TOWARDS A STRUCTURED APPROACH TO STRATEGIC ENVIRONMENTAL ASSESSMENT A CASE STUDY OF CANADIAN ENERGY POLICY ALTERNATIVES

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by

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ABSTRACT

Considerable attention has been given to the role of Strategic Environmental Assessment (SEA) in policy, plan and program (PPP) assessment; however, there is still very little consensus on appropriate methodologies for SEA. Despite calls for SEA to develop more independently of project-level assessment, existing SEA methodologies still tend to be based on project-level EIA principles, rather than also on a trickling down of objectives of broader environmental policy. This thesis argues that if SEA is to advance in application and effectiveness then a different, but structured methodological framework is required.

While SEA can perhaps utilize many of the existing methods and techniques from project-level assessment, the types of questions being addressed in *strategic* assessment are inherently different from those in project-level assessment. Accordingly, a different methodological assessment framework is required for SEA. The emphasis of strategic assessment is on the development of an appropriate strategy for action, addressing alternative courses of action, rather than the assessment of the potential impacts of a pre-determined option. In order to accomplish this, SEA methodology must be more broad brush than project-level assessment in order to allow the assessment of both the more general policy issues and the more technical plan and program issues. Similar to project-level assessment, however, a structured framework is desired in order to facilitate a more systematic and replicable assessment process.

This thesis develops a structured, generic seven-phase assessment framework to guide SEA application. The framework is demonstrated through a case study SEA of potential Canadian energy policy alternatives. Through the use of a modified policy-type Delphi and multi-criteria analytical methods, alternative options for Canadian energy policy are evaluated and the 'best practicable environmental option' is determined. While the geographic scale of the case study and the number of participants involved is perhaps not pragmatic with respect to 'real-world' policy SEA, it does serve to demonstrate the utility of the proposed SEA framework. The emphasis of this research is on the *process* of strategic assessment, rather than the policy implications of the results of the case study. A number of specific recommendations for 'good-practice' SEA are presented, and key issues are raised for future SEA research.

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List of Abbreviations and Acronyms

AHP: analytical hierarchy process
BPEO: best practicable environmental option
CANDU: Canada Deuterium Uranium
CEAA: Canadian Environmental Assessment Agency
CEARC: Canadian Environmental Assessment and Review Council
CEC: Commission of European Communities
CI: consistency index
CR: consistency ratio
CSIR: Council for Scientific and Industrial Research
CSTA: Council of Scientific and Technology Advisors
CV: consistency vector
DEAT: Department of Environmental Affairs and Tourism
DHV: Department of Environment and Infrastructure
DUAP: Department of Urban Affairs and Planning
EA: environmental assessment
EARP: Environmental Assessment and Review Process
ECE: Economic Commission for Europe
EIA: environmental impact assessment
EPB: Energy Policy Branch, Natural Resources Canada
ETF: Energy Technology Futures
FEARO: Federal Environmental Assessment and Review Office
FES: fuzzy expert systems
FIPA: Farmer's Income Protection Act
GIS: geographic information system
IUCNNR: International union for the Conservation of Nature and Natural Resources
MADM: multi-attribute decision-making
MCE: multi-criteria evaluation
MHSPE: Ministry of Housing, Spatial Planning and the Environment
MODM: multi-objective decision-making
NAFTA: North American Free Trade Agreement
NEB: National Energy Board
NEPA: National Environmental Policy Act
NGO: non-government organization
NICE: Northeast International Committee on Energy
NRCan: Natural Resources Canada
OCED: Organization for Economic Cooperation and Development
PPP: policy, plan, and program
PRI: Policy Research Initiative
RPPs: refined petroleum products
SEA: strategic environmental assessment
WEC: World Energy Council
WCED: World Commission on Environment and Development

Chapter One
INTRODUCTION

1.1 INTRODUCTION

Since the introduction of the US National Environmental Policy Act (NEPA) in 1969, and the Canadian Environmental Assessment and Review Process (EARP) in 1973, the environmental impact assessment (EIA) process has undergone a number of evolutionary changes. Of particular importance has been the growing interest in the environmental implications of policy, plan and program (PPP) decision-making (e.g. CEAA, 1999; Fischer, 1999; Therivel, 1996). In 1980 the World Conservation Strategy identified the need to integrate environmental considerations with development plans (IUCNNR, 1980). Subsequently, the early consideration of the environmental implications of proposed PPPs became an accepted part of World Bank policy, which stated that "environmental issues must be addressed as part of overall economic policy rather than project by project" (World Bank, 1987). Furthermore, the Brundtland Report, prepared by the World Commission on Environment and Development (1987), followed by the Epsoo Convention, 1991, the United Nations' 1992 'Rio Summit' on the environment, and the 1997 Kyoto convention on climate change, all reflect the growing need to address the environmental implications of PPPs at the strategic level. More recently, in a report to the European Commission, Sheate *et al.* (2001: 5) suggest that "integrating the environment into strategic decision-making is an essential prerequisite for moving towards sustainable development."

Strategic environmental assessment (SEA) broadly refers to the proactive assessment of proposed or existing PPPs and their alternatives. There is a growing recognition of the need for the assessment of the implications of PPP alternatives at an early stage in the decision-making process where there can be greater flexibility in terms of future actions (Buckley, 2000; Renton and Bailey, 2000; Boothroyd, 1995; Therivel and Partidario, 1996). This is particularly true at the policy level, as illustrated by the *Government of Canada Action Plan 2000 on Climate Change* (Canada, 2000), the recent Kyoto environmental summit, Natural Resources Canada's (NRCan) release of *The State of Energy Efficiency in Canada 1999* (NRCan, 1999), and more specifically, NRCan's (2000) recent interest in strategic policy alternatives for Canada's electricity sector. The problem is that SEA has not yet been widely accepted and there is still very little consensus on appropriate methodologies for SEA (e.g. CEAA, 2000; Machac *et al.*, 2000; Verheem and Tonk, 2000; Wiseman, 2000; Audouin, 1999; Partidario, 1996; Therivel, 1993).

Therivel (1993) notes that one of the main difficulties experienced in most countries in relation to the adoption and operationalization of SEA is the lack of methodologies that specifically address SEA requirements. For example, Machac *et al.* (2000) reviewed the state-of-the-art of SEA in the Czech Republic, and identified two related reasons attributed to the shortcomings of the Czech energy policy SEA: the lack of consistency in SEA application and, the lack of appropriate SEA methodologies and frameworks. Wiseman (2000) reviewed the state-of-the-art of SEA in the South African context, suggesting that one of the major challenges in the development of SEA is the lack of an agreed approach to SEA application. Similarly, Audouin (1999) suggested that one of the major difficulties in the development of SEA guidelines is the facilitation of context-specific SEA methodologies. In addition, CEAA's (1999) review of the Canadian Cabinet Directive on

SEA suggests that SEA application since the introduction of the Cabinet Directive has been *ad hoc* and inconsistent at best.

1.2. SEA Methodology

Sheate *et al.* (2001), Brown and Therivel (2000), Therivel and Partidario (1996), and Boothroyd (1995) suggest that effective SEA will require a move away from approaches evolving solely from the extension of project-level environmental assessment upstream. Bailey and Renton (1997) agree, suggesting that if SEA is to meet its objectives, it must break away from traditional project-level assessment approaches. Notwithstanding recent calls for SEA to develop more independently of project-level assessment, SEA still tends to be based on project-level EIA principles. As a result, SEA, particularly at the policy-level, has been constrained by the lack of appropriate methodologies to facilitate its practice (Renton and Bailey, 2000). While SEA can perhaps utilise many of the existing methods and techniques adopted from project-level assessment, it is argued here that SEA does require different, more broad-brush, but structured methodological frameworks to be effective.

A *strategic* environmental assessment is an objectives-led assessment, asking different types of questions than project-level EIA, and, accordingly, requires a different methodological approach. The emphasis of a strategic environmental assessment is on the identification and assessment of alternative options, rather than option alternatives. The objective of SEA is to identify and select the option(s) that poses the least damage or most benefit to the environment in accordance with broader strategic goals and objectives.

Addressing questions at the strategic levels of decision-making requires an assessment framework that is capable of addressing both the more general policy-type issues and the more specific programmatic issues. Thus, SEA frameworks must be more broad-brush than project-level EIA approaches, incorporating both the upward movement of EIA methods and techniques, *and* a trickling down of objectives of broader environmental policy. This does not mean, however, that SEA should be applied in an *ad hoc* or inconsistent fashion, but rather that SEA methodology must be broad enough to address multi-criteria problems that involve the evaluation of strategic alternatives against multiple criteria and objectives to identify the preferred strategy(s) for action.

In both project-level EIA and strategic level assessments, a structured assessment framework seems appropriate. Solving SEA problems requires an approach that is aimed at rationalizing the assessment process by systematically structuring all relevant aspects of a PPP choice in order to arrive at the best practicable environmental option. A structured framework allows for a more systematic evaluation of PPP alternatives and thus facilitates greater consistency in application and accountability of results. The lack of a structured approach may lead to confusion amongst non-SEA experts (Verheem and Tonk, 2000).

1.3 Proposed Research

The implementation of SEA is fraught with both technical and procedural problems and there have been few models to suggest how to carry out SEA (Glasson *et al.*, 1999: 404). "The required methods and concepts for the environmental assessment of policies have not been adequately developed and attention needs to be focused on the formulation of an appropriate conceptual framework, a body of guiding principles, and a set of tested methods" (Bridgewater, 1989). While SEA has come a long way since the late 1980s, overall SEA has been considered much more from a theoretical and conceptual than a practical perspective, and SEA methodologies, particularly at the policy level, are neither well-developed nor commonly agreed upon (CEAA, 2000; Verheem and Tonk, 2000; Partidario, 1996; Therivel and Partidario, 1996). It is of critical importance that SEA methodologies be developed if SEA application is to advance to the policy level.

The purpose of this research is to develop a structured, generic methodological framework to guide SEA application. The focus is on SEA methodology, particularly the *assessment* process, rather than on the institutional requirements for its implementation, essential though they are. The current state-of-the-art of SEA methodology is reviewed to determine how an SEA framework can be developed and applied, particularly at the policy level, based on both an upward movement of project-level environmental assessment and a trickling-down of objectives of broader environmental policy. The assessment of alternative options for Canadian energy policy serves as a case study to illustrate the framework's application to a real-world policy problem.

1.3.1 Case study

In this study, 'energy' refers to electrical generation. Electricity supplies about one-fifth of all energy used in Canada, and electrical production consumes about one-third of all primary energy sources (National Climate Change Secretariat, 1999). Electricity is a secondary energy source created by converting primary energy sources (e.g. refined petroleum products, wind, natural gas) into electrical energy. In Canada, the electrical generation industry falls primarily under provincial jurisdiction, but the overall policy and strategic direction of the electricity sector is the responsibility of the Energy Sector of Natural Resources Canada.

The continued growth of Canada's domestic electricity demand and export opportunities will require additional generating capacity. The Energy Technology Futures (ETF) group, an initiative of NRCan, has been working with representatives of the electricity sector to develop a vision for a sustainable electricity industry. Building a sustainable electricity sector to meet the projected increases in generation demand requires the consideration of new and existing energy alternatives, and the consideration of their potential environmental effects. The primary product of the ETF project is a set of internally consistent scenarios of energy service demands, technological options and fuel sources, outlining possible energy development scenarios to the year 2050. While these scenarios do not reflect the current policy direction of NRCan, they do provide a series of possible energy development alternatives that could guide energy policy.

A key issue in the energy outlook is the choice of new and existing electricity generation options (NEB, 1999). The *Government of Canada Action Plan 2000 on Climate Change* sets out a package of plans to develop and deploy emerging renewable and alternative energy sources to meet the demand for energy while reducing emissions. However, the preferred environmental-based policy is not necessarily the preferred social- or economic-based policy; several conflicting criteria must be weighted and evaluated. This study will contribute to the analysis of alternative energy development strategies through the development and application of policy-based SEA.

1.3.2 Research objectives

This research consists of three specific objectives. Objectives one and two develop the theoretical and conceptual foundations of this thesis; objective three demonstrates the applied nature of this research.

The first objective is to investigate the characteristics of 'good-practice' SEA. This objective consists of the following sub-objectives:

i. to examine the characteristics of SEA that make it *strategic* and, therefore, different from other forms of impact assessment;
ii. to provide an operational definition of SEA based on its strategic characteristics;
iii. to review the current 'state-of-the-art' of SEA, with particular attention given to the application of SEA at the policy-level.

The second objective, based on the characteristics of good-practice SEA, is to develop a practical and effective methodology for policy-level SEA. This objective consists of the following sub-objectives:

i. to review existing SEA methodological approaches and associated methods and techniques;
ii. to identify and discuss existing conceptual frameworks for SEA application;
iii. to develop a practical and effective methodological approach for policy-level SEA.

The third objective is to demonstrate good-practice policy-level SEA by applying this methodology to an assessment of alternative options for Canadian energy policy. This objective consists of the following sub-objectives:

i. to provide an overview of Canada's energy resource sector, policy, institutional structure and energy resources;
ii. to provide insight on the consideration of environmental factors in policy formulation in Canada, with particular attention given to the energy resource sector;

iii. to identify Canadian energy policy objectives, alternative energy scenarios, and potential alternative energy sources to guide the development of energy policy;
iv. to identify the best practicable environmental option for Canadian energy policy;
v. to present general recommendations regarding the methodological development of SEA.

1.4 Operational Definitions

1.4.1 Strategic environmental assessment

Strategic environmental assessment broadly refers to a higher-order type of environmental assessment at the level of policies, plans and programs. SEA is a short, concise analysis from which subsequent analyses will be tiered. SEA focuses on paths, not places, with the second level of analysis - EIA - focusing on the particular strategy the assessment yields (Clark, 2000). The last decade has seen the proliferation of literature on SEA, particularly from the European perspective (e.g. Partidario and Clark, 2000; Dom, 1996; Rumble and Therivel, 1996; Therivel and Partidario, 1996; Therivel *et al*, 1992), but despite this accumulation of literature, there still exists little consensus on a definition of SEA (e.g. Sheate *et al.*, 2001; Brown and Therivel, 2000; Noble, 2000; Barrow, 1997; CSIR, 1996; Court *et al.*, 1994).

Several authors have noted the need for a common SEA definition and understanding of its characteristics if SEA is to advance in methodology and practice (e.g. Clark, 2000; Partidario and Clark, 2000; Tonk and Verheem, 1999; Therivel and Partidario, 1996). Without a common understanding there is a fear that SEA may become no more than a catch-phrase, similar to 'sustainable', and lose its significance in the assessment process (Wood and Djeddour, 1992). The first objective of this research is to develop an appropriate definition for SEA based on its strategic characteristics, identifying what sets it apart from other forms of environmental assessment and appraisal.

1.4.2 Policy

Cunningham (1963) suggested that policy is easily recognized but not easily defined. Many authors have noted the lack of clear definition for policy (e.g. Buckley, 2000; Bregha *et al.*, 1990; Bartlett, 1989; Mitchell, 1989), and few developments have occurred since Mitchell's (1989) argument that the field of policy research is relatively underdeveloped in the geographic discipline in general. While there is no universal definition for policy, definitions proposed by Jenkins (1978) and Mitchell (1989) capture the essence of policy and are adopted in this research. Jenkins (1978: 15) defines policy as "a set of interrelated decisions...concerning the selection of goals and the means of achieving them". Mitchell (1989: 263) defines policy as "a pattern of purposive or goal-oriented choice and action."

Policy can be general or specific, stated explicitly in the form of white papers or ministerial speeches, or implicit, resulting from the incremental accumulation of decisions made over time (Bregha *et al.*, 1990). If policy SEA is to be effective, it must include not only formal policy documents, but also any instrument which gives effect to a policy (Buckley, 2000). When attention is focused upon conscious choice or strategic issues, Mitchell (1989) suggests that a distinction can be made between decision- and policy-making. Decision-making involves the process of choosing from a set of competing alternatives and balancing a number of constraints and factors. Policy-making involves a pattern of action and choices, which often extend over time and involve many decisions.

In one sense, decision-making involves identifying a single issue or alternative and is often treated as an end. In contrast, policy-making is often a goal-oriented process, identifying preferred means to an end. While decision-making is certainly not always policy-making, policy-making inevitably involves decision-making.

A variety of models describing the policy formulation process have been presented. Amongst the most familiar are the prescriptive and the descriptive models. Although this research is largely prescriptive in nature, demonstrating how policy decision-making ought to proceed in terms of SEA and the consideration of environmental factors, at the same time it is acknowledged that information may be lacking and that goals may be inconsistent and often conflicting with one another, characterizing the descriptive policy model.

Policy assessment is intended to be a "rational means to increase the effectiveness of decision-making in public policy" (Comfort, 1980: 35). While an attempt is made to establish an ideal methodological approach for policy SEA towards which policy-making should strive, it is acknowledged that rational decisions must be attempted in a complex, pluralistic environment. Policy decisions, characteristic of incomplete information and multiple objectives, are perhaps best described as subjectively rational (Radford, 1989). A subjectively rational choice is not universally maximizing, but is locally satisfying under the conditions and constraints in which it is made.

