3 (A3): An increased focus on renewables, including run-of-river hydro, reservoir hydro, biomass and wind, and small-scale on-site renewables. This could occur if climate change policy were to be adopted that restricts or places heavy penalties on carbon emissions from coal produced electricity. New single and combined-cycle natural gas, hydro, biomass and wind facilities would likely be built. No new conventional coal facilities would be built. Use of small-scale renewables including solar, wind, biomass and other industry-scale or community-scale renewable electricity generation increases demand for local transmission networks. Due to cost, it is assumed that solar technologies can only be implemented on a limited scale; and large-scale biomass facilities will be feasible. Electricity from biomass and hydro projects provide an additional benefit of efficient near-site electricity in remote communities, resulting in reduced power losses from transmission from distant facilities. Electricity generated through renewable technologies is much more variable than other generation technologies and, as a result, have implications regarding the reliability of power supply. Reliance on wind and run-of-river hydro has the potential to decrease system reliability. This reduced reliability is offset with simple cycle natural gas peaking facilities, an additional 10% in the electricity mix.

Alternative 4 (A4): An increased focus on large scale carbon capture and storage (CCS) replacing the majority of conventional coal generated portion of the electricity mix, while still including other traditional means of electricity production. This could occur if climate change policy were to be adopted that restricts or places heavy penalties on carbon emissions from coal produced electricity. New CCS coal, combined-cycle natural gas, hydro and wind facilities would likely be built. No new conventional coal facilities or simple cycle natural gas facilities would be built.

Alternative 5 (A5): An increased focus on electricity produced from natural gas, while still including other traditional means of electricity production. This could occur if there is a lack of substantial climate change policy instituted in the country, as well as limited research and development of new and renewable technologies. New single and combined-cycle natural gas, conventional coal, hydro and wind facilities would likely be built.

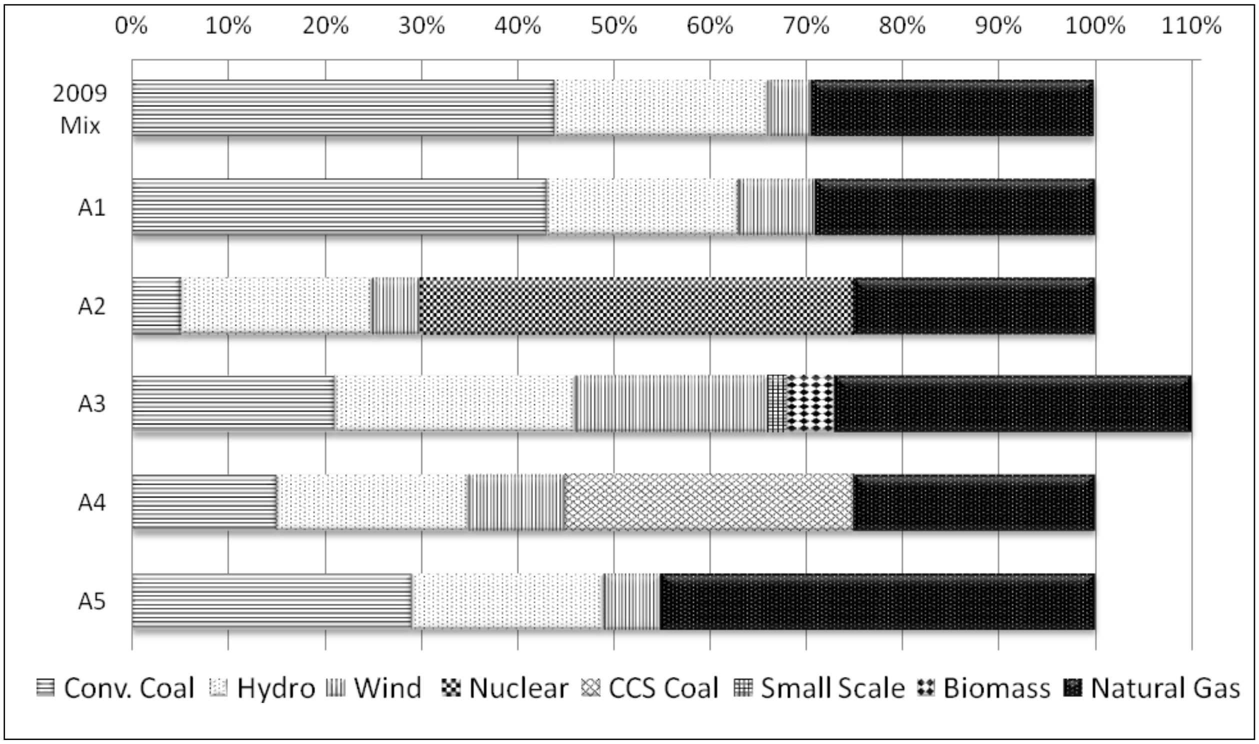

Figure 5-1. Resource mix for the current electricity regime in Saskatchewan and five electricity alternatives. (Conv. Coal = conventional coal; CCS Coal = carbon capture and storage coal; Small Scale = small scale on-site renewable electricity)

All alternatives were based on the assumptions that: i) industrial and residential demand side management efforts will continue; ii) peak load (demand) in the province will continue to grow from 1.3% to 3% per year, resulting in total electricity demand by 2040 ranging from 4,720 MW to 7,905 MW; iii) generating capacity in the province will continue to grow anywhere from 1.3% to 3% per year, resulting in total electricity production by 2040 ranging from 5,660 to 9,320 MW; v) solar power is not suitable for large-scale generation because of its high cost and low capacity factors; and v) the majority of electricity is generated and consumed within Saskatchewan (see SaskPower, 2010) (Table 5-2).

Greenhouse gas (GHG) emissions were calculated based on the electricity mix for each alternative over a one year period for a generation capacity in 2025 of 4,830 MW, using averages presented by Bigland-Pritchard and Prebble (2010)[1]. For comparison purposes, GHG emissions for 2009 were approximately 14 million tonnes of CO_2 (from SaskPower, 2011), based on

[1] Load factors are based on SaskPower (conv. coal, wind), the project's advisory committee (simple cycle, combined cycle natural gas, hydro, CCS coal) and Graham et al., 2005 (nuclear, small scale, biomass). Load factor is the ratio of average load (intensity of usage) to generation capacity in a period, or a measure of the actual output of a power plant compared to its maximum theoretical output. Small scale GHG emission rates and load factors were based on solar photovoltaics. An additional 10% of simple cycle natural gas is included in A3. It was assumed that simple cycle and combined cycle natural gas facilities have the same GHG emission intensity.

19,864 GWh of total electricity supplied. The cost of electricity was estimated based on capital costs, power operation and maintenance costs.[2] The average cost of electricity in 2009 at the generation plant before transmission and distribution was approximately 6 ¢/kWh (SaskPower, 2010). Natural gas prices have been highly variable in the past. This may increase the future cost of alternative *A5*, which relies heavily on natural gas.

Table 5-2. Required generation capacity, emissions, and electricity costs in 2040 for alternatives A1 to A5.

	2009	*A1*	*A2*	*A3*	*A4*	*A5*
Required generation capacity (MW)						
Conventional Coal	1,690	2,524	294	1,233	881	1,702
Hydro	845	1,174	1,174	1,468	1,174	1,174
Wind	173	470	294	1,174	587	352
CC Natural Gas	320	763	704	1,057	704	1,468
SC Natural Gas	813	939	763	1,115	763	1,174
Nuclear			2,642			
CCS Coal					1,761	
Small Scale				117		
Biomass				294		
GHG emissions* (million tonnes CO_2e/yr)	14.0	19.6	7.3	11.5	8.0	15.7
Cost of electricity ($/kWh)	0.06	0.11	0.12	0.14	0.13	0.10

*GHG emissions were calculated for the year 2025, with the exception of 2009 values; Notes: CCNG = combined cycle; SCNG = simple cycle; CCS coal = carbon capture and storage coal

5.3.4 Assessment Methods

Methods used in SEA have significant bearing on the nature and quality of information made available to support decision-making (Noble et al., 2012). To address the fuzzy nature of sustainability and impact assessment at the PPP level, the assessment adopted a multi-criteria analytical (MCA) approach. Multi-criteria analysis is useful when problems involve multiple criteria and options, and when problems are complex and characterized by competing knowledge and values (Kain and Söderberg, 2008; Herath and Prato, 2006). Multi-criteria analysis "aims to improve decision making by making choices about conflicting or multiple objectives explicit, rational and efficient" (Finnveden et al., 2003, p. 102).

The expert panel assessed the electricity alternatives utilizing Saaty's (1982) analytical hierarchy process (AHP) – a multi-criteria decision-aid for prioritizing alternatives using multiple criteria. The AHP uses a weighted sum method where weights are applied to criteria

[2] Capital and power costs are from SaskPower. Power costs include load factors and the impact of a cost of carbon on GHG emissions and sales revenue for CO_2 captured inA4. Power cost for a simple cycle option is not applicable as it typically has low capacity factors due to its peaking operation. Power cost for nuclear includes an allowance for decommissioning and interim fuel storage in A2.

based on ratio scales derived from paired comparisons (Wang et al., 2009), thereby enabling "decision makers to structure a complex problem in the form of a simple hierarchy and to evaluate a large number of quantitative and qualitative factors in a systematic manner under multiple conflicting criteria" (Lee et al., 2007, p. 2863). The approach allows for the management of complex knowledge in planning for sustainability, but also provides an explicit measure of inconsistency (i.e., a consistency ratio), or internal conflict, in an individual's assessment (Saaty, 1982) as an indicator of the overall quality of the assessments (Noble, 2004b).

The AHP was administered using Expert Choice © web-based Comparion Suite software. Participants were asked to indicate the relative importance of each criterion when making decisions about electricity futures (see Fig. 5-2) by weighting the criteria, pairwise, using a nine-point reciprocal scale from 1 (criterion i and criterion j are of equal importance) to 9 (criterion i is extremely more important than criterion j) to 1/9 (criterion j is extremely more important that criterion i) (see Saaty, 1982). Participants were then asked to assess each of the five electricity alternatives on the basis of each criterion using the same AHP paired comparison approach (see Fig. 5-3).

Figure 5-2. Illustration of pairwise criterion weighting for 'adaptive capacity' (C1) and 'emissions management (C2) in Expert Choice, online version based on decision goal 'identifying a preferred electricity future for Saskatchewan'.

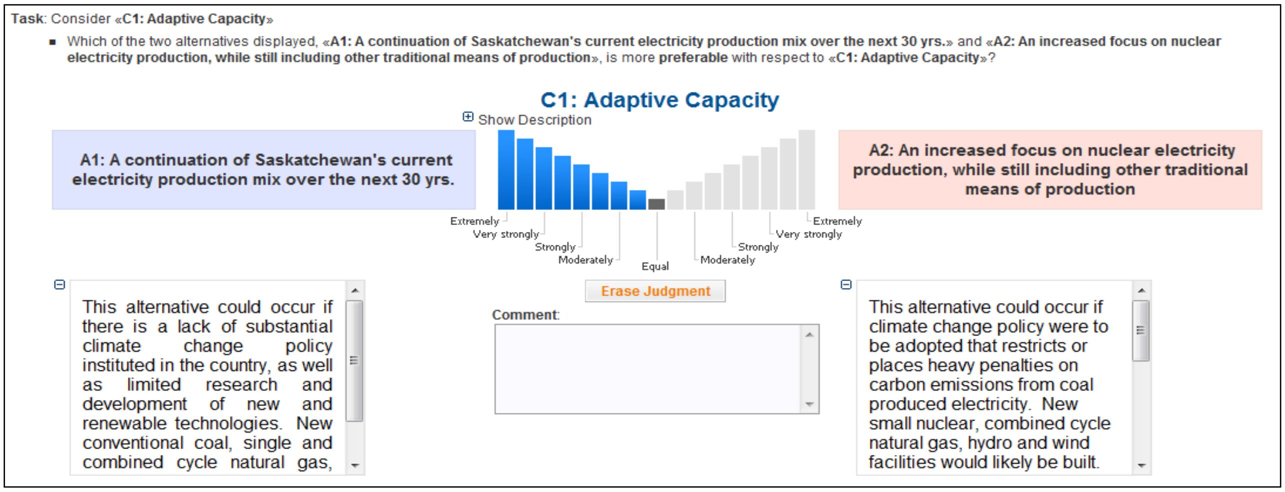

Figure 5-3. Illustration of pairwise alternatives assessment (A1 and A2) on the basis of criterion C1 'adaptive capacity' in Expert Choice, online version.