1.5 Research Rationale

1.5.1 Theoretical & conceptual perspective

Mitchell (1989: 23) stated that "many commentators have noted attempts to develop theory as one of the significant developments within geography" (e.g. Guelke, 1974; Kohn, 1970: 212; Moss, 1970: 14). At the same time, theory continues to remain poorly articulated for the discipline in general, and for resource management in particular. In simple terms, a theory can be defined as a plausible statement accounting for the relationship between two or more phenomena and is used as the basis for explanation and prediction. Thus, theoretical frameworks include statements having both explanatory and predictive power.

The theoretical underpinnings of this research are in the human-environment research tradition in geography. Originating from the writings of the Hellenistic period (Glacken, 1967), the human-environment research tradition focuses on the way in which individuals, groups, and cultures perceive, adapt, and modify the environment (Mitchell, 1989). Geographers have had a lengthy interest in examining the role of people in changing the natural environment through resource use. George Perkins Marsh (1864) published one of the earliest statements regarding the character and extent of changes to the natural environment as a result of human activity. Marsh suggested that the natural environment was not completely resilient to human intervention (Burton and Kates, 1965). Human activities frequently trigger a chain of events which impoverish the environment. As a result, Marsh urged protective and precautionary measures to ensure that human development was designed to minimize disturbance to the harmony in nature (Mitchell, 1989).

The study of human-environment interactions has often focused geographers' attention upon pressing resource and environmental problems (Biswas, 1981). Barrows (1923) suggested that geographers should be concerned with determining "the relationship existing between natural environments and the distribution and activities of man." Thus, for geographers, the human-environment research theme has set the context for contemporary environmental assessment (Greenberg *et al.*, 1978).

EIA was legally adopted in the United States in 1969 in response to the growing sense of the need to identify, evaluate, and make decisions about development proposals that could potentially have negative effects on the physical and human environment (Storey, 1995). Initially designed to address the environmental implications of human actions at the level of project development, more recent geographic research has illustrated that the nature of human impacts on the environment is often determined at higher levels of decision making (O'Riordan, 1971, 1976; Coppock, 1974; Mitchell, 1989). O'Riordan (1971: 119) emphasized the need to address the human-environment relationship at the policy level as it can reveal "the totality of forces in operation and aid the understanding of the processes involved."

In terms of this research, and its focus on SEA methodology and application, it is appropriate to make some reference to conceptualization. Conceptualization refers to defining the nature of a problem as well as identifying its parts and their relationships. The conceptual framework does not offer explanatory or predictive power, but can suggest how changes in one component may have impact on another. This research is based on the notion that the nature of environmental impacts typically is the result of higher-order decisions. Actions at one stage are conditioned by actions or inaction in previous stages and as decisions develop and progress from legislation and policies to projects, feasible alternatives become increasingly limited. While it is true, however, that higher-order decisions will set the context for actions at other levels of the decision-making process, SEA in practice is typically an iterative process of alternative, policy, plan and program assessment, rather than a tiered-forward, sequential process. Project, program or plan implementation can make evident the need for policy, which may develop subsequently. The 1999 Cabinet Directive on SEA (CEAA, 1999) currently outlines the need for the environmental assessment of the implications of policy, plan and program proposals, but provides little guidance on appropriate SEA methodologies.

1.5.2 Applied perspective

At the 24th Annual Conference of the New England Governors and the Eastern Canadian Premiers, 1999, the Northeast International Committee on Energy (NICE) tabled 'energy and the environment' as an area of key interest. NICE resolution 24-5 recognized the need to address issues regarding energy and the environment, including the consideration of new and existing energy alternatives in the development of sustainable energy policies. However, the traditional preoccupation of energy policy-makers has been to increase energy supplies to meet demands independent of energy and environmental policy. "This approach has implicitly traded off preserving environmental quality in favour of increasing energy supplies: no other economic sector has as great an impact on the environment as energy production, distribution, and use" (Bregha *et al.*, 1990: 34). Thus, the development of a practical and effective methodological approach for policy-level SEA is paramount if there is to be an incorporation of environmental considerations early in the energy policy process where there is greater decision-making flexibility. SEA would contribute to the fuller integration of energy objectives and environmental objectives, and hence the development of more sustainable energy policies.

While it is impossible to predict precisely what Canada's future energy demand will be, "in order to maximize the benefits of the development of our energy resources, we must plan not only for today but for the future, to seize new opportunities" (Newfoundland, 1994: 3). Planning for energy security requires an increased attention to existing and potential energy resources and an appreciation of the potential environmental implications associated with development alternatives (Newfoundland, 1996). A key element in the development of an energy policy is the establishment of a framework to consider all of the potential environmental impacts (Therivel *et al.*, 1992). Choosing an energy strategy inevitably means choosing an environmental strategy (WCED, 1987). The goal of early studies in energy policy should not be to identify a precise figure for energy demand, consumption, or levels of emissions for instance, but rather to give an indication of a practical and environmentally preferred energy strategy and the direction of change needed to meet specified goals and objectives.

1.6 Study Organization

This research is presented in seven chapters, including the introductory chapter. Chapter Two provides an overview of the principles and characteristics of SEA, its role in the policy process, and the current state-of-the art of SEA methodology. Chapter Three sets the context for the development and application of the SEA framework within the context of the Canadian energy policy. Chapters Four and Five outline the methodological requirements of this research and discuss the particular research methods and techniques used. The practical results of the framework application are discussed in Chapter Six. This is followed by a concluding Chapter, which discusses the lessons learned and issues raised by the research within the broader resource and environmental policy context.

Chapter Two

Strategic Environmental Assessment

2.1 Introduction

SEA has become one of the most widely discussed issues in the field of contemporary EA (Bartlett, 2001; Partidario and Clark, 2000; Glasson *et al.*, 1999). The volume of SEA literature, recent government efforts to develop national and state SEA frameworks and legislation, and the number of special sessions dedicated to SEA at international EA conferences and workshops reflect this growing interest. This chapter presents a review of the existing SEA literature and selected case studies. Particular attention is given to the identification of the underlying principles and characteristics of SEA in order to establish a working definition. This is followed by a discussion of the relationship between SEA and the policy planning process, and a review of the methodological state-of-the-art of SEA practice.

2.2 SEA Definition

A number of definitions for SEA have been proposed in recent years. While it is generally acknowledged that SEA involves the early consideration of environmental issues in policy, plan, and program (PPP) decision-making (e.g. Kessler and Toornstra, 1998; Tonk and Verheem, 1998; Barrow, 1997; CSIR; 1996; Sadler and Verheem, 1996; Sadler, 1995; Court *et al.*, 1994; Therivel *et al.*, 1992), there is no clear consensus for a definition of SEA (Clark, 2000; Partidario and Clark, 2000; Therivel and Partidario, 1996). The first objective of this research is to develop an appropriate definition for SEA based on its strategic characteristics, and to illustrate why SEA is strategic and therefore different from other forms of impact assessment and environmental appraisal. In order to do this the nature of SEA as an assessment tool is discussed, and its *strategic* characteristics are presented along with an evaluation of current, international SEA applications.

2.2.1. The Nature of SEA

Strategic environmental assessment is a 'higher-order' process by which PPPs and their alternatives are developed and assessed based on a much broader set of objectives and constraints than project-level EIA. Much has been written on the substantive issues of SEA in recent years, particularly in terms of capacity building in the planning process (e.g. Bartlett, 2001), tiering of PPP assessments (e.g. Fischer, 2001), and sustainable development (Sheate *et al*., 2001). While these substantive issues do not define the strategic nature of SEA, they can be important secondary benefits. The following discussion briefly reviews some of these more substantive issues, and their place in the SEA process, and sets the context for the nature of this particular research.

First, SEA is seen as having the potential to facilitate capacity building and a learning-oriented approach to policy and developmental planning. Considerable emphasis is placed on SEA as a soft-systems approach to policy planning and decision-making. The soft-systems approach addresses the front-end design of an unstructured problem (Checkland, 1999; Gregory, 1995). Emphasis is on SEA as a learning system and the nature of policy decision-making and how decisions are made, rather than on the systematic evaluation of the potential environmental effects of decision alternatives. As a case illustration, Bartlett (2001), for example, reviews the Kembla Grange strategic 'sustainability' assessment in New South Wales, Australia. The local community, government and industry were brought together to assess the Kembla Grange's development potential in terms of supporting "sustainable jobs, environment and communities" (DUAP, 2001). The assessment consisted of a series of small group scoping exercises to "stimulate dialogue about the site and the relevant planning problems and issues" (Bartlett, 2001). The results were then triangulated to identify priorities for further research. Bartlett (2001) argues that the soft strand of systems thinking holds significant potential in supporting participative, learning-oriented SEA.

The soft systems approach does play an important role in SEA, particularly in terms of developing and scoping PPP alternatives and strategic actions, and as a participative approach it facilitates learning and capacity building in the assessment process. However, while such characteristics are recognized as important to SEA, SEA as a scoping and learning framework alone does not provide opportunity for impact assessment.

Much has already been written in the business management and planning literature with regard to strategizing, facilitating group learning, and individual and small group decision-making processes for improved planning and decision-making (e.g. Nilsson and Dalkmann, 2001; Radford, 1989; Schwenk, 1988; Hudson, 1979) – this is not unique to SEA. While exercises such as the Kembla Grange planning sessions are effective scoping exercises with regard to identifying the key issues that an SEA is to address, such exercises alone do not formally assess the potential environmental effects of higher-order PPP decisions and PPP alternatives in an accountable, systematic manner.

Closely related to how strategic decisions are made is when such decisions are made. SEA is often presented as a 'tiered forward' planning process, where the strategic nature of

SEA is defined in terms of the timing and relationship between decisions at different tiers of the planning process (e.g. Fischer, 2001) (Fig. 2.1). Policies, plans and programs are often portrayed as a tiered forward planning process starting with the formulation of a policy, followed by a plan, and a program (Bailey and Renton, 1997; Barrow, 1997; Sadler and Verheem, 1996; Therivel and Partidario, 1996; Therivel *et al.*, 1992). PPP tiering is based on the notion of introducing SEA into the sequential planning process, which commences with the adoption of policies, proceeds to the approval of somewhat more concrete plans and specific programs, and finally reaches the stage of individual project implementation within that program. Fischer (2001), for example, suggests that SEA involves applying environmental assessment at the policy level and following it through to the planning and program implementation stage. "Only a tiered approach to SEA…will ultimately lead to assessments scoring well in the potential SEA benefits presented in the literature" (Fischer, 2001: 50).

This tiered-forward, planning approach to SEA implies a clear distinction and a hierarchical and even chronological order of actions. While tiering arrangements are advantageous and attractive from a "normative" perspective, in practice it rarely works like this. It is true that higher-order decisions will set the context for actions at other levels of the decision-making process, certainly, SEA at the policy level may develop "bottom-up" as a result of combinations of strategic decisions made at the planning, program, or project level. PPPs are normally presented in such an 'ideal-typical' tiered sequence, but this sequence can vary. Project, program, or plan implementation can make evident the need for policy, which may develop subsequently. For example, recent project-level developments aimed at Canadian bulk water export have made evident the need for a

	Category of action and type of assessment (in brackets) Sectoral and multi-sectoral actions				
Level of Government	Energy use & efficiency plans (SEA)	Policies (SEA)	Plans (SEA)	Programmes (SEA)	Projects (EIA)
National/ federal	National energy use and efficiency plan	National energy policy	Long-term energy efficiency and renewable energy plan	Renewable energy development program	Construction of hydroelectric facilities
Regional/ state	Regional energy use and efficiency plan	National economic and environmental policy	Regional strategic plan		
Sub-regional	Sub-regional energy use and efficiency plan			Sub-regional investment programme	
Local	Local energy use and efficiency plan				Local infrastructure project

Figure 2.1. Tiered planning and assessment (SEA). Simplified representation of the complex set of relations between policies, plans, and programs. In general, those actions at the highest level are likely to require the broadest and least detailed form of SEA. (Adopted from Barrow, 1997; Glasson *et al.*, 1996; Therivel, 1993; Therivel *et al.*, 1992; Lee and Wood, 1978).

broader environmental and resource policy framework. Similarly, Andre and Gange (2000) report that the problems associated with the traditional project-level approach to mitigating transportation-related noise impacts in Quebec, Canada, have made evident the need for a more 'strategic' approach to transportation impact assessment at the planning level. It is possible that groups of programs may cumulatively lead to the development of a much broader environmental policy.

Finally, recent developments in SEA have helped to revitalise discussions on sustainable development and sustainability assessment (e.g. Sheate *et al.*, 2001; Gibson, 2001; Partidario and Moura, 2000). In recent case studies the role of SEA is often related to sustainability goals, such that SEA operates to improve the design of more sustainable policies and strategies. The aim is to "test whether policies or plans have led to, or are likely to lead to, sustainable development, and, if necessary, to amend them" (George, 1999: 176). By evaluating a PPP against specific sustainability criteria, its contribution to sustainable development should become clear (George, 1999). For example, the Dutch-Canadian Workshop on Environmental Assessment (Burger, 1992) outlines a number of policy-level sustainability indicators for the environmental test, or 'E-Test', including the quantity and quality of waste and emissions flows, and levels of energy consumption. On the national scene, recent amendments to the *Auditor General Act* 1995 c.43 s.5 require that all Canadian federal departments and agencies:

> 24. (1) …to prepare a sustainable development strategy for the department and shall cause the strategy to be laid before the House of Commons…

and

> (2) …the department's sustainable development strategy is to be updated at least every three years.

These sustainable development strategies have the potential to set measurable goals and objectives for sustainability, which may prove useful when seeking particular benchmarks and indicators for SEAs within particular sectors of the economy.

While sustainable development does provide a vision, there is not always a clear path to achieve it (Mitchell, 1997). The role of sustainability in SEA is recognised as important, but it is equally important to note that SEA is not sustainable development nor is it necessarily *defined* by sustainability principles. SEA does (and should) have the potential to contribute to sustainability, but sustainable development is not unique to SEA; it may be one aspect of it, just as it is to EIA, policy evaluation, and planning processes. SEA is not exclusively sustainability-led. Objectives, visions, and goals can just as easily and rightfully be based on socio-economic demand, desired social outcomes, and fiscal objectives, as they can on sustainability criteria. For example, the SEA for water provision in Kent (Binnie and Partners, 1991) is a demand-led assessment, while the strategic assessment of the potential for fish farming in Africa (Kapetsky, 1994) is guided by the desire to develop under-utilized resources.

These substantive issues are recognized as important in the development of SEA, however, there exists a need to address the more 'process-oriented' issues of SEA – the 'how to' – if SEA is to advance in application and effectiveness (e.g. Noble and Storey, 2001; Verheem and Tonk, 2000; Glasson *et al.*, 1999; Partidario, 1996; Bridgewater, 1989). Conceptually, SEA commences with the development and identification of PPP alternatives through the planning process, is set in a tiered planning framework, and makes some overall contributions to broader goals and objectives, such as sustainability. However, without a structured and systematic assessment process to guide SEA application, the benefits of 'higher-order' assessment will not be realized. Evaluating the potential impacts of PPPs and PPP alternatives at the strategic level requires a different methodological approach than EA at the project level because strategic assessment is an objectives-led assessment and therefore asks different types of questions.

This research adopts a process-oriented and technocratic approach to SEA. The emphasis is placed on SEA as an assessment tool to aid the decision-making process and the identification of potential, preferred decision actions (e.g. Galsson *et al*., 1999). The outcome of SEA does not present 'the decision', but rather the systematic assessment of decision alternatives and their potential environmental or socioeconomic impacts such that the final decision-maker, or the decision-making institution, can make an informed choice[1]. SEA is not a substitute for decision-making, but it does help clarify some of the trade-offs associated with a PPP or alternative and provides a systematic evaluation, which leads to more rational and structured decision-making (Glasson *et al*., 1999).

It is argued here that a technocratic approach to impact *assessment* is required if SEA is to avoid becoming a "quasi-concept" where anything and everything is a SEA. At the same time, it is recognized that in order to be an effective assessment tool at the strategic level, SEA must integrate the principles of strategic decision-making, consider multiple aspects of the socioeconomic and natural environment, and find its place in the resource and environmental planning framework (Fig. 2.2). This research then, is process oriented, emphasizing the strategic impact assessment process. Although this approach closely reflects that of project-level EIA, SEA is inherently different from project-level EIA as it addresses different types of questions and at different tiers of decision-making.

[1] See Article 12, Section 1, p. 18 of the UN 2001 Draft Elements for a Protocol on SEA.

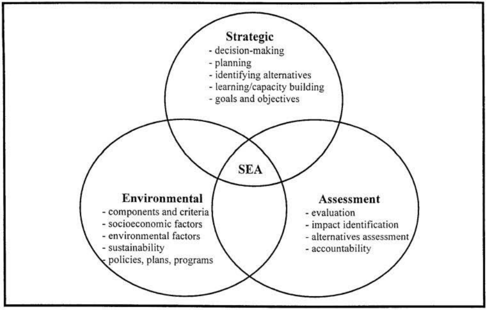

Figure 2.2. Components of SEA.