5.3.5 Data Analysis

Results were analyzed using MCA and exploratory statistics to determine an overall ranking of electricity production alternatives based on the set of criteria. An assessment matrix was developed with the pairwise comparison scores for each participant. Following Saaty (1980), eigenvectors were then calculated using Expert Choice v.11 software for each assessment matrix to derive the weight of each criterion and a score for each alternative on the basis of each criterion.

Results were aggregated for the panel and analyzed using exploratory data analysis (EDA) in IBM SPSS v.18 statistical software package. Exploratory data analysis is well suited to SEA applications where data are often limited, but where there is a need to systematically assess competing options across multiple criteria. Non-parametric statistics were used to confirm EDA results. Preference scores for electricity production alternatives were weighted using normalized criterion weights, so as to account for the relative significance of each criterion and allow an overall assessment of electricity production alternatives. A concordance analysis was used to test the robustness of the ranking of electricity production alternatives derived from the AHP process (Equation 5.1):

$$c_{ii'} = \frac{\left(\sum_{j \epsilon c(ii')} w_j + \sum_{j \epsilon c(ii')} w_j\right)}{\left(\sum_{j=1}^{m} w_j\right)} \qquad \text{(Equation 5.1)}$$

where $c_{ii'}$ = concordance set *ii'*, *w* = the weighted impact score, *i* = alternative *i*, *j* = alternative *j*.

An index of similarity (*S*) (Equation 5.2) was used to determine how similar the ordering of alternatives was between the concordance analysis and the AHP.

$$S = \frac{d}{\left\lfloor \frac{n(n-1)}{2} \right\rfloor} \qquad \text{(Equation 5.2)}$$

where *d* = the number of times the paired comparisons of a particular order agrees with the paired comparison values in the concordance matrix; *n* = number of observations. To determine the magnitude of the differences among the ranking of alternatives, an interval ranking was performed based on Euclidean distance (Equation 5.3).

$$Standardized\ scaling\ parameter\ i = \frac{i - i_{min}}{i_{max} - i_{min}} \qquad \text{(Equation 5.3)}$$

where i_{min} and i_{max} represent the minimum and maximum values of the concordance sets, respectively.

5.3.6 Sensitivity Analysis

Before a preferred option is identified some form of 'sensitivity analysis' is needed (Noble and Storey, 2001). Sensitivity analysis allows the SEA analyst to examine the implications of the fuzziness of strategic-level decisions, the uncertainties associated with changing PPP conditions, and the subjective judgements and inconsistencies of SEA participants. First, a sensitivity analysis was performed to address inconsistencies in the assessment of alternatives, as well as uncertainties in the assignment of criterion weights. Inconsistent responses could originate from a participant's lack of understanding of the problem, uncertainty in assigning assessment scores due to the complexity of the problem, incomplete information or intentional misrepresentation (Noble, 2004b). The sensitivity analysis in this case involved removal of inconsistent responses to determine if the ranking of electricity production alternatives changed significantly.

Second, sensitivity tests were performed to assess the robustness of the final ranking of alternatives against changing PPP conditions, as represented by changes in criteria weights under a series of "what if" scenarios. The first sensitivity test (S1) examined the extent to which the final ranking of alternatives was contingent on continued economic growth in the province. The weight of C3 was increased to reflect an increase in the importance of ensuring employment and income sufficiency during a period of economic stagnation, and the weight of C2 decreased to indicate a trade-off of environmental standards. The second sensitivity test (S2) examined the impact of an increase in the weight of C7, Aboriginal rights, in a scenario where electricity development or distribution in the province was contingent upon access to Aboriginal lands or settlement of Treaty rights. The third sensitivity test (S3) examined the impact of a scenario where recent international nuclear incidents resulted in increased concerns over public health and safety (C8) and emissions management (C2) in electricity production.

5.4 Assessment Results

5.4.1 Criteria Weights

The median weights for the assessment criteria are presented in Table 5-3. Health and safety (C8) and security of supply (C5) were the most important criteria with respect to electricity development, closely followed by ecological integrity (C4) and energy production and transmission efficiency (C6). Aboriginal rights (C7) was identified as the least important criterion, followed by employment and income sufficiency (C3). Based on the 95% confidence intervals for the median, the ranking of criteria for consideration in electricity sector planning in Saskatchewan was as follows: C8 > C5 *I* C4 *I* C6 *I* C2 *I* C1 > C3 I C7, where '>' indicates a significant difference between criteria based on median weights, and '*I'* indicates indifference.

Table 5-3. Criterion weights and 95% confidence interval for the median

Criteria	Median	95% CI
C1 - Adaptive capacity	0.0995	±0.0224
C2 - Emissions management	0.1110	±0.0336
C3 - Employment and income sufficiency	0.0410	±0.0105
C4 - Ecological integrity	0.1280	±0.0277
C5 - Security of supply	0.1320	±0.0326
C6 - Energy production and transmission efficiency	0.1210	±0.0174
C7 – Aboriginal rights	0.0400	±0.0135
C8 - Public health and safety	0.1920	±0.0351

95% CI = 95% confidence interval for the median. The 95 percent confidence interval for the median is a distribution free statistic calculated as follows: Upper and lower fence = median ± (1.58 x (H-spread)/√n). The H-spread is the difference between Tukey's upper and lower hinges and is the range covered by the middle half of the data (approximately the 25th and 75th percentile of the mean); n = 44 participants.

5.4.2 Electricity Production Preference Scores

The median preference scores and 95% confidence intervals for electricity alternatives, weighted based on the criterion weights (Table 5-3), are shown in Table 5-4. Alternative A3, the renewables focused alternative, was the preferred alternative, followed by A5 and A2, the natural gas and the nuclear focused alternatives, which were scored at 0.127 and 0.125, respectively. Alternative A4, the carbon capture and storage option was scored at 0.113. The least preferred was A1, a continuation of the current electricity mix, scored at 0.069. Based on a Wilcoxon test for difference, the panel's ranking for the province was as follows: A3 > A5 *I* A2 *I* A4 > A1, where '>' indicates a significant difference between alternatives based on weighted assessment scores, and '*I*' indicates indifference.

Table 5-4. Weighted aggregate preference matrix.*

	A1W		A2W		A3W		A4W		A5W		NW
Criteria	**Median**	**95% CI**	**Median**	**95% CI**	**Median**	**95% CI**	**Median**	**95% CI**	**Median**	**95% CI**	
C1	0.0064	±0.0021	0.0157	±0.0077	0.0244	±0.0088	0.0088	±0.0054	0.0165	±0.0048	0.1151
C2	0.0062	±0.0018	0.0239	±0.0064	0.0455	±0.0183	0.0193	±0.0057	0.0128	±0.0039	0.1284
C3	0.0026	±0.0009	0.0070	±0.0023	0.0123	±0.0052	0.0052	±0.0017	0.0047	±0.0013	0.0474
C4	0.0068	±0.0022	0.0163	±0.0053	0.0307	±0.0179	0.0134	±0.0044	0.0136	±0.0064	0.1481
C5	0.0133	±0.0074	0.0209	±0.0072	0.0193	±0.0075	0.0148	±0.0073	0.0194	±0.0080	0.1527
C6	0.0087	±0.0017	0.0178	±0.0066	0.0384	±0.0118	0.0130	±0.0035	0.0186	±0.0054	0.1400
C7	0.0074	±0.0022	0.0047	±0.0026	0.0081	±0.0034	0.0094	±0.0039	0.0085	±0.0025	0.0463
C8	0.0178	±0.0048	0.0187	±0.0117	0.0638	±0.0196	0.0287	±0.0088	0.0331	±0.0094	0.2221
Sum	0.06933		0.12503		0.24256		0.11263		0.12722		1.0000

* A1'W' = 'weighted' alternative based on median criteria weights; NW = normalized criteria weights; 95% CI = 95% confidence interval for the median; n = 44 participants.

5.4.3 Results by Participant Group

Criterion weights by group

Median criterion weights calculated by group are shown in Table 5-5. The 95% confidence interval indicates that for government participants and E-NGOs, criteria weights were statistically indifferent. For the private sector, criteria C2, C8, C4, C6, C5 and C1 were statistically indifferent but they were weighted more heavily than C3 and C7, which were also indifferent from each other.

Table 5-5. Criterion weights and 95% confidence interval for the median by group

Criteria	Government (G1) Median	95% CI	Private Sector (G2) Median	95% CI	E-NGOs and (G3) Median	95% CI
C1	0.101	±0.053	0.090	±0.028	0.120	±0.079
C2	0.093	±0.025	0.193	±0.074	0.107	±0.051
C3	0.030	±0.020	0.033	±0.015	0.047	±0.018
C4	0.072	±0.046	0.132	±0.050	0.150	±0.091
C5	0.182	±0.069	0.101	±0.047	0.109	±0.048
C6	0.114	±0.017	0.114	±0.034	0.138	±0.038
C7	0.050	±0.041	0.024	±0.023	0.037	±0.013
C8	0.193	±0.050	0.191	±0.055	0.194	±0.094

*Differences between criteria confirmed by Tamhane post-hoc test for sig. value ≤ 0.05.

Using normalized criteria weights (Table 5-5), the aggregate ranking of alternatives is A3 > A2 > A4 > A5 > A1. Weighted alternative rankings, using normalized criteria weights, were determined for each of the participant groups (Fig. 5-4, Table 5-6). For the aggregate panel, and for all sub-groups, alternatives A2, A4 and A5 were statistically indifferent. Based on participant group, government, private sector and E-NGOs consistently showed a demonstrated preference for A3, with A1 consistently the least preferred. This is consistent with the results of the aggregate panel, suggesting that the aggregate assessment scores captured the preferences of each of the stakeholder groups.

Alternatives A2, A4, A5, however, for the aggregate panel and for the sub-groups, differ in terms of rankings. Even though these alternatives are considered to be statistically indifferent, the aggregate assessment scores do not capture the preferences of the stakeholder groups. This indicates that there are differences between the aggregate panel and the stakeholder groups, as well as among the stakeholder groups themselves, regarding alternative preferences.

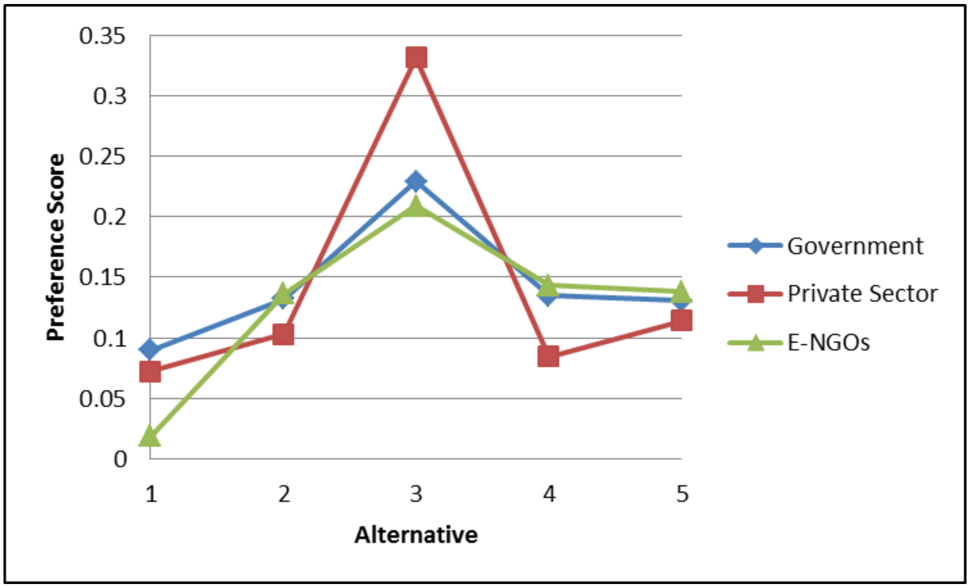

Figure 5-4. Weighted alternative preference scores by group.

Table 5-6. Alternative rankings

Participant group	**Alternative Preference**
All Participants	A3 > A2 *I* A4 *I* A5 > A1
Government (G1)	A3 > A5 *I* A2 *I* A4 > A1
Private Sector (G2)	A3 > A2 *I* A5 *I* A4 > A1
E-NGOs (G3)	A3 > A2 *I* A5 *I* A4 > A1

'>' indicates significance difference between alternatives, based on Wilcoxon test, $p \leq 0.05$; I = statistical indifference between alternatives, based on Wilcoxon test, $p \leq 0.05$.

5.4.4 Robustness of Assessment Results

Concordance analysis

Results of the concordance analysis (Table 5-7) on the normalized weighted aggregate preference scores (see Table 5-5) confirmed the AHP ranking of electricity alternatives. An interval ranking of alternatives, based on the scaled concordance results and Euclidean distance, is shown in Figure 5-5. Results indicate that A3, the renewables alternative, was consistently the most preferred. For the aggregate panel, A3 was three times as preferred as the next alternative, A5, the natural gas alternative. The private sector was similar to the aggregate panel; however, for the private sector A3 was more than six times preferred to A5. The government and E-NGO groups similarly identified a strong preference for A3; however, there were more competing alternatives for each of these groups with respect to A4, A2 and A5. For the government group, A3 was more than three times preferred to A4; for the E-NGOs, A3 was only 1.5 times more preferred than A4. Across all groups, A1, the status quo, was consistently the least preferred.

Table 5-7. Concordance matrix and AHP matrix for alternative preference using normalized criteria weights.

Group	Concordance Matrix*	AHP Matrix
Aggregate panel	A3 > A2 > A5 > A4 > A1	A3 > A2 > A5 > A4 > A1
Government (G1)	A3 > A5 > A2 > A4 > A1	A3 > A5 > A2 > A4 > A1
Private Sector (G2)	A3 > A2 > A5 > A4 > A1	A3 > A2 > A5 > A4 > A1
E-NGOs (G3)	A3 > A2 > A5 > A4 > A1	A3 > A2 > A5 > A4 > A1

*Index of similarity = 1.0 for the concordance analysis

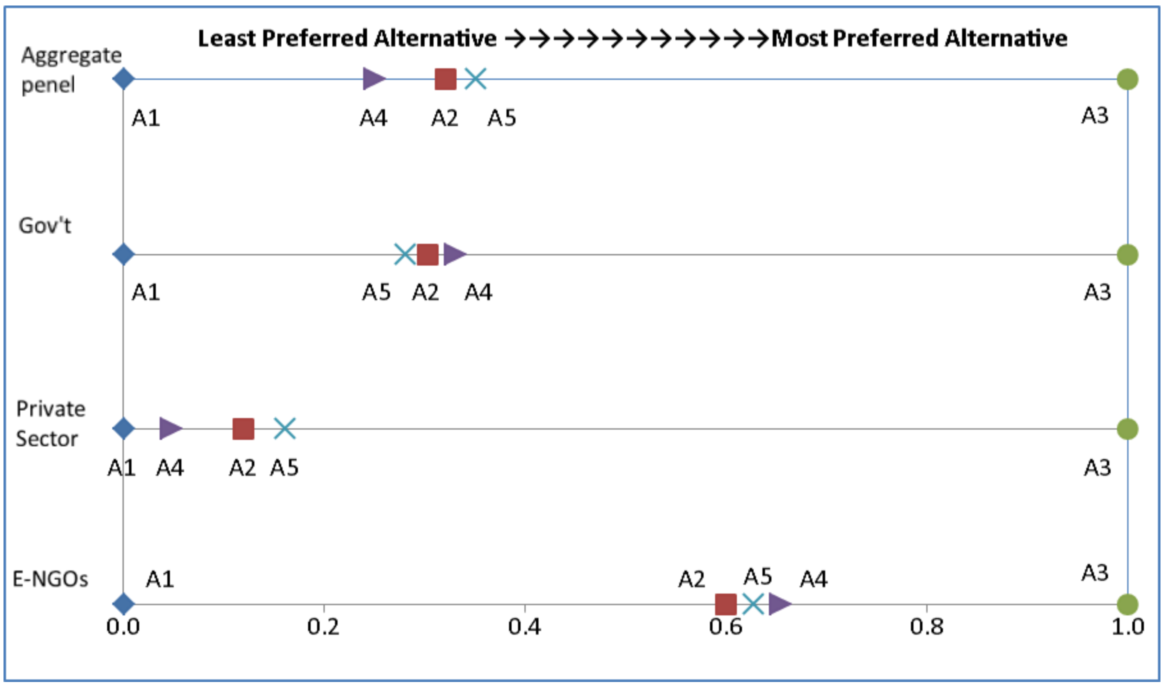

Figure 5-5. Scaled alternative preference scores by group.

Sensitivity analysis

A sensitivity analysis was performed on the consistency ratio (CR), derived from the AHP, as well as changes to criteria weights. The CR of an assessment matrix is a measure of how the assessment scores compare to a random matrix; a normal consistency ratio is considered to be 0.1 (Saaty, 1980). The mean consistency ratio of all responses was 0.142; approximately 18.5% of responses had a consistency ratio of 0.2 or greater. Hence, 0.2 was chosen as an acceptable level of inconsistency. Rather than the number of inconsistent responses, what is important is how the inconsistencies affect the decision results. The aggregate assessment matrix was recalculated from the AHP results with individual responses with a CR>0.2 removed. Results showed a ranking of electricity production alternatives based on those responses with a CR < 0.2 as A3 > A5 > A2 > A4 > A1, which is not different than the aggregate AHP results in Table 5-4. Inconsistent responses, which may be due to the complexity of the problem at hand or a lack of detailed information on the alternatives, had no significant influence on the overall results.

A set of three sensitivity tests was used to see if changes in criteria importance affected the alternative rankings (Fig. 5-6). In S1, with a 95% increase in C3, employment and income, the ranking remained unchanged indicating that the ranking is robust against significant changes in priorities regarding employment and income sufficiency. In S2, a 95% increase in C7, Aboriginal rights, resulted in a change to the ranking such that A3, the renewables alternative, was no longer preferred. This indicated that if Aboriginal rights were to become more important in terms of access to lands for electricity production or distribution, then A5, the natural gas alternative, would out-compete A3. Relative preference for the status quo (A1) would increase slightly, and A2 would be the least preferred. In S3, with an 80% increase in C8, public health and safety, the overall ranking again remained unchanged, indicating a robust ranking.

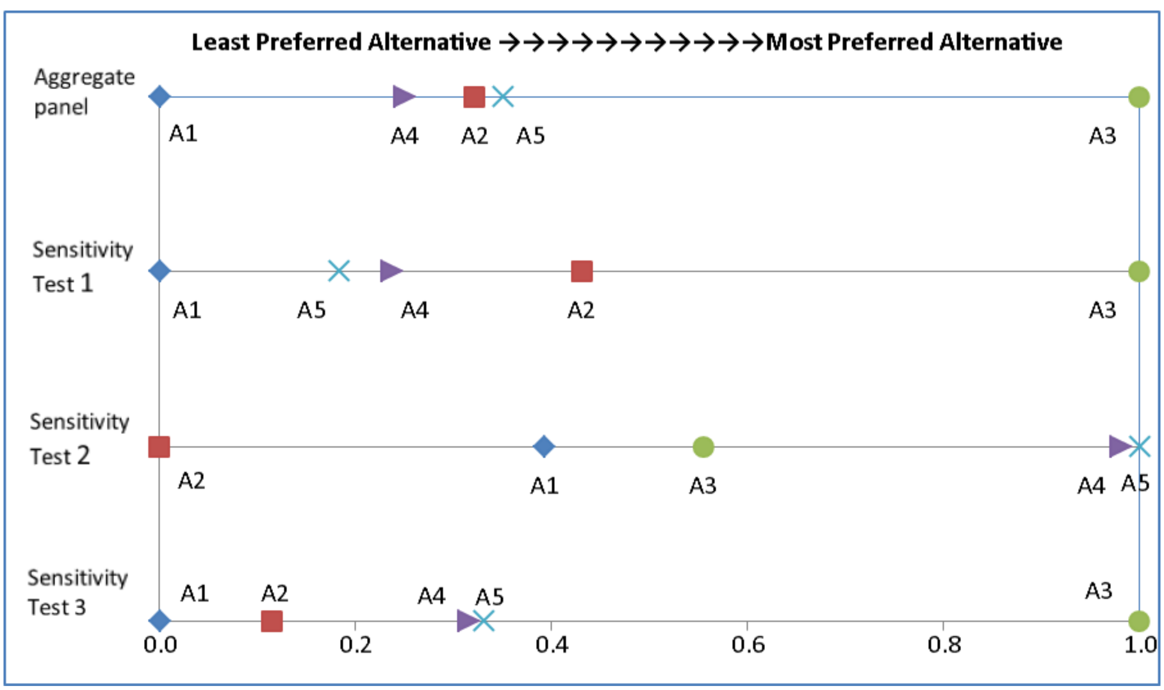

Figure 5-6. Scaled alternative preference scores for the aggregate panel and sensitivity tests 1 to 3.

5.5 Discussion

5.5.1 Implications for Electricity Sector Development in Saskatchewan

The preferred development path for the province was A3, a renewables focused future; the least preferred was A1, a continuation of the current trajectory. However, a number of factors and implications must be taken into account when implementing the preferred alternative. According to Cherp et al. (2007, p. 633), “external factors and/or internal organizational dynamics” that are critical to the successful implementation of the PPP must be identified and considered, including the feasibility of implementation and whether a supportive institutional environment exists for the preferred alternative (Gunn and Noble, 2009a), along with trade-offs associated with the preferred PPP. In the Saskatchewan case, there are several implications for implementation, including the economic viability of renewables in the short term due to infrastructure requirements, increased cost of electricity, environmental impacts from the development of hydropower and shifting priorities regarding Aboriginal rights.