2.2.2 What Makes SEA "Strategic"?

In the context of strategic environmental assessment there appears to be very little attention, if any at all, given to defining the basic meaning of the term "strategic" (Noble, 2000; Partidario, 1996). While SEA is given increasing attention in the literature, there are few attempts to explain why certain assessments are strategic and how they differ from those that are non-strategic. Therivel and Partidario (1996), for example, infer that SEA addresses the "strategic component in decision instruments at the policy, plan or program level", but they fall short in adequately addressing the meaning of "strategic." These issues should be clarified if common understanding is to be achieved.

Often it is the case that assessments have some strategic characteristics, but a closer review of the assessment reveals a strong conceptual similarity and approach to project-based impact assessment and evaluation studies. A review of recent SEA literature, including Fischer, 1999; Hedo and Bina, 1999; Marsden, 1998; CSIR, 1996; Therivel and Partidario, 1996; Wood, 1995; Therivel *et al.*, 1992, suggests several criteria that make SEA strategic, and therefore different from traditional impact assessment (Table 2.1). These characteristics are discussed by Noble (2000) and summarized in the following sections.

Emphasis on strategy

According to Baetz and Beamish (1987), the common element in discussions on strategic is an emphasis on strategy. Strategy, however, is too often indiscriminately used in an attempt to add more importance or significance to a variety of topics, including EIA.

Table 2.1. Defining characteristics of EIA and SEA.

EIA	SEA
Represents an end. • Brings closure to an issue or undertaking.	*Leads to a strategy for action.* • A means to an end.
Goals and objectives are pre-determined • EIA predicts the potential outcomes of an already pre-determined strategic option.	*Set in context of broader vision, goals and objectives.* • Examines strategies to accomplish particular goals and objectives.
Asks "what are the impacts of our option?" • Focuses on "option alternatives" rather than "alternative options" • Addresses available options at the project level in terms of a pre-determined alternative or option. • Alternatives are often limited to issues of technical design and location specifics. • Theoretically, contains a "no action" alternative – a choice can be made not to proceed. • Management emphasis on mitigating likely negative outcomes and design of management systems	*Asks "what is the preferred option?"* • Focuses on "alternative options" rather than "option alternatives" • Broader range of alternatives at an early stage. • Contains a "no change" alternative – something will be done to help reach the goal, that could include maintaining the existing pathway – "no action" is not an alternative. • Minimise negative outcomes by selecting the "least negative" alternative at an early stage.
Forecasts • Predicts and assesses the likely outcomes of a specific undertaking.	*Backcasts, then forecasts.* • Determines a range of options based on a vision, and then forecasts the likely outcomes of each option.
Reactive • An option is chosen and the EIA is designed to react to, or assess, that particular option. • Definitive: well-defined beginning (project proposal) and end (decision to proceed or not) to the assessment of a single undertaking. • Limited to only one particular stage of application.	*Proactive* • Creates and examines alternatives leading to the preferred option. • On demand: a process that can be implemented at any time should strategic choices not be meeting specified visions and objectives, or should new visions, goals and objectives develop.
Project-specific • Assessment of a particular proposed undertaking.	*Not project-specific* • Focus is on alternatives, opportunities, regions and sectors.
Narrow focus and highly detailed. • Focus is on a pre-determined alternative option. • Assessment is generally technical, often quantitative and highly detailed.	*Broad focus and low level of detail* • Focus is on a broad set of alternatives. • Focus broadens moving upscale from programs, plans, and policies to policy alternatives. • Assessment is broad, usually non-technical and qualitative.

Source: Noble (2000).

Strategy is derived from the Greek word *strategos* or the "art of the general", that which has to do with determining the basic objectives and finding the means to achieve them. In military terms, strategic generally refers to "the employment of the battle as the means to gain the end of war".

Koontz *et al.* (1976) define strategies as general programs of action and development of emphasis and resources to attain comprehensive objectives. In the business literature, strategies are broadly defined as plans for achieving goals, stated in such a way so as to "define what business the company is in or is to be in and the kind of company it is or is to be" (Andrews, 1971). A strategic approach is one in which the determination of the basic long-term objectives and the adoption of courses of action and allocation of resources necessary to achieve these goals is developed. In other words, according to Therivel *et al.*, (1992), strategic refers to a strategy or scheme for development and decision-making. The strategic component, then, is the set of principles and objectives that shape the visions and development intentions incorporated in a set of alternatives, policy, plan, or program (Mitchell, 1997; Partidario, 1993 and 1996). Curtis (1994), Dickerson and Flanagon (1994), Dyson (1991), and Schwenk (1988) agree that a strategy is the process of defining goals or visions in terms of the desirable principles to be established, proposing alternative possibilities to achieve these principles, and selecting the most desirable approach. SEA, then, is a larger process or means that identifies, evaluates and leads to a strategy for action. The key component in SEA is strategy – the art of the general; the prelude to the beginning; the determination of objectives and means, and the adoption of courses of action to achieve specified ends.

Visions and alternatives

Mitchell (1997) explains that a vision requires an accompanying process to identify issues and problems, assemble the necessary issues and viewpoints, determine alternative solutions, and select a course of action. In essence, these are the basics of strategic environmental assessment. If there is no sense of vision regarding a desirable future, according to Mitchell (1997), then almost any choice will do. Without an identified vision or set of goals, we will end up assessing the likely impacts as opposed to the most desirable impacts. If we have a vision or set of goals, we can intervene and evaluate alternatives to select the appropriate direction (policy, plan or program) that will most likely reach our vision. Once our direction is determined the process is no longer strategic, since subsequent evaluations involve determining the likely impacts of an already determined specific type of action.

A parallel exists between EIA and SEA and the processes of "forecasting" and "backcasting". Forecasting extrapolates into the future to address probable futures and assess dominant, or likely, trends (Dreborg, 1996). An EIA of a proposed hydroelectric facility, for example, aims to predict the most likely impacts and to make the necessary adjustments to avoid or to mitigate those impacts, allowing the proposed development to proceed in an environmentally acceptable fashion. The alternative of hydroelectric power has already been determined before the assessment takes place. Minor variations may be assessed, such as technical design, but the strategic decision (i.e. the preference for hydropower) has already been made. EIA considers only 'option alternatives' as opposed to 'alternative options' (Table 2.1).

The preoccupation of traditional EA practice has been to predict the most likely impacts of a proposed undertaking and to undertake the necessary actions to manage those potential impacts. However, forecasting approaches are inherently conservative and "biased toward producing images of the future which are derivatives of the status quo" (Mitchell, 1989: 64). This is illustrated dramatically, for example, by the history of energy supply and demand forecasting in Canada (Mitchell, 1989; Helliwell *et al.*, 1983; Robinson, 1983). In the late 1960s it was estimated that a substantial surplus of natural gas would exist by the 1990. However, as Mitchell (1989) explains, by the mid-1970s, the situation had reversed with a significant deficit being forecast. The forecast was reversed again near the end of the 1970s, but turned once more in the 1980s, predicting a large surplus for 1990.

SEA utilises both backcasting and forecasting respectively. Backcasting focuses on what is required to achieve desirable futures and is designed to determine the consequences of different choices regarding the preferred future endpoint (Dreborg, 1996). The general approach is to work backwards from a future endpoint in order to determine the specific actions necessary to achieve it (Mitchell, 1997). Future goals and objectives are defined and alternative means of achieving those goals and objectives are evaluated. Similarly, SEA deals with visions, goals, objectives and alternatives, representing the means to an end. For example, if the desired endpoint is an increase in the supply of electricity to a developing region, the SEA process will assess the feasibility of achieving the future endpoint and propose a range of alternative means to supply that electricity. SEA does not contain a "no action" alternative, but rather assumes something will be done to address the need or objective, including the "no change" alternative. The desire to increase the supply of electricity must be addressed, but the alternative means may be to increase the efficiency of the existing energy production system, as opposed to the development of alternative production systems. The alternatives selected to meet the desired endpoint will ideally be set in the context of a broader environmental vision, such as sustainable development or sound environmental and economic growth. Once goals are identified and objectives are set, alternatives for increased energy production are assessed against particular criteria (e.g. sustainability criteria, acceptable levels of environmental change, economic/financial criteria, required amount of energy production increase) to forecast the likely outcomes of each alternative. Each alternative that meets the criteria and is within the context of the targets and vision is reassessed. After the most desirable alternative (e.g. hydropower) has been chosen, the assessment of the alternative and its likely impacts is no longer strategic. The distinction between these processes – strategic and non-strategic – is presented in Figure 2.3.

This is not to say, however, that SEA cannot occur for an already existing PPP, if that activity is not meeting a particular vision or set of goals, such as a pre-determined level of environmental quality. If, for example, an existing hydropower program is not meeting the goals set under sustainability objectives for the area, a strategic assessment of alternative means of achieving this objective, or scoping alternative objectives, can be implemented. While PPPs are often claimed to be at the centre of attention for SEA, the actual focus of strategic assessments is on strategic alternatives.

There is no one specific type of alternative that must be incorporated into SEA. Moreover, there is no particular point in time, i.e. policy, plan, or program level, at which

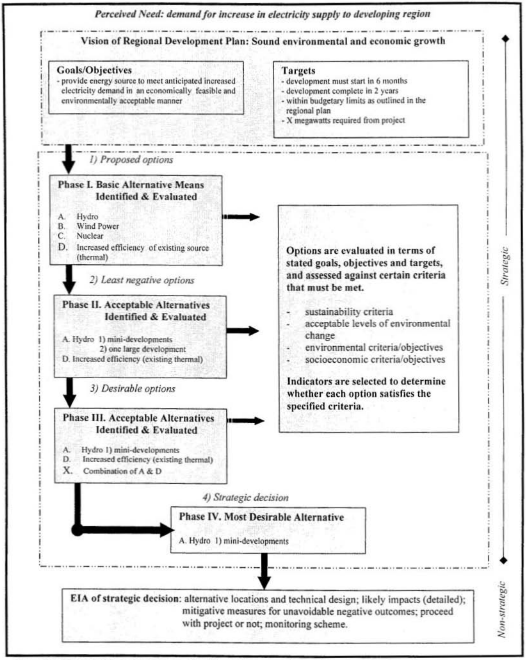

Figure 2.3. Simplified hypothetical example of the SEA process, distinguishing between strategic versus non-strategic phases (Noble, 2000).

these alternatives must be assessed (Verheem, 1992). Alternatives considered in SEA can be grouped as follows (Fig. 2.4):

i) Alternatives to meet a need or to address a problem

a) there is a particular demand for an action or a problem that needs to be addressed; alternative PPP options are presented, evaluated, and the preferred PPP approach is selected; although PPPs are likely to be one outcome of the selected alternative, they need not be a part of the initial need, problem, or purpose of the strategic assessment.

ii) Alternatives to a proposed PPP

a) when a PPP is proposed, strategic alternatives to the PPP are developed and assessed; the strategic assessment evaluates the proposed PPP and suggests alternatives in terms of a broader vision, goals and objectives; the most desirable alternative(s) is selected, which may be the original PPP or variations thereof, to meet the specified vision, goals and objectives; it may also be the case that the strategic assessment results in the selection of new desirable ends, goals and objectives.

iii) Alternatives to an existing PPP

a) a PPP may already exist that is not meeting its intended goals and objectives; strategic alternatives may be suggested, assessed, and a more desirable PPP, or an alternative form of the existing PPP, may be selected as a more effective means

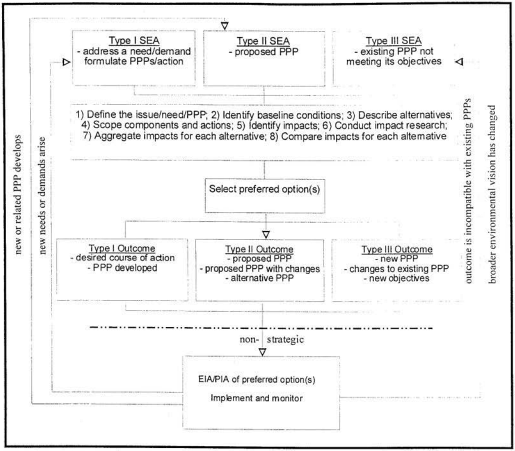

Figure 2.4. Types of SEA as defined by strategic alternatives.

Objectives, targets, and criteria

There has been frequent reference in the previous sections to setting visions, objectives, targets, and criteria. A vision bas been defined as a desirable future condition, or the anticipation of a desirable outcome or endpoint. Visions are generally set in a broad context, such as sustainability, or a desired level of environmental quality. The importance of the vision, as previously discussed, is to set the context for goals, targets, criteria, and indicators, as we propose and assess our alternatives. Goals and objectives represent the specific aim, purpose, intent, mission, or end that is to be accomplished, and may address a particular problem or need, or lead to the development of alternative goals and objectives. Targets are certain marks or milestones that we aim to accomplish; these may range from a specified timetable to certain budgetary requirements. Criteria are the specific parameters, guidelines, or standards that must be met; choices, targets, and goals must meet certain criteria, such as a carrying capacity, or a set limit of environmental change, and are usually set in the context of the broader environmental vision.

Indicators are gauges, or things that are meaningful and relatively easy to measure (qualitative or quantitative) to help determine whether each alternative will meet specified criteria. Whereas EIA can be used to evaluate possible alternatives to reach an end, the emphasis is upon 'option alternatives' rather than ' alternative options'. Where EIA predicts the potential outcomes of an already predetermined option, SEA involves examining the particular goals and objectives to be accomplished and assessing the various alternative options by which they can be met with reference to certain targets and criteria. SEA involves more than expanding existing protect-level assessment to the strategic levels of decision-making, SEA is an objectives-led assessment (Glasson *et al.*, 1999).

Proactive approach

Numerous SEA reviews, as well as recent SEA case studies, note the importance of a proactive approach to SEA (e.g. Buckley, 2000; Connelly, 2000; DEAT, 2000; CEAA, 1999). SEA acts in anticipation of future problems, needs, or challenges and creates and examines alternatives leading to the preferred option. In other words, a proactive approach is one that identifies alternative 'desired ends' and seeks the preferred option among a variety of alternative options to reach the most desired end. As illustrated by Bond and Brooks's (1997) "best practicable environmental option" framework for transportation plans in the United Kingdom, SEA involves the development of a range of alternative courses of action and then assesses each possible alternative to arrive at the preferred course of action within the context of the broader environmental vision.

As a proactive approach, SEA is a continuous process. It is not continuous in the sense that it is an on-going process, but in the sense that it is on demand and can be implemented at any stage of the 'tiered forward' PPP decision-making process to inform strategies for action. A reactive approach, in contrast, such as EIA, responds to particular stimuli to bring closure to a specific issue or undertaking. The course of action is predetermined; the "reaction" is to assess its potential consequences. EIA cannot be implemented at any point of the decision making process but rather has a discrete beginning and end. Ideally SEA and EIA are considered in sequence where SEA proactively examines a range of alternatives and selects the preferred course of action, and EIA is initiated reactively to determine in greater detail the potential impacts of the preferred alternative.

Broad-brush and non-technical

SEA is not project-specific. The focus is on identifying alternative options and opportunities for regions and sectors rather than on identifying the potential outcomes of options to a predetermined alternative. The scope of SEA will differ depending on the level of application (policy, plan or program) but it is typically more broad-brush than project-level assessment. This approach reflects the attempt to determine an appropriate strategy for action rather than to predict the potential outcomes of individual actions. The higher the order of decision making (i.e. moving from the program to the policy level) the more broad is the strategic approach. The SEA of alternatives for a national energy policy, for example, will have a broader focus than the SEA of alternatives for a regional energy efficiency program.

As the scope of SEA broadens, so do the methods and techniques. SEA typically reflects a less technical and detailed quantitative approach than project-level assessment. Techniques that are applied at the project-level become less useful as the SEA process broadens from the program level to the planning and policy levels. At the policy level, the majority of SEA applications are methods or combinations of techniques (e.g. scenario analysis) rather than phenomenon-specific techniques *per se*, reflecting the nature of 'higher-order' assessments.

2.2.3 Applying the Characteristics: State-of-the-art

Applying the above SEA principles and characteristics to a review of selected case studies indicates that not all [author-defined] SEAs that have been completed are in fact strategic in nature; many are simply various forms of project or program assessments and appraisals. Table 2.2 presents a review of twenty-two case studies from the literature, of which only cases one through twelve can be clearly identified as demonstrating the characteristics of a strategic assessment based on the criteria discussed above.

The majority of the assessments reviewed are sector-based, with comprehensive land use planning, waste management, and transportation planning being the main sectors. They are all proactive assessments, set in the context of broader visions, goals, and objectives, leading to a strategy for action, and considered a wider range of alternatives to determine the preferred option. For example, the SEA of drinking water management and production plans in the Netherlands (Case 11), was carried out to determine the potential impacts of alternative national water management policies and plans, and to compare alternative drinking water production plans within the context of broader ecological sustainability goals. The emphasis was placed on the *why* and the alternative means available to meet particular goals and objectives, rather than on the what, how and where, of drinking water production and distribution.