A renewables focused future will require large-scale development of numerous power generation facilities (see Table 5-2). These additional infrastructure needs will require significant investment to ensure that sufficient capacity is available under a renewables alternative. As a result, as well as due to operations and maintenance, the cost of electricity is projected to increase. Alternative A3 had the highest associated cost of electricity, at approximately 14¢/kWh, which is higher than the 11¢/kWh cost of A1 under the current electricity mix (Table 5-2). While greenhouse gas emissions under A3 would decline to 11.5 million tonnes of CO_2/year, compared to the current mix (A1) producing 19.6 tonnes of CO_2/year (Table 5-2), there would likely still be significant environment implications associated with A3, given the inclusion of hydropower development. Given the strong preference for A3, but considering the infrastructure investment and the time required to undertake such a significant policy shift toward a renewables option, the ranking of A1 may have been different if it were accompanied by the sustainable alternative of a more ambitious demand-side management program.

Results of the sensitivity tests also highlight potential future implications for the renewables option. Sensitivity test S2, for example, showed that the only criterion that would shift the preference away from A3 is an increase in the importance or relevance of Aboriginal rights (C7) to decisions that concern electricity development and distribution. If Aboriginal rights become the dominant criterion in making decisions about future electricity development in, then the most preferred alternative would shift to A5, a natural gas scenario, and A2, the nuclear scenario, would become least preferred. If Aboriginal rights become a priority in electricity sector planning, or if development requires access to or settlement of issues that relate to Treaty lands, there are significant political issues to resolve so as to ensure the viability of a renewable focused future.

5.5.2 Opportunities for Advancing SEA Methodology

Strategic environmental assessment has often been criticized for adopting a vague and inconsistent approach, for the uncertainty of assessment results and for the unverifiable nature of the methods used (see Noble et al., 2012; Liou et al., 2006; Auditor General, 2004). The aim to ensure flexibility and sensitivity to context, however, does not need to trade-off structure and consistency in SEA guidance and methodology. Good SEA provides both the needed methodological structure for practitioners to rely on in applying SEA, so as to ensure replicability and confidence in the process and results, and allows for flexibility in the scope of alternatives, the choice of assessment methods, the nature of the criteria developed and the scope of participation.

In this paper, a systematic and structured SEA framework was operationalized using a quantitative design. Although quantitative-based approaches to SEA have been dismissed as inappropriate (see Sommer 2005), a quantitative approach can be used effectively to address the uncertainty and fuzziness around strategic-level decisions (see Schetke et al., 2012; Brunner and Starkl, 2004). The SEA practitioner is able to repeat the SEA analysis under different ‘what if’ scenarios and generate reliable results without having to collect new assessment data. This provides flexibility for the practitioner in examining the robustness of the recommended PPP. In the Saskatchewan case, the effects on the preferred PPP of uncertainties in participant assessment scores were demonstrated, as measured by a consistency ratio, as well as the effects of changing priorities, as measured by changes in the relative criterion importance of employment and income self-sufficiency, Aboriginal rights, and public health and safety. Using this approach, there is no limit to the number of sensitivity analyses that could be undertaken to examine how uncertain futures and changing organizational priorities or other, external factors (see Cherp et al., 2007) may affect the preferred option. This provides important information for decision makers and allows them to understand the potential political risks associated with certain strategic choices under uncertain future conditions. The means by which the preferred PPP is identified is transparent and the process can be replicated.

There is also an opportunity in the framework to extend the scope and level of engagement in SEA, with minimal effort, beyond what may be possible using less structured approaches. In our example we included a relatively small sample of experts; however, the on-line assessment tool could easily be extended beyond the expert panel to include members of the public from across the province. This would allow the SEA practitioner to identify potential spatial variations in PPP preferences or to examine PPP preferences based on participant affiliation – such as Aboriginal groups, environmental organizations, or electricity providers. Using a sensitivity analysis, results can then be examined for sensitivity to stakeholder preferences and the output can be traced backwards to determine the relative influence of participant groups and the weighting of assessment criteria on the preferred option. This is important information for SEA decision makers in understanding the level of dissent or consensus amongst the various groups involved in the SEA process (see Noble, 2004b).

Finally, the case application demonstrated one approach to operationalizing sustainability principles in SEA, specifically in the context of the electricity sector and through the use of assessment criteria. Marsden (2002) argues that SEA can play a role in sustainability if "simple (and) pragmatic" indicators are used; however, it is argued that sustainability in SEA has been far from pragmatic. Sustainability is mentioned as an overarching goal in many SEAs and there are some well recognized sustainability principles (see Gibson, 2006b), but rarely does this translate to direct assessment application (see White and Noble, 2012a). There have been few concrete examples and little guidance as to how to operationalize sustainability principles in an applied SEA context (Retief, 2007a). The Saskatchewan case demonstrated one approach to developing operable criteria that capture general sustainability principles. Of course, one option to increase sustainability in SEA is to adopt only 'strongly sustainable' alternatives from the outset; however, this may not be realistic in all SEA contexts.

5.6 Conclusion

This paper demonstrated an expert-based, quantitative SEA process to assess alternative futures for electricity development based on a set of defined criteria. The proposed SEA framework allows for replicability and sensitivity testing and provides credibility and transparency in the assessment methodology; but it also allows for flexibility in participation, the range of alternatives and how criteria are designed to accommodate sustainability principles that are sensitive to the context of the electricity sector. The case demonstrated structure in SEA design and a quantitative approach to address the uncertainty and fuzziness that often surrounds PPP assessment and sustainability. That being said, the benefits of structured and quantitative approaches to SEA are under-reported and under-promoted in SEA practice (Noble et al., 2012), and there is currently only limited awareness regarding quantitative SEA designs. More attention is needed on reporting the lessons emerging from SEA applications with quantitative designs and on developing methodological guidance to aid in the choice of appropriate assessment techniques. Although further theoretical development of SEA is still needed, additional reporting of the lessons learned from SEA case application are important in order to advance SEA design and build better frameworks to guide effective SEA for sustainability.

5.7 Acknowledgements

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CHAPTER 6: CONCLUSION - INTEGRATING SUSTAINABILITY INTO SEA FRAMEWORKS FOR ELECTRICITY PLANNING

Decisions regarding the development of energy resources have significant implications for sustainability. Strategic environmental assessment (SEA), a tool to inform and add value to higher level strategic decision-making, is ideally suited to the energy development sector, as decision-makers are expected to evaluate competing development scenarios and make informed choices about the longer-term sustainability of policies, plans and programs (PPPs) (Jay, 2010). However, even with its potential to assist in the long-term sustainable development of the energy sector, the application of SEA frameworks in energy sector planning and decision-making is relatively new in comparison to other sectors, such as transportation and land planning (Fidler and Noble, 2012; Marshall and Fischer, 2006); the value of SEA in energy sector PPP development is not well understood (see Fidler and Noble, 2012; Ketilson, 2011; Noble, 2009); and it remains unclear how sustainability can be fully integrated into the PPP development and decision-making process (Pope et al., 2004).

The purpose of this thesis was to examine the relationship between SEA and sustainability in order to determine and demonstrate how sustainability principles and criteria can be integrated and operationalized in the development of energy futures using an SEA methodology. In doing so, the intent was to advance a generalized SEA methodology for sustainability that could be adapted and modified for use in other industries and for other applications. This was accomplished by the following objectives, to: i) examine the use of SEA as a tool to support sustainability integration in policy, planning and decision making; ii) determine how SEA in the electricity sector is currently applied and how sustainability principles are being integrated into the process; and iii) demonstrate, based on a case study of electricity futures in Saskatchewan, an expert-based SEA process for electricity futures analysis that incorporates sustainability principles and criteria. In the sections that follow, the main conclusions to the thesis are presented and discussed in light of existing knowledge, along with the implications of the research for future SEA practice and methodology.

6.1 An Academic Review of SEA for Sustainability

Although some academic literature has recently focused on both the state-of-the-art of SEA (Tetlow and Hanusch, 2012) and sustainability assessment (Bond et al., 2012), there has been much less attention paid to if and how SEA supports sustainability. The first manuscript in this thesis set out to examine the current state of the art regarding the incorporation of sustainability in SEA by examining relevant peer reviewed academic literature from 2000 to 2010. A total of 86 papers from the journals *Environmental Impact Assessment Review*, *Impact Assessment and Project Appraisal*, the *Journal of Environmental Assessment and Policy Management* and *Environment and Planning* were identified that addressed 'sustainability' or 'sustainable development' and 'strategic environmental assessment'. Emphasis was placed on what the academic literature reports on *how* SEA supports sustainability in decision-making. Several common themes were identified in terms of how, in principle, SEA support sustainability, namely providing a framework to support decision making based on sustainability principles, setting sustainability goals and objectives, ensuring the consideration of 'more sustainable' alternatives, integrating sustainability-based assessment criteria in PPP development and promoting sustainability outcomes through tiering and institutional learning.

Regardless of the potential SEA holds as a vehicle to support and promote the inclusion of sustainability in PPP assessment and decision-making, there was also a considerable body of literature reporting a lack of evidence that the perceived benefits of SEA are translating to practice (Noble, 2009; Gibson, 2006a). The reasons for this are several, including the variable interpretations of the scope of sustainability and the multiple definitions of 'environment' in SEA (see Morrison-Saunders and Fischer, 2006; Privy Council Office and Canadian Environmental Assessment Agency, 2004; EC, 2001), which is likely causing confusion for planners and decision-makers responsible for implementation. There is also much uncertainty resulting from the myriad of approaches to sustainability in SEA, ranging from objectives-led to principles-based (see Gibson, 2006a; Morrison-Saunders and Fischer, 2006; Pope et al., 2005) and little guidance as to when and under what conditions each approach is best, and the ongoing academic debate regarding the benefits of structure versus flexibility in SEA processes (see Browne and Ryan, 2011; Gunn and Noble, 2009a; Partidário et al., 2008). There was much concern noted in the empirical literature that sustainability principles and objectives adopted at the outset of PPP development processes are not being translated to assessment practices by way of operational criteria that are directly linked to those objectives and principles (Liou et al., 2006; Noble, 2002). Perhaps most significant is that notwithstanding the many noted benefits of SEA for sustainability in PPP development, there are consistent reports of the lack of institutional willingness to adopt SEA and the ability to change, creating difficulties in adapting PPP decision-making processes to include sustainability issues (Tetlow and Hanusch, 2012; Slootweg and Jones, 2011).

Many of these challenges to SEA in support of sustainability are not new and continue to constrain SEA practice. Further research is needed to address these long-standing challenges to SEA for sustainability, specifically research that examines the purposes of SEA in various decision-making contexts; evaluates the scope of sustainability and the efficacy of various sustainability approaches in SEA frameworks; provides guidance to the development of assessment criteria that can be linked to sustainability objectives; and focuses on how to facilitate institutional learning regarding sustainability through SEA application.

6.2 Lessons from Practice: SEA in Electricity Planning

There is significant knowledge regarding SEA application in sectors such as transportation and land use planning, but the energy sector has been slow to evolve in this regard (Jay, 2010). As such, the role and value of SEA in electricity sector PPP development remain unclear. The second manuscript in this thesis investigated environmental assessment practice in energy sector planning by evaluating recent SEA cases worldwide. Specifically, this paper set out to identify the role and contributions of SEA in energy sector planning in terms of its process elements and PPP outcomes and the broader implications for advancing SEA in the energy sector. Six SEA and SEA-type applications in the international electricity sector were identified based on a review of available SEA case practice and advice from academic experts. Attention was focused on examining the nature of SEA application and the influence or value added of SEA to electricity PPP development and decision making.

Results indicate some evidence of "best practice" SEA process elements in the international electricity sector, such as participation, development and consideration of alternatives, and impact assessment and monitoring. However, considerable variability was found across SEA applications in terms of both the types of alternatives considered and the approach to impact assessment, depending on the timing of SEA application in the PPP development process. Only those cases that applied SEA either prior to or during PPP development were reported to have significantly influenced and improved PPP decision-making, including the development of additional alternatives for consideration and SEA-derived options being chosen for PPP implementation (see also Therivel, 2010; Therivel and Walsh, 2006). Most of the cases that applied SEA at the later stages of PPP review and revision simply evaluated the impacts of a prescribed PPP, rather than assessing alternative options. But, consistent with other academic research regarding PPP outcomes in SEA practice, the SEA process was reported by stakeholders as improving communication during the planning process (see Kirchoff et al., 2011; Vicente and Partidário, 2006).

There is considerable promise for SEA to support PPP assessment and decision making in the electricity sector; however, not all cases showed a substantive influence on the PPP due in large part to the late application of SEA in the assessment and decision-making process. This corroborates findings by other researchers who indicate that early application of SEA is vital in ensuring consideration of relevant issues in PPP development, resulting in the most influential SEAs (Therivel, 2010; D'Auria and Cinneide, 2009; Desmond, 2009). Several cases also showed a demonstrable lack of influence in PPP development due to poor consideration of alternatives, supporting calls by other researchers for better consideration of alternatives in SEA practice (Jay, 2010; Desmond, 2009; Retief, 2007a). Finally, in some instances restrictions set on the scope of SEA by a 'higher-level' policy or commitment was found to have prevented SEA from having an influence on the PPP at hand, suggesting that the expectation of tiering in SEA practice may be too unrealistic (Song and Glasson, 2010; Noble, 2009). However, this research also found demonstrable evidence of SEA tiering to lower-level assessments and decisions in several cases, as well as upward tiering to higher level policy and legislation in one case, which is contrary to suggestions that SEA is only capable of promoting tiering to lower levels of decision-making (Kirchhoff et al., 2011; Partidário, 2000).

6.3 Lessons from Practice: SEA and Sustainability in Electricity Planning

Electricity sector planning is closely tied to sustainability, due to its natural resource requirements and the large footprint of distribution systems; however, sustainability has been poorly operationalized in electricity sector planning practice (see Jay, 2010; Jay and Marshall, 2005). It is well-recognized that SEA can contribute to the sustainable development of the electricity sector (Noble and Storey, 2001), but there is a need to examine how SEA can best operationalize sustainability objectives in PPP decision-making processes and thereby contribute to improved electricity sector planning and decision-making (Pope et al., 2004). As such, the third manuscript in this thesis examined the same six electricity sector SEA cases discussed in the previous section to determine whether and how sustainability is being operationalized in electricity sector SEAs internationally. The obligation to incorporate sustainability in each of the cases varied from legislative and directive-based requirements to the electricity provider's own mandate, but every case demonstrated some attempt to incorporate sustainability or sustainable development in the SEA process.

The cases illustrated some ability for SEA to operationalize sustainability in PPP decision-making in the electricity sector. All of the cases explicitly stated sustainability as an overall goal for the PPP, adopted sustainability principles and objectives in the SEA and set out an approach to sustainability, as reported by interview participants and evidenced in SEA or PPP documentation. While there is little documented evidence in electricity planning, sustainability outcomes from SEA application in other sectors support results from this research, namely helping to identify and address key sustainability issues (D'Auria and Cinneide, 2010; Partidário et al., 2008), increasing awareness and understanding of sustainability issues (Sheate and Partidário, 2010) and promoting trickle down of sustainability to lower levels of decision-making (Kirchhoff et al., 2010; Jackson and Dixon, 2006). In particular, Portugal's electrical system plan demonstrated the most success in terms of sustainability outcomes. In this case the SEA was undertaken within an explicit sustainability mandate (both directive based and provider based) that was well-embedded in the SEA process; the SEA methodology was specifically designed to incorporate sustainability as the main objective; and the SEA practitioner showed a demonstrated understanding of how to operationalize sustainability goals in practice.

That being said, some significant concerns emerged regarding the incorporation of sustainability in PPP development in the electricity sector. While all six cases reviewed identified sustainability as an overarching principle in the SEA, only half developed assessment criteria directly from those sustainability objectives; thus preventing the provision of information regarding the sustainability impacts of the PPP (and its alternatives) to decision-makers and potentially hindering the choice of a more sustainable option(s). This confirms results of other researchers who indicate that SEA can only support sustainability when objectives and criteria are effectively incorporated into PPP assessment processes (Croal et al., 2010, Marsden, 2002; Noble, 2002). It may be that practitioners and planners are unclear as to how sustainability should be operationalized in SEA practice, from an overall goal to specific assessment criteria; there is little practical guidance outlining how to develop criteria from sustainability principles in SEA processes (see Croal et al., 2010; Gibson, 2006a; Pope et al., 2004). Or, it may be that practitioners are sometimes less than successful at operationalizing sustainability in SEA because they are simply not adopting 'best practice' SEA process elements, including early SEA application and the development of PPP alternatives that allow for the adoption of sustainability principles, or the development of more sustainable alternatives in the PPP development process (Therivel, 2010; D'Auria and Cinneide, 2009; Gunn and Noble, 2009a). This lack of 'best practice' SEA process elements and use of assessment criteria linked to sustainability objectives may also be hindering trickle down of sustainability to lower levels of decision-making and preventing increased knowledge and understanding of sustainability issues on behalf of decision-makers and planners.

6.4 Operationalizing Sustainability in SEA for Electricity Planning

While some academics believe that SEA must be flexible in order to add value to the PPP development process (Partidário et al., 2008; Retief, 2007a), others argue that structure in SEA methodology is essential (Browne and Ryan, 2011; Therivel, 2010). The main criticism leveled against flexible SEA methodologies is that they are difficult to apply consistently in practice, mainly because guidance for practitioners is often vague and unclear, resulting in uncertain and inconsistent outcomes from the process (Noble et al., 2012; Liou et al, 2006). As such, the demonstrated use of more systematic SEA frameworks is required in order to guide application, along with examples of where and how context-specific adaptability can be integrated into the assessment process. More case evidence is also needed to show how sustainability, an important yet vague concept that is proving difficult to operationalize in the electricity sector, can be incorporated into systematic assessment and decision-making methodologies (Brunner and Starkl, 2004; Gibson, 2001). The final manuscript in this thesis illustrated an expert-based, quantitative SEA application of alternative scenarios for future electricity development in Saskatchewan, Canada based on a set of defined sustainability criteria. The goal of the case application was to: 1) identify a preferred future electricity production path for Saskatchewan; 2) demonstrate the application of an SEA process that operationalizes sustainability criteria; and 3) advance the methodological development of SEA to operationalize sustainability criteria.

The case application illustrates the use of SEA for sustainability by identifying sustainability principles and providing a framework for the operationalization of assessment criteria in electricity PPP development. This included the use of a structured SEA framework with additional elements of flexibility; assessment criteria developed explicitly from sustainability objectives that incorporated higher level sustainability principles (see Gibson, 2006b); and a quantitative impact assessment methodology. Similar to findings by Gunn and Noble (2009) and Therivel (2010), the use of a structured set of assessment rules around which strategic decisions can be made allowed for transparency in and replicability of the SEA process, while elements of flexibility enabled the process to be tailored to the decision-making context at hand. The assessment criteria developed to assess the sustainability impacts of electricity supply alternatives were identified by experts as supporting the sustainable development of the electricity sector in Saskatchewan, responding to the call for operable assessment criteria developed from sustainability principles (see Liou et al., 2006; Noble, 2002). The assessment criteria were developed based on a number of principle-based sustainability factors (see Gibson, 2006b) in recognition that all aspects of sustainability need to be taken into account in order to determine the real-world impacts of each alternative, thus allowing for more comprehensive and informed decision-making (Croal et al., 2010; Gibson, 2006a; Morrison-Saunders and Fischer, 2006).

Finally, the quantitative impact assessment approach used, adopting a multi-criteria evaluation design, helped add clarity to a relatively high-level strategic decision-making process, allowed for explicit assessment of trade-offs between criteria and alternatives, enabled assessment results to be analyzed in terms of stakeholder dissent or consensus and provided a means to test the sensitivity of the assessment results and preferred supply option against the fuzzy nature of the assessment criteria and to accommodate for changing future conditions. In doing so, the potential implications for electricity sector investment and sustainability resulting from the implementation of the preferred development path, namely economic viability due to infrastructure requirements, the increased cost of electricity and environmental impacts from the development of hydropower, could be identified, thus confirming Cherp et al.'s (2007) assertion that SEA frameworks can and do allow for the identification and examination of external factors and repercussions that may affect PPP choices and result from PPP implementation.

6.5 Recommendations and Conclusion

First, the relationship between SEA and sustainability has long been recognized, but there has been much more 'principles-based' discussion than demonstrated practice. Academic literature promotes SEA's sustainability mandate in PPP development, ranging from informing decision-makers about the sustainability of strategic actions to ensuring that projects are implemented within a broader sustainability framework (Tetlow and Hanusch, 2012; Therivel, 2010; Fischer, 2003). However, regardless of the sustainability potential for SEA, sustainability itself remains a concept that is difficult to operationalize (Brunner and Starkl, 2004; Gibson, 2001); there is confusion and uncertainty regarding the scope of sustainability and the different sustainability approaches in SEA (Tetlow and Hansuch, 2012; Bina, 2007) and it is unclear to many how sustainability principles can be operationalized as assessment criteria (Liou et al., 2006; Noble, 2002). These factors all contribute to limited empirical evidence of the operationalization of sustainability in SEA practice to date (Noble, 2009; Gibson, 2006a), resulting in few opportunities to show how SEA does, in practice, contribute to sustainability in PPP development. Guidance that defines the scope of sustainability in SEA and the different approaches to sustainability in SEA (e.g. environmental, triple bottom line, principles-based) is needed, along with decision rules on how to select a sustainability approach that is most appropriate for the planning context. Improved guidance that shows how to effectively operationalize sustainability from principles to practice, including the development of impact assessment criteria that are expressly linked to sustainability objectives and principles is also needed. Future research should investigate sustainability outcomes from SEA that is well-embedded in PPP decision-making processes, including the development of indicators that illustrate the extent to which SEA influences the identification of sustainability issues in PPP development processes.

Second, the potential for SEA to deliver on its sustainability mandate requires structured methodological design as a means to operationalize the fuzzy concept of sustainability. Quantitative approaches in doing so have been significantly under-utilized in practice (Noble et al., 2012; Liou et al., 2006), with most practitioners favouring the use of qualitative methodologies. This SEA case application in this research confirms findings by Schetke et al. (2012) and Brunner and Starkl (2004), who report that the use of a quantitative assessment methodology to assess alternatives can address the uncertainty around PPP decisions and operationalize sustainability principles as criteria against which alternative choices can be made in electricity sector decision-making. Lessons learned from SEA applications with quantitative design need to be reported and, in line with the views of Noble et al. (2012), guidance needs to be developed for practitioners that describes quantitative and qualitative impact assessment methods and illustrates how to select the most appropriate method, or combination of methods, in SEA to support decision-making. With little literature available illustrating the development of assessment criteria that are directly linked to sustainability principles (Liou et al., 2006; Noble, 2002), guidance is also needed in this regard. Future research is also needed that investigates how to extrapolate the lessons learned from SEA design and application in the electricity sector to other sectors and decision-making contexts.