The remaining ten of the twenty-two cases reviewed are predominately reactive, forecasting the likely outcomes of a predetermined alternative option(s), and bringing closure to a particular issue. For example, in some cases, such as the assessment of hydrological and irrigation plans in Castilla y Leon, Spain (Case 13), alternative options were introduced late in the decision-making process. The assessment of alternatives focuses more on the identification of potential adverse impacts and alternative recommendations for major changes to the existing draft plan (Hedo and Bina, 1999), rather than leading to a strategy for action. The assessment was an exercise to mitigate

Table 2.2. Scan of strategic criteria and selected case studies.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
"strategic" characteristics																							
Leads to a strategy for action	•	•	•	•	•	•	•	•	•	•	•	•											
Examines goals, visions and objectives	•	•	•	•	•	•	•	•	•	•	•	•	•	•									
Asks "what is the best option?"	•	•	•	•	•	•	•	•	•	•	•	•				•							
Backcasting (and forecasting)	•	•	•	•	•	•	•	•	•	•	•	•											
Proactive	•	•	•	•	•	•	•	•	•	•	•	•										•	
Not project-specific	•	•	•	•	•	•	•	•	•	•	•	•	•	•						•		•	
Low level of detail	•	•		•	•	•	•	•				•			•		•	•		•	•	•	•
Broad focus	•		•	•	•	•	•	•	•	•	•	•				•				•	•		
"non-strategic" characteristics																							
Represents an end													•	•	•	•	•	•	•	•	•	•	•
Pre-determined goals and objectives														•	•		•	•	•	•	•	•	•
Asks "what are the impacts of the action/s?"													•	•	•	•	•	•	•	•	•		•
Forecasting														•	•	•	•	•	•	•	•		•
Reactive													•	•	•	•	•	•	•	•	•		•
Project-specific															•	•	•	•	•		•		•
High level of detail			•						•	•	•		•	•		•			•				
Narrow focus		•											•	•	•		•	•	•			•	•
case-study type																							
Energy sector		•																	•				
Forestry sector														•	•								
Transportation sector							•																
Waste management sector	•			•																			
Other sector								•	•	•	•		•										
Comprehensive land use planning					•	•						•				•						•	•
Policy-based																	•	•		•	•		
Is it strategic?	•	•	•	•	•	•	•	•	•	•	•	•											

1. SEA of restoration and waste management programs in the United States (Webb & Sigal, 1996)
2. SEA of wind farm development proposals in Germany (Kleinschmidt & Wagner, 1996)
3. SEA of the trans-European transportation network (Dom, 1996)
4. SEA of the Dutch 10-year program for waste management (Verheem, 1996)
5. SEA of Hertfordshire County council's structure plan (Rumble and Therivel, 1996)
6. SEA of comprehensive land use planning in Sollentuna, Sweden (Asplund & Rydevik, 1996)
7. Best practicable environmental option for transportation planning in the UK (Bond & Brooks, 1997)
8. SEA for water provision in Kent, UK (Binnie and Partners, 1991)
9. An assessment of the potential for warm water fish farming in Africa (Kapetsky, 1994)
10. An assessment of the potential for freshwater fish farming in Latin America (Kapetsky & Nath, 1997)
11. SEA for drinking water management and production in the Netherlands (Verheem, 2000)
12. Assessment of management options for Rio Dulce National Park, Guatemala (Ensminger *et al.*, 1998)
13. SEA of hydrological and irrigation plans in Castilla y Leon, Spain (Hedo & Bina, 1999)
14. SEA of the Bara Forest management plan (Khadka *et al.*, 1996)
15. SEA of comprehensive land use planning in Karlskoga, Sweden (Asplund & Rydevik, 1996)
16. SEA of the San Joaquin County General Plan 2010, California, US (Skews-Cox, 1996)
17. Policy-oriented impact assessment of climate variations (Chen, 1987)
18. Macroeconomic impacts of an EEC policy to control air pollution (Klassen & Nentjes, 1992)
19. SEA for restructuring of the US nuclear weapons complex (US Department of Energy, 1992)
20. North American Free Trade Agreement SEA (Canada, 1992)
21. SEA of a Danish subsidy scheme for private urban renewal (Elling, 1997)
22. Kembla Grange strategic sustainability assessment (Bartlett, 2001)
23. SEA of the Neiafu Master Plan, Vava'u, Tonga (Morgan & Onorio, 2000)

* Some case studies were reviewed based on secondary sources.

likely negative effects rather than a strategic approach to minimize potential negative outcomes by selecting the "least negative" option(s) early in the planning process. In other cases, such as such as the Kembla Grange's strategic sustainability assessment (Case22), no actual environmental assessment actually took place as the process did not move beyond the scoping phase.

The SEA of the Neiafu Master Plan (Case 23) is different again and is better described as a programmatic assessment, focusing on the area-wide assessment of multiple development activities. Programmatic assessment involves grouping sets of actions that are geographically linked, generic, or at the same stage of technological development, into a single, broader, environmental assessment and site-specific analysis. The purpose of the Neiafu SEA was to address the potential environmental impacts of a set of proposed development activities within the Neiafu region of the Vava'u islands, "that might possibly have the same effects on the same geographical area" (Morgan and Onorio, 2000). The emphasis was placed on identifying potential biophysical and socioeconomic impacts and mitigating those impacts, rather than on identifying strategic alternatives and selecting the preferred, practicable option.

Whether programmatic assessments are strategic in nature is arguable and case sensitive. The US Department of Energy's programmatic environmental impact statement of an environmental restoration and waste management program (Table 2, Case 1), for example, is a strategic assessment that provides information on policy and programmatic alternatives, in the context of a broad vision and set objectives. On the other hand, the Department of Energy's programmatic assessment for restructuring a nuclear weapons complex (Table 2, Case 19), similar to the Neiafu SEA, does not conform to the definition of a strategic approach given above. The assessment applies EIA to a large geographic scale, but alternatives are limited, the focus is narrow, and the issue is project-specific. Equating SEA at the program level with programmatic assessment should be done only on a case-by-case basis, after the programmatic assessment process is carefully evaluated for its strategic characteristics.

Types of SEAs

Based on the type of actions being considered, SEAs can be grouped into three categories: sectoral, comprehensive, and policy SEA (Table 2.2). Examples of sectoral SEA application include the assessment of the best practicable environmental option for transportation planning in the UK (Bond and Brooks, 1997), and the assessment of alternative options for the Dutch ten-year program for waste management (Verheem, 1996). Comprehensive SEAs are exemplified by Asplund and Rydevik's (1996) review of comprehensive land-use plans in Sollentuna, Sweden. The practical application of formalised SEA at the policy level is limited. While a number of proclaimed policy-level SEA applications do exist, (e.g. Table 2.2: Case 19 – US nuclear weapons complex SEA; Case 20 – NAFTA SEA), the limited numbers of formal SEAs prepared to date under any legal SEA framework have been carried out primarily for plans and programs, with little or no attention to policies (DEAT, 2000).

Working Definition

The review of SEA case studies presented in the previous section demonstrates that not all assessments identified as SEAs are in fact strategic in nature. On the other hand, there are those assessments not specifically identified as SEAs that indeed appear to be strategic. For example, McCarthy (1996), Krohn (1997) and Stone (1997) suggested that there are many examples of strategic planning in Australia that incorporate the principles and characteristics of SEA, but do not have the SEA label, such as the environmental assessment prepared for the development of a management strategy for the Great Barrier Reef Marine Park (RAC, 1993). Similarly, Kapetsky's (1994) assessment of the potential for warm-water fish farming in Africa (Table 2.2, Case 9) does not carry the SEA tag, but does demonstrate all of the characteristics of a *strategic* assessment.

Tonk and Verheem (1998) suggest the need for adoption of a clear definition of SEA to sell the benefits of its application. Based on the *strategic* characteristics identified above, the following definition for SEA is suggested:

> *SEA is the proactive assessment of alternatives to proposed or existing PPPs, in the context of a broader vision, set of goals, or objectives to assess the likely outcomes of various means to select the best alternative(s) to reach desired ends.*

This definition will be adopted for the remainder of this thesis. The reason for a narrow definition is to emphasize SEA as an *assessment* process, rather than a quasi-planning concept. It is important to remember, however, that SEA is an issues-driven concept. The specific form SEA takes will to a large degree depend on the specific vision, objectives, targets, and alternatives in question.

2.3. THE ROLE OF SEA IN THE POLICY AND PLANNING PROCESS

The term 'policy' is typically used to describe a range of different activities including (i) defining objectives (ii) setting priorities (iii) describing a plan and (iv) specifying decision rules. Policy analysis (PA) is defined as the continuous evaluation and review of policies as they are planned and implemented, in terms of the objectives they are designed to meet (Boothroyd, 1995). The SEA of policies and legislative proposals is arguably the most significant type of SEA, as large-scale government policies commonly have more far-reaching effects than individual development plans, programs and projects (Buckley, 2000; Bothroyd, 1995; Bregha *et al.*, 1990; Clark and Herington, 1988; Coppock, 1974; O'Riordan, 1971, 1976). In a survey of Commonwealth and state government agencies in Australia by Bailey and Renton (1997), government officials were asked to indicate where, if at all, in the policy and planning decision-making process it would be appropriate and most effective for them to consider environmental effects. The most common response – 63 percent – was 'during agency policy formulation.' Sadler (1996) in an *International Study of the Effectiveness of Environmental* Assessment outlines "extending SEA as an integral part of the policy process" as one of the key agendas for EA research and development. The importance of SEA at the policy level is further echoed by Section 2.2.1 of the *1999 Cabinet Directive of the Environmental Assessment of Policies, Plans and Programs* (CEAA, 1999), which states that:

> ...To support sound decision-making...the consideration of environmental effects should begin early in the conceptual planning stages...before irreversible decisions are made.

What follows is a review of the Canadian public policy process, particularly as it relates to resource and environmental policy. The potential role of SEA in the public policy process is discussed, and the current state-of-the art of policy-level SEA is reviewed.

2.3.1 Resource Policy Frameworks in Canada

Policy analysis assists in identifying policy successes and failures – what works and what doesn't – and the factors that contribute to those particular outcomes. Policy analysis originated during the 1950s in the US to address the need for a more rational basis to public policy decision-making. A variety of models describing the policy process are presented in the policy analysis literature (e.g. Jenkins, 1998, 1978; Winsemius, 1986; Dye, 1972; Lineberry and Sharkansky, 1971), but few works have systematically examined the overall Canadian natural resource and environmental policy process (Hessing and Howlett, 1997). Despite a large literature on a variety of aspects of Canada's natural resource sector and the operation of the Canadian political economy and government policies toward the sector, there has been very little said about Canada's natural resource and environmental policy-making processes (Hessing and Howlett, 1997).

Two policy frameworks were offered in the early 1980s in an attempt to develop taxonomies of relevant political and economic variables in the Canadian natural resource and environmental policy process. The first framework was the 'public choice' or 'rational choice' framework, proposed by Sproule-Jones (1982). The second framework was the 'institutional-ideological' framework, proposed by Doern and Toner (1985) in their work on the Canadian National Energy Program.

The public choice model attempts to link together the economic, political and decision-making aspects of the overall policy process concerning natural resources. Its emphasis is on the individual decision-maker as the appropriate unit for policy analysis, and on the costs and benefits of policy decisions that impact on the individual, rather than on groups, corporate bodies, or government (Hessing and Howlett, 1997; Sproule-Jones, 1982). The institutional ideological framework emphasizes the institutional context of natural resource and environmental politics, in that policy development takes place within the context of the institutions of representative government and the policy interests with which these institutions deal must be addressed.

In contrast to the public choice model, which relies on maximizing individual self-interests, the institutional model defines interests according to 'ethical and procedural norms and values' that various actors bring to the policy process[2] (Hessing and Howlett, 1997).

While both frameworks attempt to develop a conceptual tool for understanding natural resource policy-making, there are at least two identifiable limitations (Hessing and Howlett, 1997). First, neither model generates a clear sense of where the policy process begins and how to proceed in the process of evaluating policy decisions and policy decision-making processes. Second, both frameworks have difficulty establishing the roles played by interests and actors in the policy-making process. Taken individually, neither framework is able to capture the entire range of actors and sub-actors involved in the policy process. "Resource and environmental policy is forged by a variety of policy actors dealing with constantly changing knowledge, information and technology" (Hessing and

[2] See B. Doen and G. Toner 1985. *The Politics of Energy: The Development and Implementation of the National Energy Program*. Toronto: Methuen.

Howlett, 1997: 90). The Canadian public policy environment consists of two key policy subsystems: the policy community and the policy network (Hessing and Howlett, 1997). There are a variety of actors within the policy community who influence the course of public policy decisions. These include, for example, state policy makers (administrative, judicial and political), representatives of non-government organizations, the media, academics, industry, and the general public who, for whatever reason, may have taken an interest in the subject (Herman *et al.*, 1994). However, it is still the sectoral policy networks, which interact more within the formal institutions and procedures of government, who effectively hold power and forge the policy paradigm.

Dunn (1988) notes that a more conventional and usable framework for natural resource and environmental policy analysis can be derived from the general model of the public policy process devised over the past four decades. This framework, commonly referred to as the 'policy-cycle' model, attempts to simplify the public policy process by breaking it into a series of decision-making stages, and highlights the significance of rational calculations of actor self-interest and policy ideas, ethics and values (Hessing and Howlett, 1997). In short, the policy-cycle model can be described in terms of an iterative five-stage process (Fig 2.5) (Bots and Hulshof, 2000; Howlett and Ramesh, 1995).

The first stage, agenda setting, refers to the process by which problems come to the attention of governments. "The agenda setting stage in Canadian resource and environmental policy-making is best interpreted as representing a form of 'inside initiation', in which specialized groups have priority access to the agenda" (Hessing and Howlett, 1997). This particular stage of the policy process is typically characterized by incomplete or partial problem definition. Further development of an objective, systematic and comprehensive information base to provide policy-makers with the necessary information to address the problem is key.

The second stage, information analysis, consists of a scientific evaluation of the data that has been provided. This refers to the process by which policy options are formulated and estimations concerning the costs and benefits are raised. The objective of this stage is to narrow the range of plausible policy choices, which typically reflects the condensation of general actors and interests into specific groups and the articulation of potential policy options on the part of these groups (Hessing and Howlett, 1997).

During the policy development stage, the issues that have been raised from normative evaluation are modeled into concrete social and political objectives, such that priority setting becomes possible. The actual decision on a particular course of action to follow is made at this stage. The next stage, policy implementation, involves the actual implementation of the particular policy choice, and the further development of required legislation or specific programs. The policy cycle closes with an evaluation of the policy activities and their various outcomes with respect to the stated goals and objectives.

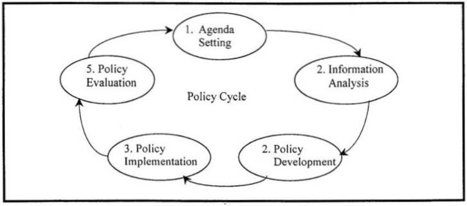

Figure 2.5. Rational model of policy-making (Bots and Hulshof, 2000; Howlett and Ramesh, 1995)

2.3.2 Implications for SEA

In the past two decades policy analysis, particularly in the field of resource and environmental management, has been undergoing significant changes in theory and practice. Wallace *et al.* (1995) reviewed the literature on policy analysis in the resource and environmental field, and suggested that four themes can be identified with regard to the changing nature of policy analysis.

First, scholars have begun to question the underlying theories and approaches to policy analysis and evaluation research. Schneider (1985) argued that changes are needed in traditional policy research methodologies, particularly the rational comprehensive approach, which imposes expectations for policy that are too high and too narrow. Second, there is a shift from policy analyses and evaluations that attempt to exclude politics to approaches that accept politics as a key and influential factor to be included. Torgerson (1986), for example, suggested that traditional policy analysis has been blind to political reality and has failed to appreciate its political context. Third, there is a search for more subjective, user-oriented policy analysis methods. The traditional approach relied heavily on methods such as cost-benefit analysis, selecting variables that best fit the model, rather than those most related to the issue. Recent trends are placing greater emphasis on stakeholder involvement and policy analyses that incorporate a wider array of information, resulting in a more comprehensive evaluation of what is happening on the ground. Fourth, there is a growing support for a more bottom-up approach to policy analysis through 'multi-organizational analyses' (Hjern, 1992). Traditionally, policy analysis focused on the primacy of centralized decision-makers within the deciding government agency. However, Sabatier (1987) noted a growing recognition of the need for involving those who are affected by policy, as well as those who affect policy, in setting evaluation criteria to assess goals and strategies

A fifth theme can be added to this list: the recognition of the need to better incorporate environmental concerns in policy-level decisions. "Resource (and environmental) policy has been traditionally located within the context of economic activity, and its analysis has largely been directed toward concerns of the marketplace" (Hessing and Howlett, 1997). Until recently, policy-making has been largely reactive and in response to environmental damage (Sheate *et al.*, 2001). "The relatively recent expansion of resource policy-making to encompass broader environmental concerns…affords a different perspective on the subject" (Hessing and Howlett, 1997). SEA was developed as a tool specifically to enhance the attention and weight given to environmental concerns in higher-order decision-making. "SEA aims to provide a process by which policy is developed based on a much broader set of properties, objectives and constraints…" (Brown and Therivel, 2000). It is a tool directed at providing the decision-makers with an holistic understanding of the environmental and socioeconomic implications of policies, policy proposals, and policy alternatives.