Third, while acknowledging that the use of alternatives and early application of SEA in PPP decision-making processes are fundamental building blocks of effective SEA (Therivel, 2010; Desmond, 2009), this research showed that there is still inconsistent application of best-practice process elements in SEA practice. It appears that the state of SEA practice is still subject to the same challenges that have plagued it for the past 20 years (see Eales and Sheate, 2011; Brown and Therivel, 2000; Partidário, 1996). Arguably, and underlying reason for this is that planners and decision makers may still be unaware or unconvinced of the value of SEA in PPP development and decision-making (see Partidário, 2000; Brown and Therivel, 2000). These issues could simply be due to decision-makers' lack of understanding regarding the role of SEA and the importance of its timing in decision-making, or due to a difference of opinion among researchers and practitioners regarding the purpose of SEA and what it is meant to achieve in PPP development processes (Kelly et al., 2012), ranging from promoting institutional learning (Bina, 2007), engaging stakeholders and informing decision makers (Croal et al., 2010), to protecting the environment, promoting sustainability (Therivel, 2010) and designing more sustainable PPPs (Partidário, 1996). The varying opinions as to the purpose of and rationale for SEA, along with the myriad of SEA methodologies available for use, is likely causing confusion among practitioners as to what SEA is supposed to achieve in terms of its methodological focus, its environmental role and its contribution to sustainable development (Kelly et al., 2012). The development and reporting of further case-practice evidence in the policy arena that elucidates the purpose of SEA in various contexts and demonstrates the added value and benefits from SEA application may enlighten planners and decision makers and contribute to better uptake of best-practice SEA elements.

Fourth, tiering in SEA has been criticized as being overly idealistic (Fischer, 2010; Nitz and Brown, 2000); however, this research showed clear evidence of tiering in practice – both tiering down and, unusually, tiering up, thus illustrating SEA's influence not only on lower tier project assessments but also on higher levels of PPP decision-making to potentially produce more sustainable higher-level policy and legislation. This is a significant finding for SEA in terms of setting the sustainability context for high-level policy and promoting 'trickle up' of sustainability outcomes, such as identifying and addressing sustainability issues, helping to identify trade-offs and increasing awareness and understanding of sustainability issues, to the highest levels of decision-making. This counters recent literature arguing that tiering is demonstrably lacking in practice or limited to lower level decision-making at best (Kirchhoff et al., 2011; Song and Glasson, 2010; Noble, 2009). Tiering mechanisms in SEA need to be further developed and explored in order to add value to decision-making processes in the future, along with how the lessons learned from the electricity sector in this regard could potentially be applied to other decision-making contexts and sectors.

Fifth, notwithstanding the use of well-designed SEA methodologies and tools in practice, institutional arrangements providing for effective SEA has received limited attention and should be a priority in future SEA research. SEA application holds the potential to markedly improve institutional decision-making, as "the introduction and implementation of SEA supports good governance, gives visibility to more strategic, proactive planning and decision-making and demonstrates commitment to environmentally sustainable development" (Dalal-Clayton and Sadler, 2005, p. 24). As early as 1996, Partidário concluded that "open and flexible political and institutional structures are key conditions for effective development and implementation of SEA systems" (p. 40); however, in many countries institutional and political paradigms that encourage communication and cooperation between institutions and support integrated decision-making frameworks such as SEA do not exist or need marked improvement (Srivastava et al., 2012; Partidário, 1996). As a result, many institutions are confronted with a lack of financial resources to conduct SEA, inexperienced or non-existent SEA practitioners, an absence of clear SEA guidance, a lack of willingness to change existing decision-making processes and limited appreciation of how SEA can add value to PPP development (Bochman and Kroth, 2010; Dalal-Clayton and Sadler, 2005). In addition, the broader system of institutional governance must also be examined in order to understand the context for and potential influence of SEA in decision-making. Finally, SEA may be seen as a threat to existing political mandates due to its ability to promote transparency and accountability in decision-making processes, resulting in a lack of political will to implement SEA. Thus, there is a keen need to ensure that institutional frameworks are in place to support the use of SEA frameworks to inform and influence PPP decision-making.

In conclusion, the role of SEA in ensuring the sustainability of resource development is now more important than ever, given recent streamlining of project-based EIA in Canada at the federal level. The Government of Canada recently adopted a new *Canadian Environmental Assessment Act* (July 6, 2012) that eliminates a majority of lower level project assessments and significantly limits the scope of EIA application for large resource developments (CEAA, 2012; Gibson, 2012). It has been well argued that significant cumulative impacts can result from a number of small-scale projects in a region, indicating that these new regulations may have significant repercussions for sustainable development. Gunn and Noble (2009) argue that environmental assessment in Canada must advance "beyond the evaluation of site-specific, direct and indirect project impacts to include issues of broader regional, cumulative and higher-tiered policy, plan, and program (PPP) development significance" (p. 258) and that SEA needs to play a greater role in regional, sector and cumulative effects assessment (see also Alshuwaikhat, 2005; Cooper and Sheate, 2004). With recent regulatory changes to EIA in Canada, there is a window of opportunity for SEA to fill an obvious significant void in the assessment and management of the potential sector-based, regional and cumulative impacts of development actions. That being said, SEA was designed to tier toward, inform and influence lower-level assessment and decision-making actions, rather than eliminate the need for it altogether (Partidário, 2000).

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APPENDIX A: SURVEY INSTRUMENT

University of Saskatchewan

Dear Sir/Madam:

Thank you for agreeing to participate in my study. Your contribution is important to this research. As indicated in my earlier correspondence, you are being asked to provide your assessment of alternative electricity development scenarios for the province of Saskatchewan based on a set of sustainability criteria. Please find enclosed the following documents:

Document A: Detailed description of the electricity development alternatives

Document B: Definitions of the criteria upon which you are asked to evaluate the alternatives

Document C: Instructions for performing the online assessment procedure

Much of the enclosed material is background information on the electricity alternatives and instructions for performing the online assessment. The questionnaire itself has been designed in the form of an online assessment tool, so as to minimize the amount of time required to complete the exercise. **You will receive an email link to the assessment website** and you can expect to spend between thirty and forty-five minutes to complete the assessment after having become familiar with the electricity alternatives and sustainability criteria. **It is not necessary that you complete both the criteria weighting and alternatives assessment in one sitting.** Each response you provide will save automatically, so that if you have to leave your session it will resume with the next unanswered question. When completing the online assessment, I recommend that you have Documents A (electricity alternative summaries) and B (sustainability criteria) at hand for reference.

Please read the enclosed information and complete the online assessment at your earliest convenience using the web link provided to you. Please retain Documents A and B for future reference.

Upon receipt and analysis of all assessments, I will forward you a statistical summary of the group's response and provide you with an opportunity to re-evaluate your own response in light of the group's response. In order to ensure that panellists' responses are individual responses, you are asked not to discuss your responses with others.

All information provided will remain confidential and you will not be personally identified in any reports or publications. A summary of the study's findings will be made available to you online. Should you have any questions, comments or concerns please feel free to contact me. I will follow-up with you to ensure that the instructions for the assessment are clearly understood.

Thank you in advance for your cooperation. I look forward to hearing from you soon.

Sincerely,

Lisa White
Ph.D. Candidate, University of Saskatchewan

Document A - Electricity Production Alternatives for Saskatchewan into 2040

Background Information

Saskatchewan's net electricity generation capacity for 2009 was 3,840 MW, including 43.8% conventional coal, 29.5% natural gas (including 21.2% simple cycle and 8.3% combined cycle natural gas), 22.2% hydro and 4.5% wind.[3]

Growing electricity demand means that SaskPower will need to rebuild, replace or acquire a projected additional 4,100 MW by 2030.[4] Energy demand has grown by an average of 1.3% per year over the past ten years in Saskatchewan, and is expected to grow by 3% per year in the next decade.[2] Issues for electricity supply mix development in Saskatchewan include outside pressures regarding climate change and greenhouse gas emission targets, population growth and limited research and development capacity,[5] along with new federal environmental regulations, aging infrastructure and peak load growth.[2]

An attempt was made to take into account a number of these factors when developing alternative electricity supply scenarios for Saskatchewan. Assumptions in each of the alternatives described in the attached documents include:

- industrial and residential demand side management efforts will continue
- infrastructure will not be replaced until it has served its useful economic life
- the urban-rural population distribution will remain about the same[6]
- peak load (demand) in the province will continue to grow from 1.3% to 3% per year, resulting in total electricity demand by 2040 ranging from 4,720 MW to 7,905 MW[2]
- generating capacity in the province will continue to grow anywhere from 1.3% to 3% per year, resulting in total electricity supply by 2040 ranging from 5,660 to 9,320 MW[2]
- solar power is not suitable for large-scale generation in Saskatchewan because of its high cost and low capacity factors[2]
- the majority of supplied electricity is generated and consumed within Saskatchewan
- demand response to climate change, such as increased use of air conditioners and heating, is incorporated into the projected increased load and capacity
- all alternatives will require additional transmission infrastructure and, as a result, were not included in capital cost estimates

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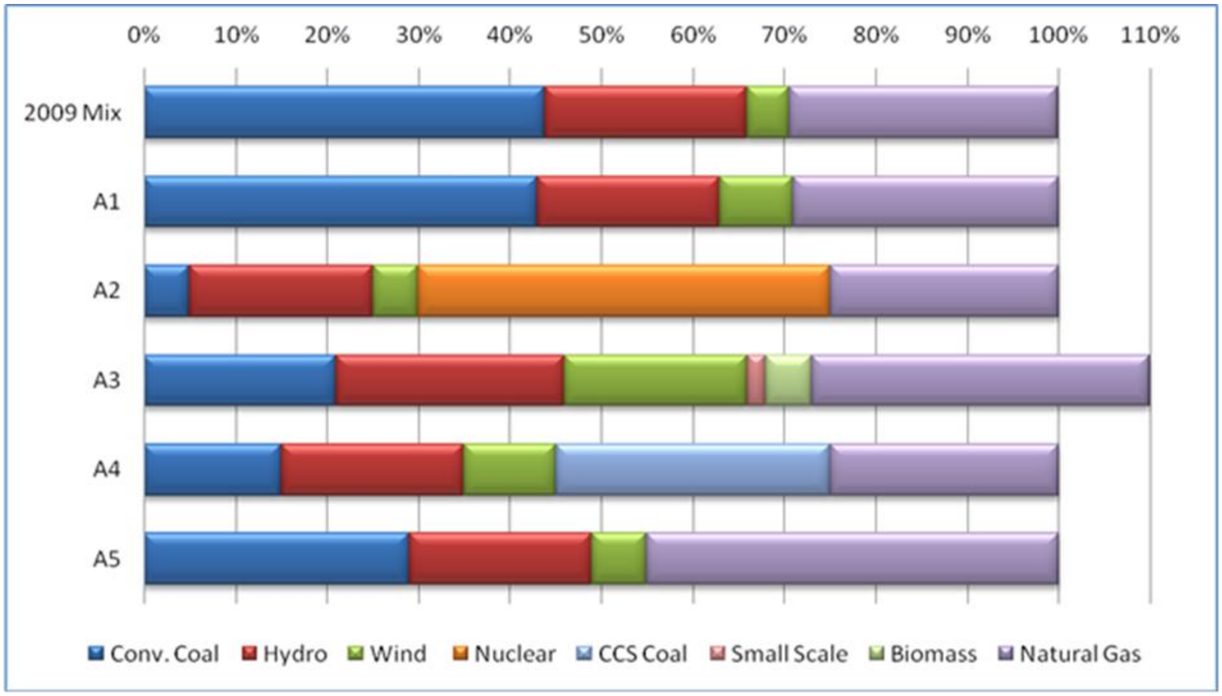
[3] Source: SaskPower 2010
[4] Source: SaskPower 2010
[5] Rayner 2011
[6] NRCan 2004

<u>**Alternative Electricity Development Scenarios**</u>



***CCS coal =** carbon capture and storage coal; **Conv. Coal =** conventional coal.

Alternative 1 (A1): A continuation of Saskatchewan's current electricity production mix over the next 30 years.