The policy-cycle model presented above has been critiqued for its overly rational approach, as it often shows poor correspondence with the political dynamism of the reality of the policy process (Bots and Hulshof, 2000; Walker, 2000). Forester (1984), for example, suggested that for policy-making to take place along the lines suggested by the rational model, five conditions must be met. First, the number of decision-makers involved in the policy process must be limited, preferably to only one person. Second, the policy environment must be isolated from the influence of other policy actors. Third, the problem must be clear and well defined with the consequences of different courses of action clearly understood. Fourth, information must be complete and accurate. Fifth, there must be no time constraints of the decision making process such that all alternatives and potential outcomes can be comprehensively assessed. When the conditions of the rational model are not met, as is most often the case, other styles of decision-making will predominate. Most policies made by governments are usually, in some way, a continuation of past practices (Polsby, 1984). Typically, the same set of actors are involved in the policy process over a long period of time, and the differences between proposed and existing policies are therefore largely incremental in nature (Hayes, 1992).

Real-life policy-making is a process of highly dynamic interaction between a large variety of stakeholders within a network of formal and informal relationships (Weimer, 1995; Cohen *et al.*, 1972). The policy process never ends, but is viewed as a sequential chain, involving an ongoing series of incremental decisions (Mitchell, 1997). SEA is a continuous (i.e. on demand) assessment process applied at particular point(s) in time when (incremental) decisions are to be made, or to evaluate alternatives to existing ones. Many policies are nebulous, and evolve in an incremental and often unclear fashion with decisions being made at numerous stages of the policy cycle, with different consequences for the development of policy (Glasson *et al.*, 1999). It is at these decision points that SEA can be most effective.

"Decision-making is not…a synonym for the entire policy-making process, but a moment in policy-making rooted firmly in the previous stage of the policy cycle. It involves choosing from among a relatively small number of alternative policy options identified in the process of policy formulation" (Hessing and Howlett, 1997: 156-7). The particular points at which SEA is applied varies, and should be adapted to the specific policy and planning process which is being undertaken (DEAT, 2000). Eck (1998), for example, suggests that SEA can be a useful tool when the policy or planning process or document contains real decisions that have potential environmental impacts; when there are several strategic alternatives that are limited or foreclosed by decisions made in the policy or planning process or document; and when it is possible to illustrate (at least relatively) the potential environmental impacts of each strategic alternative.

SEA should be seen as a tool to complement the planning process by providing the information necessary to ensure that PPP development proceeds in the best practicable environmental manner, in accordance with the specified goals and objectives (DEAT, 2000). This way, SEA may "work as an incentive to improve the planning system" (DHV and MHSPE, 1999).

2.3.3. Policy SEA: Current Practice

If and when policy-level EA is conducted, it is typically reactive in nature and limited to policy evaluations or the analysis of policy content (Table 2.3, Types 2 and 3). While this approach facilitates adaptive learning and capacity building, it does not effectively address the potential environmental effects of strategic alternatives, nor does it contribute directly to their assessment (e.g. Sheate *et al.*, 2001). The assessment of Danish bills (Elling, 1997) and the environmental review of the North American Free Trade Agreement (NAFTA), for example, are perhaps the most widely referenced case examples of [proclaimed] policy-level SEA.

The Danish rules for the assessment of national policies were introduced in 1993. Elling (1997) reviewed the assessment of two Danish bills under Denmark's EA and legislative review process. The first bill was related to a proposal to amend laws relating to tenancy and housing conditions and rent subsidies. The environmental concern was over behavioural incentives to promote infrastructure improvements and introduce individual residential water meters. The second bill was a subsidy scheme for private urban renewal with a view to advancing ecological prospects such as water and sewer infrastructure improvements. Both assessments were largely focused on plan- and project-level issues and impacts, rather than strategic alternatives for policy formulation. In addition, both assessments were reactive in nature: the first bill was assessed retrospectively, the second during its actual development.

Table 2.3. Typology of policy analysis

Type 1

(i) *policy advocacy*: research that serves to challenge policies or to terminate the direct advocacy of a policy or group of related policies

(ii) *information for policy*: research that provides policy-makers with information and advice; assumes a case for action, such as the development of a new policy or revision of an existing policy; suggests and evaluates policy options

Type 2

(i) *policy monitoring and evaluation*: *post hoc* analysis of policies and subsequent programs; can be aimed at providing direct results to policy-makers about the impact and effectiveness of specific policies

Type 3

(i) *analysis of policy determination*: emphasis is upon the inputs and processes operating upon the construction of policy (e.g. environmental influences, influences of particular goals and objectives in the policy process)

(ii) *analysis of policy content*: study of the origin, intentions and operations of specific policies; typically descriptive accounts of particular policies such energy policy

Source: Gordon *et al.* (1998).

Canada has had mixed success with EA application at the policy level. On the one hand, the North American Free Trade Agreement (NAFTA) EA (Canada, 1992), for example, illustrates one of Canada's 'lesser successes' of assessment at the strategic level. Included among the objectives in the NAFTA EA terms of reference was "to ensure that environmental considerations were taken into account during all stages of the negotiating process; and to conduct and document a review of the potential environmental effects of NAFTA on Canada." A review committee was assembled to review the proposed NAFTA agreement, to identify the potential environmental effects on Canada, and to submit the review to Cabinet by no later than the signing date of NAFTA itself (Hazell and Benevides, 1998). However, by the time the policy assessment was triggered, the policy document was already in place and many decision options had already been foreclosed. The NAFTA EA contained no information suggesting that policy alternatives were ever considered and, since the NAFTA policy document had already been prepared prior to the assessment, the assessment process made few contributions to environmental sustainability and had minimal influence on the trade agreement outcome. Clearly, the added value of policy-level assessment is severely diminished when conducted at such a late stage in the policy process (Brown and Therivel, 2000). The NAFTA EA is perhaps best described as a policy review, rather than a strategic environmental assessment.

On the other hand, Connelly (2000), in a speech to the Ontario Association for Impact Assessment, notes the recent success of SEA in the assessment of options for achieving Canada's Kyoto Protocol target of reducing greenhouse gas emissions to six percent below 1990 levels over the next eight to twelve years. According to Connelly, an SEA was undertaken to systematically identify and evaluate the potential environmental impacts of the options being considered to meet Canada's Kyoto target, and the analysis "was done early enough in the policy development process to identify future research needs and opportunities for mitigation" (Connelly, 2000: 4). Connelly notes that the SEA broadened the analysis of Canada's Kyoto implementation options beyond issues of greenhouse gas emissions to include a greater variety of potential environmental implications. However, whether this interpretation is correct is debatable, as there is no public documentation available.

Despite calls for environmental considerations to be better integrated in government PPP decision-making processes, governments continue to adopt legislation, industry and economic policies, and enter trade and investment agreements with little or no formal policy-level SEA (Buckley, 2000). Case examples of policies subject to some form of formalized SEA are few in number (Bailey and Renton, 1997). There are several suggestions as to why assessment at the plan and project level is much more common than policy-level SEA. On the one hand, Boothroyd (1995), for example, suggests that the limited number of formal policy assessments can be attributed to the difficulty of predicting higher-order impacts. On the other hand, Buckley (2000) and Elling (1997) suggest that the main barriers to policy-level SEA are of an institutional nature: first, governments are not willing to adopt an accountable, formal SEA procedure for public-policy decision-making and second, as many policies are often unwritten, or not under the policy label, they are not open to formal assessment processes.

Perhaps the most significant reason for the lack of policy-level SEA is given by Davey (1999) who, in a study of Canadian SEA in Nova Scotia, found that the main reason for the lack of SEA application and the lack of a legislative SEA framework was the limited understanding of SEA concepts and methodology. Machac *et al.* (2000), Partidario and Clark (2000), Audouin (1999), and Therivel and Partidario (1996) agree, suggesting that amongst the main barriers to SEA development and application are the lack of common understanding of SEA principles and characteristics, and the lack of appropriate methodological frameworks to support SEA application. Only when there is a common understanding of SEA principles and characteristics, a structured methodological approach is developed, and the benefits of SEA are demonstrated, will SEA begin to receive widespread acceptance and effective application. Formulating SEA as an integral part of PPP decision-making requires the development and modification of new and existing methods and techniques, and extended application (Glasson *et al.*, 1999).

2.4 SEA Methodology

Considerable attention has been given to the role of SEA in policy, plan and program assessment; however, there remains little consensus on appropriate methodologies for SEA. The process of evaluating environmental impacts at the strategic level is not necessarily the same as evaluating them at the project level (Glasson *et al.*, 1999). *Strategic* environmental assessment asks different types of questions than project-level assessment and at different tiers of the decision-making process. While SEA can utilize many of the existing project-level methods and techniques, appropriate methodologies are required. This section reviews the current state-of-the-art of SEA methodology, and presents a generic SEA methodological framework based on the notion of the 'best practicable environmental option.' The framework serves as a basis for the remainder of this thesis.

2.4.1. SEA Frameworks: Current state-of-the-art

SEA has come a long way since its inception, but it has been considered much more from a theoretical than a conceptual or practical perspective. Recent developments, however, are displaying considerably more emphasis on the practical side of SEA. In recognition of the need for a more process-oriented approach to SEA, numerous frameworks have been proposed. For example, Fischer (1999), Hedo and Bina (1999), Therivel (1996), and FEARO (1994), present frameworks for the SEA of a proposed plan or program. NRCan (1992) presented a set of guidelines for the strategic assessment of proposed energy programs. Finally the U.S. Department of Housing and Urban Development (1981) have developed a SEA approach specifically for comprehensive land use planning. All of these frameworks assume a proposed plan or program and then follow through a set of sequential steps to assess the impacts of the proposed plan or program and implement the required mitigative measures and monitoring procedures.

The above frameworks are very much based on project-level EIA principles and practice, addressing traditional project-type and phenomenon-specific impacts, and are designed for particular sectors and applications. However, if SEA is to advance in understanding and application, then an assessment framework is needed that is appropriate for the types of questions asked at the strategic levels of decision-making. Such a framework must be broad enough to address both the higher-order policy issues and the more detailed plan and program issues, while at the same time maintain a structured approach so as to allow the systematic break-down of the decision problem in an accountable and replicable fashion.

2.4.2. Guidance for SEA methodology

A number of SEA principles or characteristics were developed and discussed earlier in this chapter (Table 2.1). What do these principles and characteristics offer with respect to the development of SEA methodology? First, SEA methodology should reflect the underlying characteristics of the notion of a "strategic" assessment. The emphasis of SEA methodology should be on identifying or developing the preferred strategy for action, asking "what is the preferred, practicable option?" within the context of visions, goals and objectives. This means minimizing negative outcomes by adopting a proactive approach to PPP assessment to select the "least negative" alternative(s) at the earliest possible stage of the PPP decision-making process. A proactive approach to SEA means that SEA should be implemented at an early stage in the decision-making process in order to shape the development and assessment of alternatives and arrive at the preferred, rather than the most likely, future. For example, Hedo and Bina (1999) note the diminished value of the SEA of hydrological and irrigation plans for Castilla y Leon, Spain, as the SEA process was limited by the advanced stage of the plan formulation. Similarly, as discussed, the North American Free Trade Agreement SEA was no more than a policy environmental review, as the assessment was limited to an inventory of the potential environmental effects of the trade agreement.

Second, SEA methodology should be flexible to the different types of SEA application or different 'tiers' of decision-making. The emphasis of SEA is on evaluating alternative appropriate strategies for action, and the focus broadens moving upscale from programs and plans to policies. The CEC (1991), for example, notes that:

> Which environmental impacts should be assessed at any given stage…and in which degree of detail, is a matter to be settled…For example, in the transport sector $C0_2$ impacts may be more meaningfully assessed when approving a national transport policy…than when authorizing individual road schemes. On the other hand...localized impacts…may be more appropriately assessed at the…authorization stage (CEC, 1991).

The more recent EC Directive similarly reflects the need for flexible methodological approaches. However, while SEA requires a flexible methodology, adaptable to the different contexts of PPPs and capable of facilitating a variety of methods and techniques depending on the particular questions asked, it should at the same time be based on a structured methodological framework in order to allow a more objective and systematic assessment process and to facilitate consistency in application and more wide-spread SEA understanding.

There is a wide range of strategic actions for which SEA can be implemented, and a wide range of contexts in which these strategic actions might be assessed. SEA methods and techniques need to be tailored closely to the particular circumstances of the PPP under consideration. Brown and Therivel (2000) suggest that no one set of SEA methods and techniques will apply to all strategic actions in all socio-political contexts, but rather that we must begin to think in terms of an array of SEA tools from which the appropriate ones can be selected to meet the needs of the particular circumstance (Brown and Therivel, 2000). Policies, plans and programs have quite distinct characteristics in terms of their scope and objectives, and any system requiring the assessment of their environmental impacts should take these differences into account (Street, 1992). However, at the same time, if SEA is to receive widespread understanding, then there is a need for a structured SEA methodology.

SEA techniques and methods

Literature on impact assessment often tends to use "techniques" and "methods" in an imprecise way, treating them as synonymous. At the outset, it is important to differentiate between these terms if a consistent methodological approach is to be constructed. Techniques and methods are used to provide information and to assess that information. Techniques can be distinguished from methods in that techniques provide the data, whereas methods are concerned with the various aspects of assessment, such as the identification and description of likely impacts and classification of data (Barrow, 1997; Canter, 1996; Bisset, 1988). Techniques, such as aerial photography or energy demand and supply forecasting, "provide data which are then collated, arranged, presented and sometimes interpreted according to the organisational principles of the...methods being used" (Bisset, 1988). A technique, such as a Gaussian dispersion model, provides data on some parameter such as the anticipated dispersion of air pollutants from a specific industrial development; those data are then organised according to a particular method, such as Geographic Information Systems (GIS), where the researcher evaluates and presents the data. In any single assessment a number of techniques and methods may be used. This techniques/methods distinction will be adopted throughout the remainder of this thesis. It is important to note, however, that the distinction is not always this clear and often depends on the context in which the particular methods or techniques are applied.

SEA methods and techniques differ at different tiers of the assessment process. SEA at the policy level is often more general than SEA at the plan and program level. It makes sense that SEAs conducted for "higher-tiered" decisions make use of broader policy-based methods, such as policy scenario analysis, whereas SEAs for "lower-tiered" decisions adopt more "analytical-based" methods and techniques such as Geographic Information Systems. Assessment techniques, which provide the data, are much more selective than assessment methods. Many of the techniques adopted for project- and program-level assessments, such as pollutant dispersion models or population forecasting models, may not be appropriate at the policy level where the issues are by nature more general. On the other hand, many surveying and forecasting techniques based on the use of expert opinion, such as the Delphi technique (Dalkey, 1969), are just as applicable to the SEA of PPPs and project-level assessment. However, the nature of the questions asked and data produced differ considerably from level to level.

Methods, which are concerned with the various aspects of assessment, are equally applicable to all levels of assessment (e.g. Clark and Harington, 1988: 104-6). There is no reason why some or all of the methods applied at the project or program level cannot be applied at the plan and policy level. For example, the SEA of trade and industry policy for Kawa Zulu-Natal (CSIR, 1996) used GIS to evaluate policy scenarios. At the same time, some or all of the methods applied to address questions at the policy and planning levels can be used at the program level. For example, the SEA of the Dutch ten-year program on waste management used scenario analysis to investigate alternatives to the intended management program (Verheem, 1996). The analysis was quantitatively based, using available data to determine the dispersion of toxins associated with each scenario.

There is no shortage of SEA methods and techniques. The particular methods and techniques used in SEA depend on the case in question. Each SEA adopts the methods and techniques most appropriate and/or adaptable to its needs. While there is no single comprehensive set of methods and techniques capable of doing all that is required for SEA, good practice SEA asks the right questions at the right time, using the tools that are appropriate (Partidario, 1996).

SEA methodology

A methodology is a higher-order activity - a structure for organizing a process, a way by which SEA is performed, a system of conduct, a series of systematic steps. The debates over which methodological approach should form the basis for SEA is a recurring theme in recent literature (e.g. Brown and Therivel, 2000; Bond and Brooks, 1997; Partidario, 1996; Wood and Dejeddour, 1995). On the one hand, CEARC (1990), for example, suggest that SEA methodology can be adopted in large part from approaches already applied at the project level. Wood (1995) agrees, suggesting that "nearly all the tasks involved in SEA are similar to those of EIA" and that SEA would involve similar methodological approaches to project-level assessment. The same argument has been presented by the UN Economic Commission for Europe (1992), suggesting that environmental assessment procedures for PPPs should reflect project-level EIA principles related to assessment initiation, scoping, external review, public participation, documentation, decision-making, monitoring, and a basic shift of EIA methodologies upstream.

On the other hand, Bailey and Renton (1997) and Boothroyd (1995) propose that in order to integrate environmental decisions into the SEA of higher-order decisions, an alternative approach to the extension of EIA methodology upstream is required. Brown and Therivel (2000: 186) agree, suggesting that "...grafting SEA onto existing PPP formulation procedures will not be achieved by attempting to translate existing project-based EIA upstream".