This alternative could occur if there is a lack of substantial climate change policy instituted in the country, as well as limited research and development of new and renewable technologies. New conventional coal, single and combined cycle natural gas, hydro and wind facilities would likely be built.

Alternative 2 (A2): An increased focus on nuclear electricity production, while still including other traditional means of production.

This alternative could occur if climate change policy were to be adopted that restricts or places heavy penalties on carbon emissions from coal produced electricity. New small nuclear, combined cycle natural gas, hydro and wind facilities would likely be built. No new conventional coal facilities or simple cycle natural gas facilities would be built. Several new small scale nuclear power units with capacity no larger than that of current coal facilities (300 to 500 MW) would likely be built. The assumptions made in this particular alternative are that the reactors are built in areas with sufficient workforce, access to cooling water and access to power markets.

Alternative 3 (A3): An increased focus on renewables, including run-of-river hydro, reservoir hydro, biomass and wind, along with small scale on-site renewable electricity production.

This alternative could occur if climate change policy were to be adopted that restricts or places heavy penalties on carbon emissions from coal produced electricity. New single and combined cycle natural gas, hydro, biomass and wind facilities would likely be built. No new conventional coal facilities would be built. Use of small-scale renewables including solar, wind, biomass and other industry-scale or community-scale renewable electricity generation increases demand for local transmission networks.

Assumptions for this alternative include: 1) solar technologies can only be implemented on a limited scale in the province; and 2) large scale biomass facilities will be feasible in the future. Electricity produced from biomass and hydro projects in northern Saskatchewan provide an additional benefit of efficient near-site electricity in northern communities, resulting in reduced power losses from transmission over hundreds of kilometres of line from southern power facilities.

Energy generated through renewable technologies have much more variability and uncertainty associated with them than other forms of electricity generation technologies and, as a result, have implications regarding the reliability of power supply. Heavy reliance on wind and run-of-river hydro power has potential to decrease the reliability of the system. This reduced reliability is offset with simple cycle natural gas peaking facilities (an additional 10% in the electricity mix).

Alternative 4 (A4): An increased focus on large scale carbon capture and storage (CCS) replacing the majority of conventional coal generated portion of the electricity mix, while still including other traditional means of electricity production.

This alternative could occur if climate change policy were to be adopted that restricts or places heavy penalties on carbon emissions from coal produced electricity. New CCS coal, combined cycle natural gas, hydro and wind facilities would likely be built. No new conventional coal facilities or simple cycle natural gas facilities would be built.

Alternative 5 (A5): An increased focus on electricity produced from natural gas, while still including other traditional means of electricity production.

This alternative could occur if there is a lack of substantial climate change policy instituted in the country, as well as limited research and development of new and renewable technologies. New single and combined cycle natural gas, conventional coal, hydro and wind facilities would likely be built.

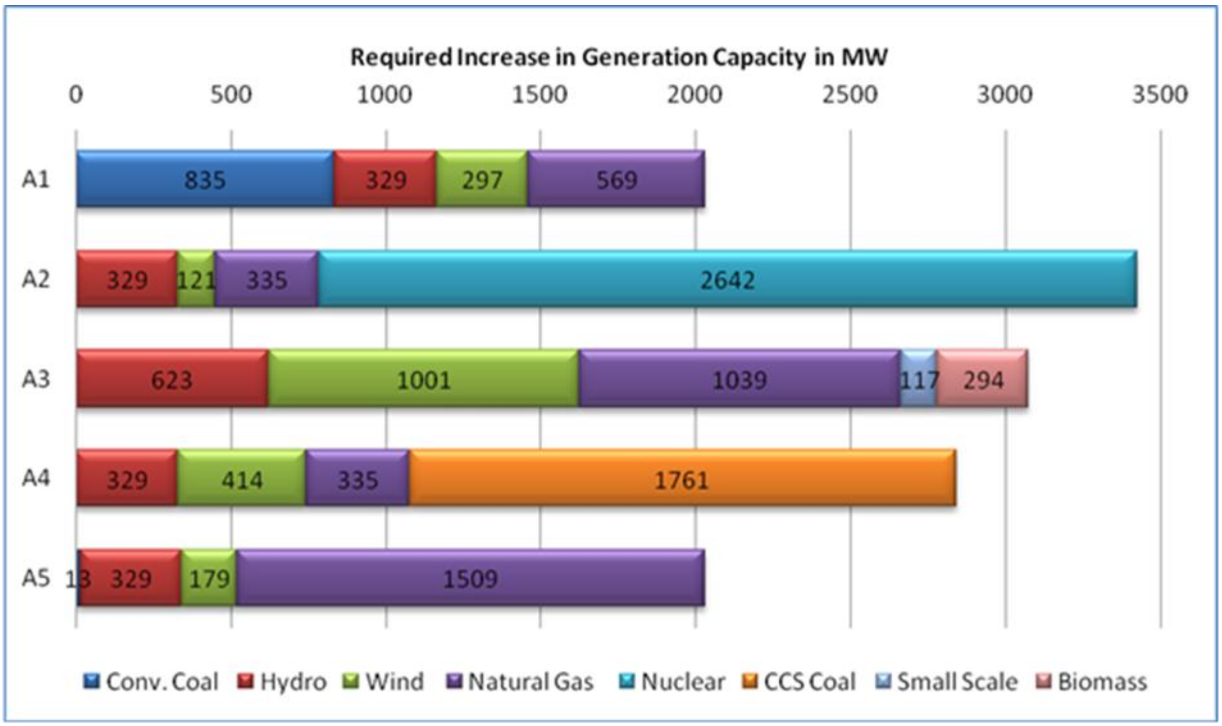
Assumptions for Comparing Alternatives

1. Required generation capacity in 2040[7]

	2009 Mix (MW)	Alternative 1 (MW)	Alternative 2 (MW)	Alternative 3 (MW)	Alternative 4 (MW)	Alternative 5 (MW)
Conv. Coal	1,690	2,524	294	1,233	881	1,702
Hydro	845	1,174	1,174	1,468	1,174	1,174
Wind	173	470	294	1,174	587	352
CCNG	320	763	704	1,057	704	1,468
SCNG	813	939	763	1,115	763	1,174
Nuclear			2,642			
CCS Coal					1,761	
Small Scale				117		
Biomass				294		

*Conv. Coal = conventional coal; CCNG = combined cycle natural gas; SCNG = simple cycle natural gas; CCS coal = carbon capture and storage coal

2. Required increase in generation capacity (MW) in 2040 in comparison to 2009 capacity[8]



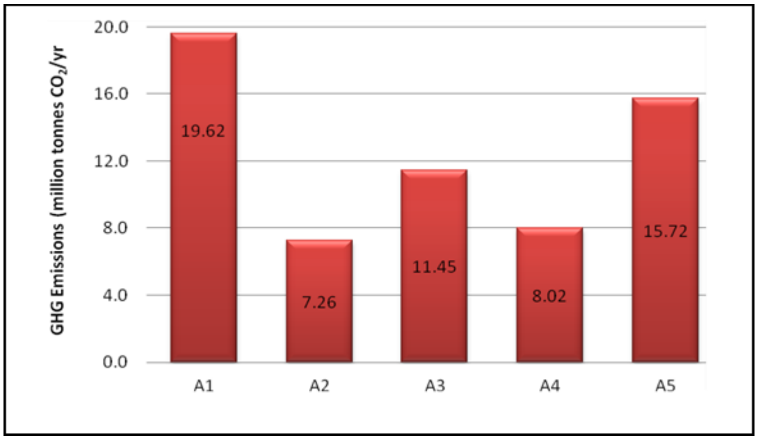
*Conv. Coal = conventional coal; CCS Coal = carbon capture and storage coal

[7] Required capacity was calculated based on the electricity mix for each alternative for generation capacity in 2040 of 5,870 MW (resulting from a 1.3% increase in capacity from 2009 levels of 3,840 MW).

[8] Required capacity was calculated based on the electricity mix for each alternative for generation capacity in 2040 of 5,870 MW (resulting from a 1.3% increase in capacity from 2009 levels); alternative 3 includes an additional 10% capacity of SCNG to offset the increased use of wind.

3. Greenhouse Gas Emissions[9]

Greenhouse gas (GHG) emissions were calculated based on the electricity mix for each alternative over a one year period for generation capacity in 2025 of 4,830 MW (resulting from a 1.3% increase in demand from 2009 levels of 3,840 MW). For comparison purposes, GHG emissions for 2010 totalled approximately 17 million tonnes CO_2 (from SaskPower, 2010b, based on 18,862 GWh of total electricity supplied and an emission intensity of 0.9 tonnes CO_2e/GWh).

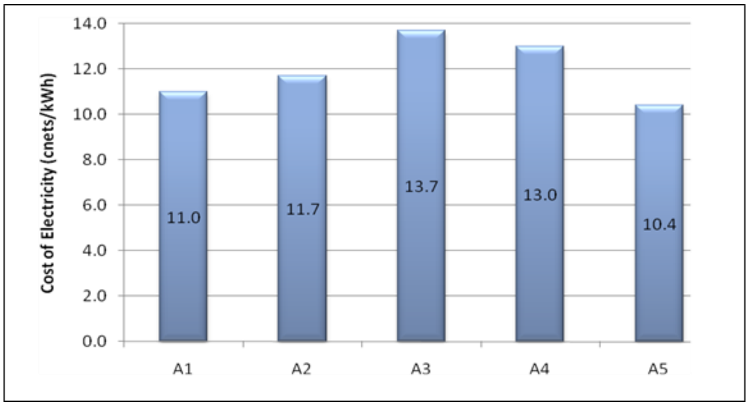


4. Cost of Electricity[10]

The cost of electricity was estimated based on capital costs, power operation and maintenance costs. The cost of electricity in 2009 was approximately 6 ¢/kWh. Natural gas prices have been highly variable in the past. This may increase the future cost of Alternative A5, which relies heavily on natural gas.

[9] Required capacity was calculated based on the electricity mix for each alternative for generation capacity in 2025 of 4,830 MW (resulting from a 1.3% increase from 2009 levels). GHG emission intensities are based on averages from Bigland-Pritchard and Prebble, 2010. Load factors are based on SaskPower (conv. coal, wind), the project's advisory committee (simple cycle, combined cycle natural gas, hydro, CCS coal) and Graham et al., 2005 (nuclear, small scale, biomass). Load factor is the ratio of average load (intensity of usage) to generation capacity in a period, or a measure of the actual output of a power plant compared to its maximum theoretical output. Small scale GHG emission rates and load factors were based on solar photovoltaics. An additional 10% of simple cycle natural gas is included in A3. It was assumed that simple cycle and combined cycle natural gas facilities have the same GHG emission intensity.

[10] Capital and power costs are from SaskPower. Power costs include load factors and the impact of a cost of carbon on GHG emissions and sales revenue for CO_2 captured inA4. Power cost for a simple cycle option is not applicable as it typically has low capacity factors due to its peaking operation. Power cost for nuclear includes an allowance for decommissioning and interim fuel storage in A2.



5. Reliability

Reliability means that electricity will be delivered to the consumer with a high degree of assurance. This is usually accomplished by maintaining reserves of generation and transmission capacity. Alternative A2 incorporates the use of a number of small nuclear power units instead of fewer large ones. Since small nuclear is more reliable than large nuclear (in line with that of coal generation facilities), the decreased reliability of one or a few large nuclear units is offset by more small nuclear units. In Alternative A3, the decreased reliability of solar, hydro and wind may be offset by increasing the peaking capacity of natural gas facilities, which is included in cost estimates for this alternative.

Document B: Sustainability Criteria

The following sustainability criteria were developed based on a review of international practices in energy planning and with the assistance of a focus group of energy experts:

C1 – **Adaptive capacity**: maximizes the ability to accommodate projected, as well as unanticipated future demand growth

C2 - **Emissions management**: minimizes emissions to air and water during electricity production, distribution and use over the life cycle of the system

C3 - **Employment and income sufficiency**: maximizes short and long-term income and employment opportunities

C4 - **Ecological integrity:** ensures biodiversity conservation and ecological resiliency by minimizing use and disturbance of land & water resources

C5 - **Security of supply**: ensures secure and affordable access to energy supply for current & future generations

C6 - **Energy production and transmission efficiency**: meets electricity demands while minimizing energy use, raw material use and generation of waste during production and energy loss during transmission

C7 – **Aboriginal rights:** minimizes infringement on culture, traditional land use practices and Treaty Rights

C8 - **Public health and safety:** minimizes risk to public health and safety during electricity production and transmission

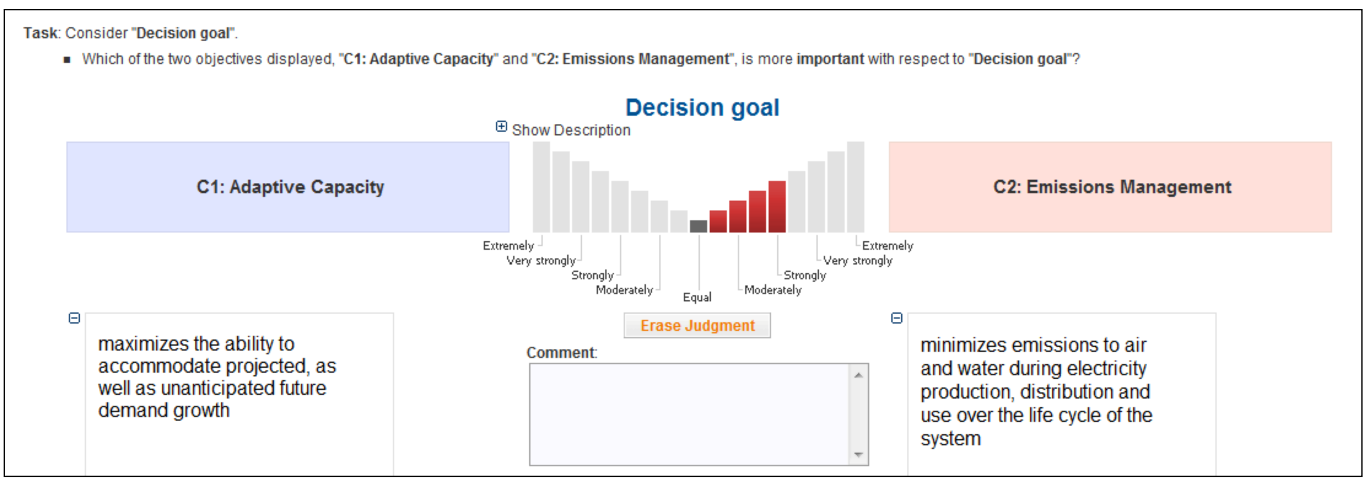
Document C: Assessment Procedure

PART 1 – Criteria Evaluation

You are first asked to 'weight' the sustainability criteria (outlined in Document B) using the online tool and indicate their **relative importance** when making decisions about energy futures. The assessment scale is as follows:

Definition	Explanation
Equally important	The two criteria are equally important
Slightly more important	The criterion is slightly more important than the other
Moderately more important	The criterion is more important than the other
Strongly more important	The criterion is strongly more important than the other
Extremely more important	The criterion is extremely more important than the other
Intermediate values	Reflects judgments between the two adjacent judgements

An example of the online criteria weighting is illustrated below. The pairs of criteria that you are asked to evaluate are listed side by side on the screen. When evaluating two criteria, you are evaluating the relative importance of one criterion in comparison to the other when making energy future decisions.



For example:

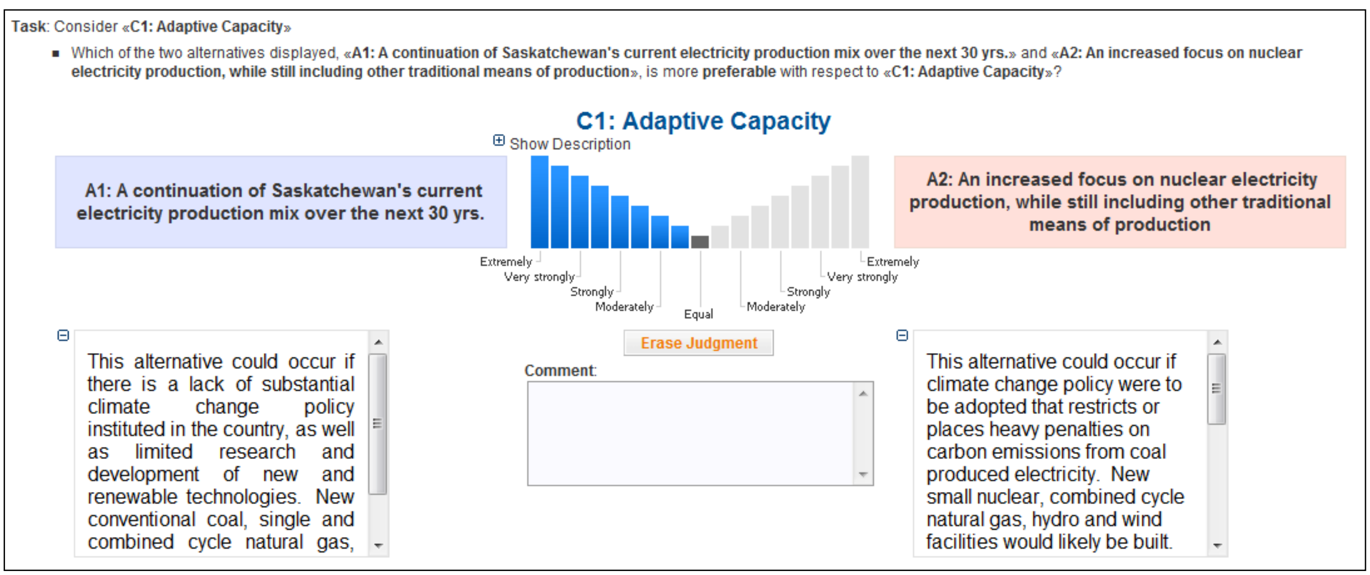
- If *criterion C2* is **strongly more important** than *criterion C1*, then you would click on the word "strongly" on the *right* side of the bar scale, as illustrated above.

- If *criterion C1* is **extremely more important** than *criterion C2*, then you would click on the word “extremely” on the *left* side of the bar scale.
- If *criterion C1* is **equally important** to *criterion C2*, then you would simply click on the word “equal” in the middle of the bar scale.

PART II – Assessment of Alternatives

Once you have finished weighting the sustainability criteria, you are asked to evaluate the alternative energy scenarios (detailed in Document A) based on the sustainability criteria and indicate, using the online assessment tool, your **relative preference** for each alternative. You will be using the same scale as above, but this time you are indicating your ‘relative preference’ as opposed to ‘importance’.

An example of the online alternatives assessment is illustrated below. The pairs of alternatives that you are asked to evaluate are listed side by side and the sustainability criterion against which you are evaluating the options is listed at the top. When evaluating two alternatives, you are evaluating the relative preference for each alternative based on the identified criterion. For example, a strong preference for alternative A1 over A2, based on criterion C1, does not mean that A1 is the *overall* preferred alternative, but that it is preferred to A2 with regard to criterion C1.



For example:

- If *alternative A1* is **extremely more preferred** to a*lternative A2*, based on criterion *C1* (*adaptive capacity*) then you would click on "extremely" on the *left* side of the bar scale, as illustrated above.
- If *alternative A2* is **strongly more preferred** to *alternative A1*, then you would click on "strongly" on the *right* side of the bar scale.
- If *alternative A1* is **equally preferred** to *alternative A2*, then you would simply click on the word "equal" in the middle of the bar scale.

APPENDIX B: INTERVIEW QUESTIONS

Role of assessment

1. What was the purpose of the assessment? For example:
    a. To meet regulatory requirements? To promote social, environmental and economic considerations (or other)? To strengthen environmental governance and/or capacity for environmental planning? Institutional change?
2. What were the outcomes from the assessment (or what were the deliverables)? For example:
    a. Direct/Procedural: Was a "best" option identified? Did the assessment improve understanding of the PPP and its impacts?
    b. Indirect/Transformative: Did the assessment enable an institutional learning process (how: clear responsibilities and roles, improved collaboration and communication between government departments, development groups, experts, decision makers, public)? Did the decision-making process become more transparent? Was there improved environmental governance?
    c. Influence: Did the assessment identify key issues for decision-making? Did the assessment contribute to or have influence on the final decision or the decision-making process? Were the assessment recommendations incorporated into the final PPP? Was the assessment started early enough in the PPP development process to influence the number and types of alternatives considered and did the assessment influence the number and types of alternatives considered? Did the assessment influence stakeholder (ENGOs, public) opinion and was there broad based acceptance of the assessment recommendations?
    d. Tiering & Trickle Down: Was there trickle down of outcomes to the project level? Has the assessment informed subsequent lower tier decision-making? Was the PPP legislated into lower level decisions? Were higher level initiatives considered?
    e. Monitoring: How was the success/effectiveness of the PPP evaluated? Were impacts monitored after implementation of the PPP and was there follow up for corrective action? Were indicators and criteria used to monitor impacts and what were they? Were they measurable? Were procedures in place for monitoring of impacts and follow up for corrective action?
3. Based on your experience in this case, what are the challenges and opportunities for assessment in the future?
4. Based on your experience in this case, what were the benefits and drawbacks of completing the assessment?

Assessment and Sustainability

1. How was sustainability viewed in this case? For example:
    a. Triple bottom line, environment alone, other?
    b. Was it explicitly stated or implicit? Was sustainability or sustainable development a guiding principle of the PPP? Was there a sustainability 'vision' for the assessment?
    c. Was there a sustainable development framework or sustainability strategy/regulations in place (government, environmental authorities)?
2. How was sustainability operationalized/incorporated in the assessment? For example:
    a. Issues: Did the assessment identify key sustainability issues? How?
    b. Criteria: Were assessment objectives linked to criteria and indicators? What was the procedure for developing criteria? What types of sustainability criteria were developed: SEE or other? Were the criteria broad and general or specific and detailed? Why were those specific sustainability criteria chosen? Were the sustainability criteria measurable or not?
    c. Methodology: Did the assessment methodology provide the structure and support necessary to implement sustainability objectives?
3. How was sustainability evaluated in the assessment? For example:
    a. How did you evaluate whether the alternatives satisfied the criteria (MCA, qualitative, quantitative)?
    b. Did the assessment process identify more sustainable alternatives?
    c. Were trade-offs made in order to determine a best option?
4. What were the sustainability outcomes from the assessment? For example:
    a. Issues: Did the assessment effectively address key sustainability issues?
    b. Impacts: Was the PPP more sustainable after completion of the assessment?
    c. Awareness and Understanding: Did the assessment changed decision-makers' awareness and understanding of environmental and sustainability issues (increased awareness and concern for environment, attitude and value changes, paradigm shifts)?
5. Based on your experience in this case, what are the challenges and opportunities for integration of sustainability in assessment?
6. Based on your experience in this case, do you think sustainability can be successfully integrated into assessment? What was the most important lesson learned regarding sustainability in assessment?

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