New methodologies appropriate for the types of questions asked at the strategic levels of policy, plan and program assessment are required. A strategic assessment is an objectives-led assessment, beginning early in the development of a PPP or in the assessment of alternatives to an existing PPP, and investigates alternative means of achieving particular goals and objectives. The focus is on the identification and evaluation of alternative options to identify the preferred strategic course of action. An appropriate SEA framework must support these strategic characteristics.

2.4.3 A Methodological Framework for SEA

Environmental assessment problems should be thought of as multi-criteria problems. A multi-criteria problem is one in which the decision maker(s) must evaluate and assess competing and often conflicting alternatives in order to select the preferred, practicable option. Multi-criteria problems are not new to the resource and environmental management literature. For example, Saaty and Mariano (1979) addressed alternative strategies for rationing energy resource use to US industries during the oil crisis of the 1970s. In the planning literature, Huylenbroeck and Coppens (1995) applied a multi-criteria approach to address multiple land-use conflicts in Scotland. More recently, Yin *et al.* (2000) illustrated the use of multiple physical, biological and socioeconomic sustainability criteria to evaluate the linkages between climate change and regional sustainable development in the Mackenzie Basin, Canada.

Solving a multi-criteria problem "is not about searching for some kind of hidden truth, it involves helping the decision-makers master the complexity of the data involved and advance toward a decision" (Vincke, 1992) – in other words helping to determine the best practicable environmental option. The UK Environmental Protection Act defines the 'best practicable environmental option' as "the outcome of a systematic consultative and decision-making procedure..." (Tromans, 1993). The best practicable environmental option establishes, for a given set of objectives, "the option(s) that provides the most benefit or least damage to the environment as a whole, at acceptable cost, in the long-term as well as in the short term (Tromans, 1993).

Similarly, the underlying objective of SEA is to determine the option(s) that provide the most benefit/least damage to the environment (biophysical, social, economic) for a given PPP or PPP alternative, or to evaluate whether various alternatives are achieving particular objectives. However, despite the similarity between the SEA of PPPs and the approaches to dealing with multi-criteria problems in other disciplines (e.g. transportation planning - Bond and Brooks, 1997; business management- Curtis, 1994; strategic decision-making - Baetz and Beamish, 1987; multi-criteria evaluation - Roubens, 1982), SEA has not been adequately conceptualised as a multi-criteria problem. It is argued here that lessons can be learned from the multi-criteria decision-making literature for the development of SEA methodology, particularly in terms of how one can use available methods and techniques from policy- and project-level assessment in a SEA context.

What is required is an appropriate methodological framework for SEA within which a variety of methods and techniques can be used to address particular questions at the strategic levels of decision-making. Figure 2.6 outlines a proposed seven-phase generic assessment framework for SEA application, which is further developed throughout the remainder of this thesis. In accordance with the recommendations to guide SEA methodology set out earlier in this Chapter, the proposed framework can utilize a variety of methods and techniques to identify strategic alternatives, evaluate those alternatives against specific assessment criteria, and determine the preferred strategic action. There is no specific set of methods and techniques that will apply to all situations in all locations. The generic framework provides the structure that allows the strategic alternatives to be evaluated to determine the preferred strategic action without in any way constricting the choice of methods and techniques to be used. While the framework is similar in structure to project-level EA frameworks, its application is objectives-led, focusing on 'alternative options' rather than 'option alternatives' and asking different types of questions than project-level assessment. A case study of policy-level SEA in the Canadian energy sector serves to illustrate this methodological framework. The following chapters set the context for the case study, and outline the methodological requirements of this research.

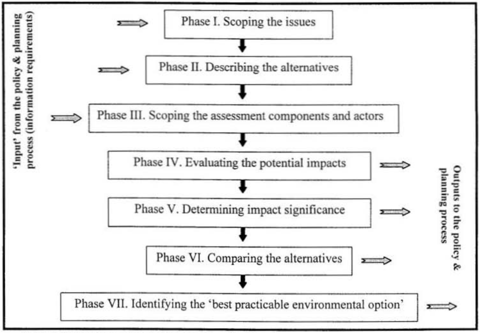

Figure 2.6. Generic seven-phase SEA assessment framework.

Chapter Three

The Canadian Electricity Sector: Energy Policy and Environmental Assessment

3.1 Introduction

There is a fair degree of consensus among the Organization for Economic Cooperation and Development (OCED) countries that long-term energy trends are unlikely to experience radical changes over the next twenty-five years (OCED, 1999). While new technologies may come on-stream, the future energy mix for electrical generation is unlikely to disrupt recent trends (Lahidji *et al.*, 1999). The dynamics of energy demand have been quite stable since the early 1980s and are expected to continue along this trajectory.

The period from 2025 to 2050, however, could prove to be a watershed in the transition of energy systems (ETF, 2000; Lahidji *et al.*, 1999). Fuel sources for electrical generation are not expected to change much, however, concerns over energy security and new directions in socioeconomics, trade and environmental policy issues are expected to have significant effects on the energy scene (OECD, 1999; NRCan, 1997; World Energy Council, 1993). Developing an energy strategy involves not only the consideration of existing and potential fuel sources, but also the consideration of broader socioeconomic and environmental policy issues. This chapter reviews Canada's electricity sector, its projected outlook for electrical generation, and the current state of energy policy and environmental assessment. The review is not comprehensive with respect to all of the issues and concerns surrounding Canada's electricity sector and energy policy; rather it concentrates on particular issues to set the context for the application of the SEA methodological framework introduced in the previous chapter. The purpose of this case study application is to demonstrate the nature of the SEA methodology and to illustrate the use of a variety of methods and techniques to address a policy SEA issues within the context of a structured assessment approach. The practical results of the case study (a particular or preferred scenario) are secondary to the overall objectives of this research.

3.2 Canada's Electricity Sector

In Canada the bulk of the generation, transmission and distribution within each province or territory is typically provided by one dominant utility. Provinces are assigned exclusive jurisdiction over electricity matters that are wholly intraprovincial in nature, including issues of electrical production and export to other parts of Canada, provided they are not discriminatory in electricity pricing. Among the major electric utilities in Canada, the majority are provincially-owned crown corporations (Table 3.1). Provinces or territories where this is not the case, have either investor-owned utilities (e.g. Alberta and Prince Edward Island) or a private utility company as well as a crown corporation (e.g. Newfoundland). In addition to the major electric utilities, there are approximately 350 smaller utilities across Canada, mostly owned by municipalities (e.g. Edmonton Power), which purchase power from their province's major utility, and self-use industrial generating plants, such as pulp and paper mills, which in some cases generate electricity from wood waste (NRCan, 2000). Provincial utilities are expected to continue to own the bulk of Canada's total installed generating capacity and provide approximately eighty percent of generated electricity over the next few decades (Harker, 1995). Non-utility

Table 3.1. Major electric utilities in Canada.

Province	Electric Utility	Ownership
Newfoundland	Newfoundland and Labrador Hydro	Provincial
	Newfoundland Light and Power Company Ltd	Private
Prince Edward Island	Maritime Electric Company Limited	Private
Nova Scotia	Nova Scotia Power Incorporated	Private
New Brunswick	New Brunswick Electric Power Corporation	Provincial
Quebec	Hydro-Quebec	Provincial
Ontario	Ontario Hydro	Provincial
Manitoba	Manitoba Hydro-Electric Board	Provincial
Saskatchewan	Saskatchewan Power Corporation	Provincial
Alberta	Alberta Power Limited	Private
	Edmonton Power	Municipal
	TransAlta Utilities Corporation	Private
British Columbia	BC Hydro and Power Authority	Provincial
Yukon	Yukon Energy Corporation	Territorial
NWT	North West Power Corporation	Territorial

Source: OECD and IEA (1996)

generators, however, are expected to play a more active role in the development of Canada's electricity sector, particularly where such generation is produced from non-conventional electricity sources, such as solid waste reduction units and wind energy (NRCan, 2000).

Canada ranks sixth in the world in electricity production, behind the U.S., Russia, Japan, China and Germany, with an installed generating capacity of 109,028 megawatts[3] (MW) (NEB, 1999), accounting for 3.7 percent of the world total electrical generation capacity (NRCan, 2000). The majority of Canada's electrical generation is hydroelectric, in contrast to the total world generating capacity which is primarily conventional thermal (NRCan, 2000). Hydroelectricity accounts for nearly two-thirds of total electrical generation in Canada, with over 350,000 GWh[3] generated in 2000 (Table 3.2), and 182,832MW of gross potential remaining, of which 34,371MW is considered promising for future development (NRCan, 2000). The bulk of hydroelectric production is generated in about half of Canada's provinces, with the largest producers being provincially owned electric utilities, notably BC Hydro, Hydro Quebec, Manitoba Hydro, Newfoundland and Labrador Hydro, and Ontario Power Generation, Inc.. Industry and independent power producers account for one percent of Canada's total hydroelectric production (NRCan, 2000).

Hydroelectric production is supplemented primarily with nuclear energy, coal, natural gas, and refined petroleum products. Canada, a world leader in uranium production, currently has 22 CANDU reactors fuelled by domestic uranium, which are owned and operated by utilities in Ontario (20), New Brunswick (1) and Quebec (1). Nuclear

Table 3.2. Primary sources Canadian electricity generation (GWh) by technology and fuel type, 2000*.

Hydro	351,820
Nuclear	67,340
Steam	
Coal	99,793
Natural gas	14,597
Heavy fuel oil	7,371
Combined Cycle	
Natural gas	24,958
Diesel	138
Combustion Turbines	
Natural gas	4,961
Heavy fuel oil	124
Light fuel oil	97
Diesel	145
Internal Combustion	
Natural gas	82
Heavy fuel oil	1
Diesel	883
Renewables	
Biomass	8,091
Wind	281
Tidal	30

Source: NEB (1999) and NRCan (1997). *2000 figures projected based on 1995-1999 data

[3] 1 MW = 10^6 joules; 1 TW.h = 3.6 petajoules = 10^{15} joules; 1 GW.h = 3600 gigajoules = 10^9 joules

generating capacity currently accounts for approximately 15 percent of domestic electricity supply (Fig 3.1). Coal production currently accounts for less than 20 percent of total electrical generation in Canada. However, nearly 90 percent of the coal consumed in Canada is used to generate electricity. Alberta is the largest producer and consumer of coal, using approximately 26 MT of bituminous and subbituminous coal in 1998 for electrical generation – approximately 50 percent of Canada's total coal consumption (NRCan, 2000).

A key concern facing the continued use of coal is the emission of sulphur dioxide and nitrogen oxide during coal combustion. However, new clean coal technologies, such as coal gasification combined cycle production, are currently being developed which are expected to increase the efficiency of coal combustion and reduce overall emissions. Natural gas and refined petroleum products, which account for approximately 20 percent, of Canada's electricity generating capacity, face similar concerns with respect to greenhouse gas emissions.

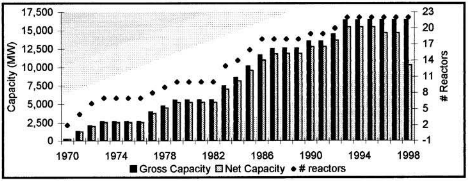

Figure 3.1. Nuclear electricity generating capacity (NRCan, 2000).

Renewable energies presently make only minor contributions to total electricity generation (Table 3.2) (NEB, 1999; NRCan, 1997). Wind and tidal power are seen to have the greatest production potential. The estimated technical wind energy potential in Canada is 28,000 MW (NRCan, 2000). The completion of Le Nordais, for example, a 134 turbine, 100 MW wind farm launched in 1998 in Quebec, brings the annual electricity production from wind in Canada to approximately 300 GWh. However, due in large part to low cost and competing electricity sources, the introduction of wind generation as a key source of electricity has not penetrated the main electricity grid. The total potential annual production of tidal-based electricity in Canada is estimated at 22,000 GWh. Canada currently hosts the second largest reservoir- and hydroelectric turbine-based tidal generation station in the world. The Annapolis plant, constructed in 1984, has an annual electrical output of 30GWh. Other sources of electrical generation from non-conventional sources include biomass from municipal and industrial waste, methane from landfill sites, biogas from sewage and effluent treatment plants, and solar photovoltaics.

3.2.1 Electricity Outlook

Total electricity demand in Canada is projected to grow at an average annual rate of 1.2 to 1.6 percent to 2025 (Figure 3.2) (NEB, 1999). These projections are based on a number of factors, including predicted trends in international energy prices, demography, economics, policy initiatives, and energy developments in the United States (NRCan, 1997). Domestic electricity demand is expected to account for the majority of this growth, increasing by approximately thirty percent near the end of the twenty-five year projection period. The majority of domestic electricity demand increase is expected to be in the industrial sector. The industrial sector is currently the primary consumer of electricity, accounting for over 40 percent of total electrical consumption (NRCan, 2000). Total domestic industrial electricity demand is expected to increase by approximately 33 percent near the end of the projection period. Commercial and residential electricity demands are expected to increase by 26 percent and 19 percent respectively, above 2000 levels by 2025 (NEB, 1999, NRCan, 1997).

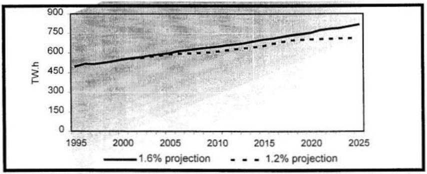

Figure 3.2. Projection of total Canadian electricity demand to 2025, cases 1 (1.6% growth projection) and 2 (1.2% growth projection) (NEB, 1999).

Electricity has traditionally ranked relatively low in terms of its share in the value of total Canadian energy exports (Fig. 3.3). The projected trend is towards generally lower exports in the twenty-five year projection period compared with current levels. Net exports are expected to increase at about 3.7 to 4.7 percent of total domestic generation per year up to 2010, but only to decline by 1.4 to 2.4 percent per year thereafter (NEB, 1999). Net electricity trade is projected to represent a small proportion of production. Canada has traditionally been a net exporter of electricity, with total exports amounting to 43.3-terawatt hours[3] (TW.h), 43.9 TW.h and 41.2 TW.h in 1995, 1996 and 1997 respectively

(NEB, 1999). B.C. Hydro, Ontario Hydro, N.B. Power, Hydro-Quebec, and Manitoba Hydro accounted for nearly ninety-five percent of these exports, with hydroelectricity dominating the export scene (NRCan, 1997). In recent years, however, total electricity export has declined. The total electricity exported in 2000 was 32.7 TW.h, of which the majority went to Minnesota and the New England States. Future electricity exports are projected to fluctuate between 20TW.h and 30TW.h, or between three and six percent of total generation to 2025 (NEB, 1999).

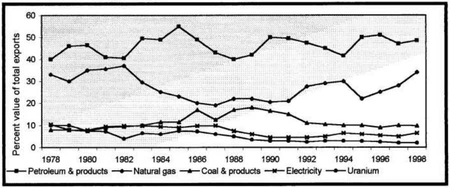

Figure 3.3. Share of each conventional energy source in the value of total Canadian energy exports (NRCan, 2000; Energy Statistics Handbook, 2000).

3.2.2 Energy Policy

While the electrical generation industry falls primarily under provincial and territorial jurisdiction, "Canada's constitutional division of powers requires that the federal, provincial and territorial governments work together in such areas as climate change, environmental assessment and the regulation of Canada's energy infrastructure" (NRCan, 2000). The overall policy and strategic direction of Canada's electricity industry is the responsibility of the Energy Sector of Natural Resources Canada. The federal role regarding the electricity industry is confined primarily to taking the lead on international and inter-provincial electricity trade and agreements, environmental issues pertaining to energy, sustainable development and other long-term energy strategies, and nuclear power generation. Nuclear power generation is regulated by two federal agencies: the Canadian Nuclear Safety Commission (formerly the Atomic Energy Control Board), which is responsible for issues pertaining to health, safety, security and environmental aspects of nuclear power and the National Energy Board, which regulates matters concerning energy exports (all sources) and interprovincial power lines.

The unit responsible for domestic energy policy issues is the Energy Policy Branch (EPB). The EPB takes the lead on federal energy policy and environmental issues pertaining to energy development and strategic energy planning. The EPB is also responsible for the development of Canada's long-term energy outlook and energy-related emissions projections. The EPB is divided into five divisions: the Policy Analysis division, which takes the lead in the development of federal energy policy; the International Energy division, which coordinates energy trade and energy security issues; the Environment division, which has the lead responsibility on policy relating to energy and climate change, the Economic and Fiscal division, which provides financial, economic and fiscal studies to support PPP development, and the Energy Forecasting division, which is responsible for Canada's energy supply and demand forecasting.

Canadian energy policy is largely market-based and oriented toward sustainable development. This is in sharp contrast to the more energy security orientation of energy policies during the 'oil crisis' years. "In the case of energy resources, sustainable development does not necessarily imply preserving one particular source of energy or another. The challenge of sustainable development is not to guarantee future generations with specific reserve levels for any particular form of energy, rather, the challenge is to provide secure, safe, efficient, reasonably priced and increasingly environmentally-friendly access to energy services" (NRCan, 2000). The principle objective of Canada's current energy policy is "to enhance the economic and environmental well-being of Canada by fostering the sustainable development and use of the nation's energy resources to meet the present and future needs of Canadians" (NRCan, 1998: 1). More specifically, the objectives of Canada's energy policy, as outlined in NRCan's *Energy Sector Business Plan 1998-2001*, are threefold:

1. *Environmental Protection* – To reduce and manage atmospheric emissions, effluents and wastes resulting from energy development and use and to help meet Canada's climate change commitments and its environmental, health and safety goals.

2. *Economic Growth* – To increase investment in energy development and infrastructure and to decrease costs of energy development and use, while creating and preserving employment.

3. *Energy Security* – To ensure secure, reliable access to competitively priced energy supply for current and future generations of Canadians while increasing the flexibility and diversity of the Canadian energy supply system.

Canadian energy policy must, therefore, reflect a balance of issues – energy production that respects the environment and is sustainable for future generations; an economically competitive and innovative energy sector that contributes to the wealth of society; and a safe and secure energy supply for the greatest number of potential users (NRCan, 2000). The traditional preoccupation of energy policy-makers, however, has been to increase energy supplies, exploit new energy resources and introduce new energy technologies to meet demands independent of 'energy-and-environmental' policy (Bregha *et al.*, 1990). Energy policies have been largely incentive-based, relying on tax codes and deregulation to promote investment and development. By contrast, environmental policy has been largely interventionist, relying on regulations rather than incentives, to minimize the environmental impacts associated with energy resource development, distribution and use (Anderson, 1994; Bregha, 1992). Although there have increasingly been attempts to incorporate environmental considerations into energy policy design, such attempts are "tacked on" rather late in the policy development process, at a point where the relevant policy options have already been defined" (Anderson, 1994). NRCan's forthcoming business plan for 2002-2005, for example, suggests that key to Canada's energy policy "…is a market orientation where prices are established and investments are made in competitive and freely functioning competitive markets and where long-term security is provided by a robust energy sector that has open access to both product and capital markets." One of the key goals of the 2002-2005 plan is "to achieve environmental and economic excellence", however, there exists no formal EA process to ensure that environmental factors are given full consideration in the identification of energy strategies and the formulation of energy policy.

At the same time, however, environmental issues are defining a new agenda for energy research and energy policy. NICE (1999) and NRCan (2000) identified energy and environment as a key issue in the near-term policy landscape. What is required is a means by which a strategic direction for energy policy can be developed, one which considers existing and future resources, technologies and market situations, and is accountable to environmental, social and economic impacts, goals and objectives.

3.3 Canadian Environmental Assessment

In June 1992 Bill C-13, the *Canadian Environmental Assessment Act* (*Act*) received royal assent. The *Act* was proclaimed on January 19, 1995 and sets out, for the first time in legislation, responsibilities and procedures for environmental assessments involving the federal government ensuring the early consideration of environmental effects in the planning stage.

Section 4(b) of the *Canadian Environmental Assessment Act* states:

> 4. The purposes of the *Act* are:
> ...
> (b) to encourage responsible authorities to take actions that promote sustainable development and thereby achieve or maintain a healthy environment and a healthy economy;...

In a similar tone, Section 2.1.1 of the recent *1999 Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals* (CEAA, 1999) reads as follows:

> By addressing potential environmental considerations of policy, plan and program proposals, departments and agencies will be better able to:
> ...
> 4. Implement sustainable development strategies;...

This implies that the acceptance of an undertaking (PPP or project) should depend on its ability to make a positive overall contribution to sustainability – both environmental and socioeconomic.

"Canada is recognized as a country that has made major contributions toward…the improvement of assessment procedures for environmental decision-making at project, program and policy levels, and in the establishment of strategies to achieve a sound balance between economic and environmental development objectives" (Partidario, 1993: 31). 'On paper', Canada has been committed to assessing the environmental implications of policies since 1984, when the federal Environmental Assessment and Review Process Guidelines Order (1984) defined 'proposal' as including 'any initiative, undertaking or activity for which the Government of Canada has a decision-making responsibility'. However, the expansion of EA above the project level has not been manifest in practice.

Recent trends, however, are moving towards the better integration of environmental considerations at the strategic levels of decision-making (Table 3.3). In June 1990 the Canadian government announced a reform package for EA that included a new EA legislation, and an EA process for new policy and program proposals. The Canadian Environmental Assessment Research Council (CEARC) (1990) subsequently released its guidelines for the *EA Process for Policy and Program Proposals*, demonstrating Canada's commitment to the EA of higher-order decision-making (Partidario, 1993; Wood and Dejeddour, 1992). In 1991, in response to the CEARC guidelines, the Federal

Table 3.3. Brief timeline of key SEA developments in Canada

1990 – The Canadian government announced a reform package for EA that included a new EA legislation, and an EA process for new policy and program proposals.

The Canadian Environmental Assessment Research Council (CEARC) released the first guidelines for the *EA Process for Policy and Program Proposals*, demonstrating Canada's commitment to sustainable development.

1991 – Federal Environmental Assessment and Review Office released *Environmental Assessment in Policy and Program Planning: A Sourcebook.*

1992 – *North American Free Trade Agreement: Canadian Environmental Review.*

1993 – Procedural guidelines were released to federal departments regarding the environmental assessment process for policy and program proposals.

NRCan released guidelines for the integration of environmental considerations into energy policies.

An internal review of the Cabinet Directive suggested that SEA was poorly understood and application was ad hoc and inconsistent at best.

1995 – "SEA: A Guide for Policy and Program Officers" and "The Environmental Assessment of Policies and Programs" was released to government departments.

1996 – *Environmental Assessment of the new Minerals and Metals Policy.*

1997 – The Department of Foreign Affairs tabled "Agenda 2000", outlining its commitment to conduct environmental reviews of all recommendations to Cabinet.

1999 – An update to the 1990 Cabinet Directive was released reinforcing the Canadian government's commitment to SEA.

Canadian Environmental Assessment Agency released its *Five Year Review*, but makes very little mention of SEA except for its ability to streamline the EA process.

CEAA commences internal SEA training for government departments.

SEA applied to assess Canada's commitment to the Kyoto Protocol.

2000 – National stakeholder workshop and CEAA's Agenda for Research and Development places SEA on a list of high priority EA areas requiring additional research and understanding.

Environmental Assessment and Review Office (FEARO) released its guidelines for the integration of environmental considerations into energy policies, stating that "assessment at the policy stage provides the earliest opportunity to shape and influence options that best satisfy social or economic objectives in order to minimize environmental problems or perhaps enable the opportunity to gain environmental advantage" (FEARO, 1991).
In 1999, Canada reinforced its commitment to integrate environmental considerations in higher-order decision-making processes with its release of the *1999 Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals (Directive)*. The *Directive* requires, by matter of policy, the consideration of environmental factors within all federal government departments of all policy and program initiatives submitted to Cabinet for consideration. Its objective is to systematically integrate environmental considerations into policy, planning and decision-making processes, such that environmental information derived from the examination of proposed policy or program initiatives could be used to support decision-making in the same way that social and economic factors are considered in policy and planning processes (Hazell and Benevides, 2000).

Notwithstanding Canada's growing interest in higher-order assessment, recent SEA applications, such as the NAFTA SEA (Canada, 1992) and the SEA of the Minerals and Metals Policy (NRCan, n.d.), for example, have been described as *ad hoc* and inconsistent at best (CEAA, 2000; Hazell and Benevides, 1998). While the *Directive* was apparently applied to the assessment of options for achieving Canada's Kyoto protocol target (Connolly per. com., 2001) (although no public SEA documentation exists at the time of the writing of this thesis) there has been no formal SEA application to domestic energy policy or energy policy related issues. Furthermore, Sections 2.2 and 2.3 of the *Directive*, which present the guidelines for conducting a SEA, provide little guidance as to the methodological requirements which should underpin the assessment process in order to ensure that environmental objectives are given full consideration in a systematic and accountable fashion. As outlined in CEAA's *Agenda for Research and Development* (2000), "challenges presented by SEA are largely methodological and developmental."

3.4 SEA IN CANADA'S ELECTRICITY SECTOR

In 1997, as part of the Kyoto protocol, Canada agreed to reduce its emissions of greenhouse gases by six percent from 1990 levels by the year 2010. The federal government's response to the Kyoto agreement is being coordinated by a committee under the Deputy Ministers of Natural Resources Canada and Environment Canada. As part of Canada's action plan to respond to the Kyoto challenge, the Energy Technology Futures (ETF) group of NRCan has been undertaking a policy research program on energy technologies, climate change, and long-term energy demands and services. The ETF group has been working with the energy sector to develop a vision for a sustainable electricity industry based on long-term energy, environmental, and socio-economic goals.

Through a series of focus groups, web site conferences, private sector advisory groups, and key managers in federal and provincial energy-related research institutes, the ETF group devised a set of internally consistent and technologically feasible scenarios of Canada's energy system to 2050. The scenarios include possible future energy economies, technologies, fuel mixes and energy carriers, and provide alternative views of what Canada's electricity system could look like in 2050. These alternative energy development scenarios are used as the basis for the case study under consideration in this research, and are summarized in Figure 3.4.

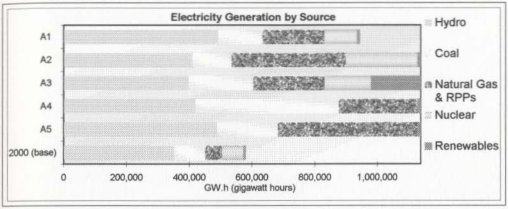

Figure 3.4. Canadian electricity generation by source: development scenarios A1 – A5, and 2000 base case.

The first energy policy scenario (A1) assumes the *status quo*, and a continuation of the current policy. Hydroelectricity remains the predominant source of electricity, supplemented with increasing shares of natural gas and refined petroleum products, coal and nuclear energy. Alternative energies, notably wind generation, play only a minor role in total generation. Emphasis is placed on the status quo, while managing electricity end-use demand through increased energy efficiency and energy conservation programs.

The second scenario (A2) assumes significant increases in natural gas, as natural gas usage in co-generation becomes more popular together with nuclear energy, as technology allows more efficient and safe hot gas reactors to replace traditional deuterium reactors. Hydroelectricity continues to remain a key source of electrical generation, supplemented with coal and minor contributions from renewable energy technologies, particularly solar and wind resources in remote, off-grid communities.

The third scenario (A3) emphasizes the growing use of natural gas and cleaner coal technologies to provide the electricity that would otherwise be produced from nuclear sources. The focus of attention is on cost-effective means to diversify the electricity generation mix and to improve fossil-fuelled electrical generation technologies. The search for nuclear energy turns toward improved gas-cooled reactors with increased overall system stability and longer life expectancy. The contribution of renewables as a source of electrical generation increases significantly. Photovoltaic, wind and solid waste systems become increasingly popular for stand-alone, on-site production and use.

In the fourth scenario (A4) approximately 40 percent of Canada's base-load electricity is generated from coal as clean coal technologies are developed. Hydroelectricity remains an important component with more efficient turbines, but development slows as most run-of-river hydroelectric sources become exhausted. Investments in natural gas and nuclear energies slow, and existing nuclear plants are decommissioned. Renewable electricity technologies, particularly wind turbines, photovoltaics and micro-hydroelectric facilities, provide only a small portion of Canada's electrical generation capacity, particularly in remote, off-grid communities.

The final scenario (A5) sees nuclear energy coming to a halt in the early 2030s. Hydro and natural gas, with improved natural gas turbines, constitute the bulk of electrical generation. Renewable sources grow to about one percent of total electrical generation, with biomass increasing slightly, and more renewable components incorporated into energy systems.

The results of the ETF project are intended to provide a long-term framework that will contribute to strategies for altering the relationship between economic growth and emissions, science and technology priorities and investment, and industrial development (ETF, 2000). While these scenarios do not necessarily reflect all possible policy options, they do provide a series of possible electricity generation alternatives that could guide future energy policy. "A key issue in the energy outlook is the choice of new and existing generation" (NEB, 1999). An energy strategy is required today in order to address the anticipated increased demand for electrical generation, and to address the environmental implications of alternative means to meet this demand. Since any preferred environmental-based policy may not necessarily be the preferred social- or economic-based policy, several competing and conflicting criteria and alternatives must be weighed and evaluated in the development of that energy policy. Accordingly, some attention must be given to the role of SEA in energy policy development. This makes a strong case for SEA application to the ETF policy research project in order to identify the most practical and environmentally preferred electricity alternative(s) to guide the development of energy policy.

Chapter Four

METHODOLOGICAL REQUIREMENTS: A MULTI-CRITERIA APPROACH

4.1 INTRODUCTION

Appreciating the complexity of policy-level SEA, and the diverse interests involved in the electricity sector and energy policy development in general, a combination of methods and techniques are required for this assessment. This chapter outlines the methodological requirements of this assessment, and discusses the relevant methods and techniques available to address multi-criteria problems in a broad-brush, policy SEA environment.

4.2 METHODOLOGICAL REQUIREMENTS

Notwithstanding recent calls for SEA to develop more independently of project-level assessment, existing SEA methodologies still tend to be based on project-level EIA principles. In cases where SEA has developed more independently of project-level EIA, such as CEAA's *1999 Cabinet Directive on the Environmental Assessment of Policies, Plans and Programs* (CEAA, 1999), the SEA process tends to reflect a policy or legislative review (e.g. the NAFTA EA) rather than a strategic assessment process. While SEA can perhaps utilise many of the existing methods and techniques adopted from project-level assessment to address strategic-level questions, a different methodological framework is required. The following are seen as the key methodological requirements of SEA.

One of the underlying objectives of SEA is to identify the preferred, practicable environmental option. Partidario (2001) suggests that SEA should focus more on the strategy that supports a PPP rather than on the PPP itself. In this particular assessment, the preferred, practicable environmental option is that which provides a strategic direction for the sustainable development of an energy policy in Canada's electricity generation sector. The SEA methodology then, must be capable of accommodating a broad range of alternatives, interests and assessment criteria, and balancing competing and often conflicting goals and objectives, in order to assess the potential environmental effects of alternative, potential strategic policy directions. In other words, the SEA methodology must be able to address a multi-criteria problem.

A multi-criteria problem arises when a decision-making process involves the simultaneous evaluation of assessment criteria, competing objectives and decision alternatives (Amrhein, 1985; Sobral *et al.*, 1981). Solving multi-criteria problems at the policy level requires an assessment that is aimed at rationalizing decision problems by systematically structuring all relevant aspects of policy choices (Janssen and Halfkamp, 1988). It requires an approach that enables us to use a variety of information including both 'hard' data, such as quantifiable information, and 'soft' data derived from intuition, experience, values, and judgments (Saaty and Kearns, 1985).

The SEA methodology must be able to investigate a number of choice possibilities in the light of multiple criteria and often conflicting perspectives, and arrive at the best practicable environmental option(s) from which subsequent action(s) can be taken. The purpose of SEA application at the policy level is to *assist* policy decision-makers in choosing a course of action, by identifying the potential environmental impacts of that option, from amongst complex alternatives under uncertain conditions (Walker, 2000).

SEA is to serve as a decision aid in the policy process, to clarify the problem, by presenting the alternatives and assessing their relative effects and attractiveness.

Second, the SEA methodology must accommodate an integrated assessment process. Addressing multi-criteria problems at the strategic level requires a certain degree of integration. Integration has become a favored means of increasing the effectiveness of environmental assessment and decision-making (Kirkpatrick and Lee, 1999), as "no single institution has the competency or resources to tackle horizontal meta-problems above the project level" (Bell, 2000: 6). If SEA is to effectively integrate environmental considerations into higher-order decision-making processes, then increased integration, order and congruity through the facilitation of horizontal decision-making and improved communication among agencies and organizations is required.

The effects of PPP decisions are almost always multi-disciplinary and involve multiple levels of interest, ranging from political decision-makers to disciplinary specialists (Jones and Greig, 1985). The Council of Science and Technology Advisors (CSTA, 1999), an independent council established to provide the Cabinet Committee on Economic Union with advice on federal government science and technology issues that require strategic attention, notes the importance of an interdisciplinary and interdepartmental approach to scientific research. In the CSTA report on *Science Advice for Government Effectiveness* (1999), the Council emphasizes a cross-disciplinary approach, enabling decision-makers and experts to identify and address horizontal issues, and to appreciate where, and in what form, their information is useful to others. Similarly, in March of 1999, as part of the Government of Canada's Policy Research Initiative, the Coordinating Committee of the Deputy Minister (Policy) endorsed a proposal for an interdepartmental policy research program, reflecting the growing awareness of the importance of ensuring that PPP development is based on horizontal research (PRI, 1999).

Third, the SEA methodology must be flexible to different types of SEA application, and to different tiers of decision-making. The scope of SEA broadens as SEA moves upstream from programs to plans to policies. Good-practice SEA must be capable of adapting to a variety of methods and techniques depending on the level of decision-making and the nature of the specific problem at hand. However, there is no need to 'reinvent the wheel' each time SEA is applied to a different tier of decision-making (Brown and Therivel, 2000). Given the 'forward-looking' nature of this assessment (an impact prediction time frame to 2050), the availability of formal quantitative baseline data with respect to the environmental impacts of potential energy policy alternatives is limited. When choosing impact prediction techniques, the researcher should be concerned about the relative appropriateness of the techniques for the task involved, in the context of the resources available (e.g. baseline data), the geographic scale of the assessment, and the nature of the impact data required (Glasson *et al.*, 1999).

Notwithstanding the temporal scale of this assessment, and the lack of available quantitative baseline data, a quantitatively-based assessment is required. A quantitative assessment will allow data aggregation (and disaggregation) and a consistent, systematic analysis of potential impacts, such that the preferred strategic policy alternative can be identified and accounted for, and various regional and sector-based perspectives regarding Canada's energy policy future can be explored. The information itself need not be quantitative, but quantitative measures are of value when assessing options against stated assessment criteria, even though it is recognized that a quantitative approach does not necessarily lead to 'better' decisions.

Given these requirements (and data limitations), and following the lead of Bonnell (1997), Richey *et al.* (1985), and Linstone and Turoff (1975), the use of an assessment panel to assign impact scores was deemed to be the most appropriate approach. This requires a technique, such as the policy Delphi, which is capable of efficiently collecting such information from a diverse panel over a large geographic scale (Turoff, 1970), but at the same time is flexible to potential regional and sectoral variations in energy policy perspectives. The role of the assessment panel in this study is twofold: first, in providing an expert role-determining impact scores for energy policy alternatives across a number of assessment criteria based on experience, knowledge and judgment, and second, establishing the decision-maker role-weighing assessment criteria according to personal, organizational, scientific, and/or political preferences.

Fourth, while a flexible methodology is required, capable of accommodating a variety of methods and techniques as the scope and scale of SEA changes, the methodology must be structured so as to ensure consistency in application and accountability of results. In practice, there is a tendency to use less formal predictive techniques at the policy level, such as expert opinion. However, this does not mean that such techniques be applied uncritically or in an ad hoc or unstructured way (Glasson *et al.*, 1999). Hazel and Benevides (2000), for example, reviewed EAs applied under the Canadian federal Cabinet *Directive* and under the Farmer's Income Protection Act (FIPA) and found that compliance with the FIPA has been high, whereas compliance with the *Directive* has been inconsistent at best. The FIPA, established in 1991, requires, by law, an EA of all programs established under the Act to provide income protection to producers of agricultural products. These authors conclude that EAs of programs carried out under the FIPA have been more systematic and thorough, the methodologies employed in analyzing potential environmental effects have been superior and the elaboration of policy or program alternatives have been better developed than for the Cabinet *Directive* (Hazel and Benevides, 2000).

At the policy level, there are both conceptual and practical difficulties in collecting impact assessment data and linking that data in a meaningful way to the potential impacts of policy instruments (Bots and Hulshof, 2000). Although a variety of methods and techniques may be used in SEA, a structured approach is required in order to allow a more systematic evaluation of strategic alternatives, to achieve a common understanding of SEA application, and to ensure a greater accountability of results in higher-order, particularly policy-level, environmental decision-making.

4.3 Multi-criteria Evaluation

Nijkamp *et al.* (1990) define 'evaluation' as the classification and arrangement of the information needed for a decision in order that the various participants in the decision process are enabled to make that decision as balanced as possible. A good evaluation is "the cornerstone of attempting to improve the quality of planning activities and policies, and...involves making explicit value judgments about the worth of particular policies" (Bracken, 1981; cited in Massam, 1988). Up until the 1960s, decision analysis and the evaluation of decision alternatives were dominated by simple optimization methods. Included among these methods and techniques were, for example: cost benefit analysis, which assigns monetary values to objectives and criteria, discounting possible alternatives to a single 'net present value' (Voogd, 1983); public choice theory, which examines ways of incorporating individual views and opinions into a consultation which seeks to maximize collective satisfaction (Massam, 1988); and multi-attribute utility theory, which seeks to identify the individual utility function of a single decision-maker in relation to the outcomes of alternatives for which probability distributions are known (Voogd, 1983). The majority of these methods used to aid decision makers, however, typically addressed only single-objective problems and, as a result, a systematic analysis of conflicts involved in decision problems with multiple criteria and multiple actions often received insufficient attention (Nijkamp *et al.*, 1990; Bell *et al.*, 1977). One of the main elements in the planning process that had been lacking was a framework to integrate and incorporate information with the values of multiple decision-makers in order to examine the overall implications of each alternative choice possibility (Keeny, 1981).

4.3.1 Definition and Scope

Multi-criteria evaluation (MCE) emerged during the early 1970s from a critique of traditional neoclassical environmental economics, particularly as it related to regional economic planning and facility site location (Carver, 1991; Voogd, 1983; Nijkamp, 1980). Nijkamp *et al.* (1990) suggested that the reasons for the increasing influence of MCE techniques during the early 1970s could be attributed to a number of factors, notably: the possibility of including intangibles and incommensurable effects in the conventional cost-benefit methodology; the shift from conventional 'one-shot' decision-taking to institutional and procedural decision-making, and; the desire in modern public decision analysis not to end up with a single and forced solution dictated by the researcher but with a spectrum of feasible solutions from which choice could be made.

In essence, MCE provides a means by which the relative attractiveness, or potential environmental effects, of alternatives can be assessed against multiple criteria and evaluated by multiple decision-makers in an orderly and systematic manner (Yongynan *et al.*, 2000). Appropriate units of measurement are applied to each component of the problem rather than "trying to impose artificial shadow prices, as in many neoclassical models (e.g. cost-benefit analysis)" (Carver, 1991: 322). Multi-criteria decision and evaluation methods provide a means of analyzing the trade-offs between choice alternatives with different environmental and socioeconomic impacts (Carver, 1991). In doing so, the researcher can generate compromise alternatives and rankings of alternatives according to their attractiveness (Janssen and Rietveld, 1990). MCE is particularly useful when a decision has to be made from a large number of alternatives, when there are many different types of potential impacts, and when there are several criteria upon which the alternatives must be assessed.

MCE is a mixture of several maximum or minimum problems which condenses to that of satisficing conflicting objectives. In practice there is no optimal solution, only efficient and satisfying ones (Tabucanon, 1988). In addition, MCE does not offer a rigid set of rules for evaluation but rather a flexible framework that may be adapted to various circumstances without changing the basic nature of the approach (Sobral *et al.*, 1981). Traditional decision analytical techniques are not well suited to multi-criteria problems, and to this study in particular, as such rigid evaluation techniques are typically oriented only towards particular types of problems (e.g. utility maximization) and run the risk that the evaluation does not cover all relevant aspects of the problem (Huylenbroeck and Coppens, 1995).

As discussed previously, multi-criteria problems are not new to resource and environmental planning and management, and MCE methods have been applied to a variety of resource management 'meta-problems' (Trist, 1983). Notwithstanding the numerous applications, there has been much less attention given to MCE application in the context of strategic EA, particularly in terms of the broader resource and environmental policy development process.

4.3.2 Classifications, Components and Functions

Classes of MCE problems

There are two broad classifications of multi-criteria evaluation problems: multi-objective decision-making (MODM) and multi-attribute decision-making (MADM) (Table 4.1). An objective is defined as a statement about the desired state of the system under consideration. It indicates the desired direction of improvement of one or more system attributes (Malczewski, 1999). The role of MODM approaches is to provide a framework for designing a particular set of alternatives based on underlying objectives to address the particular issue at hand. The MODM problem is continuous, in the sense that the best solution may be found anywhere within the region of feasible solutions and may involve any part of or any combination of feasible alternatives (Malczewski, 1999).

An attribute is used to measure performance in relation to a particular objective. MADM requires that choices be made between those alternatives described by their attributes (Malczewski, 1999). In contrast to MODM problems, MADM problems are discrete in that they are assumed to have a limited number of alternatives, as is the case in this particular assessment, and the MADM process is a selection process – what is the best practicable environmental option – rather than a design process.

Table 4.1. Comparison of multi-objective decision-making (MODM) and multi-attribute decision-making (MADM) approaches to multi-criteria evaluation.

	MODM	MADM
Criteria defined by:	Objectives	Attributes
Objectives defined:	Explicitly	Implicitly
Attributes defined:	Implicitly	Explicitly
Constraints defined:	Explicitly	Implicitly
Alternatives defined:	Implicitly	Explicitly
Number of alternatives:	Infinite	Finite
Decision-maker's control:	Significant	Limited
Decision modeling paradigm:	Process-oriented	Outcome-oriented
Relevant to:	Design/search	Evaluation/choice

Source: Hwang and Yoon (1981) and Starr and Zeleny (1977) as cited in Malczewski (1999: 86).

Components of MCE

At the basis of all multi-criteria evaluations is a series of organizational matrices – decision matrices - that reflect the characteristics of a given set of choice possibilities that are determined by a means of a given set of evaluation criteria. The fundamentals of this approach consists of a (at least) two-dimensional matrix, where one dimension indicates the various decision alternatives and the other dimension the various criteria by which each alternative must be evaluated (Voogd, 1983). The decision outcomes depend on the set of criteria for evaluating each alternative. An entry at each intersection of each row and each column of the decision-matrix is the decision outcome associated with a particular alternative and a particular evaluation criterion. According to Voogd (1983), three broad types of decision matrices can be identified: (i) the evaluation matrix - the most basic type of decision matrix, used if the criterion scores can be measured in different units; (ii) the priority matrix – used to summarize views concerning possible conflicting criteria and criterion priorities, the priorities (or weights) are typically represented by a set of quantitative numbers, ordinal expressions, or binary statements; and (iii) the appraisal matrix: used to give an indication of the general quality of the choice possibilities under consideration. An obvious contrast at the project versus the strategic level is the nature of the information required to complete such matrices. In project-level EIA considerable technical detail is often required to complete the decision matrices, whereas at the increasingly more strategic level less detail is needed as the actions do not concern particular project design and are often much less place specific (Sheate *et al.*, 2001:59).

The matrices used in MCE consist of (at least) three essential components, which, in this study, form the basis of the assessment: alternatives, criteria (i.e. factors and constraints), and interests. (Massam, 1988; Voogd, 1983). The alternatives are simply defined as the finite possible choice options or strategic options, which are under consideration. In this particular assessment, the decision alternatives are pre-determined, and modeled after NRCan's ETF project.

'Criterion' is used in a flexible way; defined as a measurable aspect of judgement by which the various alternatives under consideration can be characterized. (Voogd, 1983). Whereas in EIA-based matrices the characteristics of a particular undertaking are assessed against the particular baseline parameters, in SEA it is more common to assess the elements of the PPP against a set of evaluation criteria, which typically are based on specific objectives, targets and environmental parameters (Sheate *et al.*, 2001).

Voogd (1983) notes two general types of criteria in MCE: attainability criteria and desirability criteria. Attainability criteria relate to the presence of factors and constraints, such as the availability of government policy, availability of certain technologies, or social acceptance. Desirability criteria relate to the degree to which a particular alternative is desirable from a certain point of view, such as minimizing atmospheric emissions, maximizing financial returns, or maintaining ecological integrity. This assessment focuses primarily on desirability criteria as it is safe to assume that all alternatives under consideration are technologically and institutionally attainable given the time frame under consideration.

Closely related to the criteria are the criterion weights. The criterion weights are assigned by the individual decision-maker and are used to assign a measure of relative importance to each evaluation criterion (attribute) under consideration (Voogd, 1983). The interests are often defined according to each decision-maker's assessment and weighting scheme. In this case, particular emphasis is placed on identifying relevant interests in the selection of Canadian energy policy alternatives by region, sector and individual area of expertise, and identifying potential areas of dissent.

Decision-makers

A distinction can be made between individual and group decision-making in MCE problems. The distinction, as discussed by Molczewski (1999:87), rests not on the number of decision-makers involved but on the consistency of the group's interests, goals, preferences and beliefs. If a single group interest, and set of goals, preferences and beliefs can be assumed, then we are dealing with individual decision-making, regardless of the number of decision-makers involved. On the other hand, when these characteristics vary, group decision-making is involved.

A key characteristic of MCE is its ability to address - in an operational sense - assessments marked by various conflicting interests. Policy level decision-making is a process of highly dynamic interactions between a large variety of stakeholders with various interests, preferences and beliefs within a network of formal and informal relationships (Bots and Hulshof, 2000; Weimer, 1995; Dowding, 1995). Policy-level SEA should address the pluralism and dynamics of such a network, rather than hide them, in order to sufficiently address the multiplicity of different perceptions and often-conflicting interests involved in the policy process (Bots and Hulshof, 2000). Therefore, in this particular assessment, a key objective is to systematically identify these potential conflicts so as to make the trade-offs in the assessment more transparent to the final decision-maker(s) or policy agency (Nijkamp *et al.*, 1990). The various interests involved in the assessment can be 'disaggregated' according to sector and region, which may prove useful in identifying various perspectives on national energy policy issues.

Functions

In addition to the common components of MCE problems, at least four different functions of MCE can be identified (Nijkamp *et al.*, 1990). First, MCE has an analytical function, where MCE is used to describe and analyze spatial patterns, and to determine statistical patterns and relationships in urban and regional planning (e.g. Van Setten and Voogd, 1979). Second, MCE has a selection function. This involves the use of MCE methods to select appropriate strategies for action in order to define a decision area (e.g.

Gurocak and Whittlesey, 1998). Third, MCE serves an accountability function, where it is used to account for a proposed line of action to ensure that the decision-makers have (or have not) made the proper use of the information available in defining their decision area and identifying their course of action. Traditionally, very little attention has been paid to the accountability function and uncertainty aspects in MCE applications (Voogd, 1983). Finally, MCE has a testing function. This involves the use of MCE to test the likely appropriateness of a particular strategy for action or line of policy. In other words, is the strategic decision operational with respect to, for example, existing technologies, institutional arrangements, and financial and time constraints?

In this particular assessment, MCE must serve at least three main functions in the SEA methodology. First, it must serve a selection function in order to identify an appropriate line of action, or a strategic direction for energy policy, through the evaluation of the potential environmental effects of each development alternative. Second, it must serve to ensure accountability in that the decision-makers have considered all appropriate information in their assessment of each alternative. Third, it must serve a testing function, in order to test the appropriateness of the selected policy alternative(s) against particular environmental and socioeconomic components, and according to the various interests and sectors involved in the assessment. An analysis of the positions, interests and interrelations of the actors involved may provide insights that could help to identify creative and workable solutions (Kornov and Thissen, 2000). While a multi-criteria analytical approach to SEA is the subject of much criticism amongst the soft-systems thinkers (e.g. Bartlett, 2000), particularly in terms of its perceived technocratic and pseudo accurate characteristics, proponents of MCE emphasize the structured, thematic approach, and the reproducibility and clarity of the method (e.g. Malczewski, 1999; Huylenbroeck and Coppens, 1995; Massam, 1985; Voogd, 1983; Sobral *et al.*, 1981).

4.3.3 Decision Rules: A Typology of Methods

In general, MCE involves a set of alternatives that are evaluated on the basis of a set of evaluation criteria. A decision rule is a procedure that allows the ordering of those alternatives (Starr and Zeleny, 1977). It is the decision rule that determines how best to order the set of decision alternatives or to decide which alternative is preferred to another. The decision rule orders the decision space of outcomes to decision alternatives (Malczewski, 1999).

A wide range of formal decision rules is available for handling multi-criteria evaluation problems, and a number of taxonomies have been proposed for classifying them. There is no single MCE approach that will do all that is required of SEA in every situation. Different problems with different alternatives, criteria, and interests require different MCE approaches, consisting of a variety of different methods and techniques depending of the level (i.e. policy, plan or program) and context of the SEA. There are numerous decision rules that can be used in MCE to rank and choose amongst alternatives (Table 4.2).

Table 4.2. Classification of MCE decision rules.

	cardinal information	qualitative information	mixed information
discrete MCE methods	• utility-based MCE methods • weighted summation additive models • concordance analysis • ideal point method	• cardinalization methods • e.g Saaty's AHP, Borda-Kendall consensus maximization • frequency method • multi-dimensional scaling	• combination of cardinal and qualitative methods
continuous MCE methods	• multiple criteria linear programming • pay-off matrices	• fuzzy sets • hierarchical programming models	• combination of cardinal and qualitative methods

Source: From Nijkamp *et al.* (1990), Voogd (1983) and Massam (1980).

Discrete methods display a finite number of feasible choice possibilities. The aim is to provide a basis for classifying a number of alternative choice possibilities on the basis of multiple criteria. Perhaps the largest collection of MCE methods can be grouped under 'additive models'. Simple additive models seek to reduce the evaluation and selection problem to one in which each of the alternatives is classified using a single score, which represents the relative attractiveness of a particular alternative. The selection of the preferred alternative(s) is then based upon these scores (Massam, 1988).

One of the more common 'cardinalization' approaches to additive models is Saaty's Analytical Hierarchy Process (AHP) (Saaty, 1977, 1997) (Table 1), where each decision-maker constructs a pairwise comparison matrix of weighted criteria and the alternative choice possibilities in order to derive, for each plan, the normalized principal eigenvector indicating the most attractive alternative. Although this method was developed in the 1970s, it continues to be the foundation on which modern multi-criteria evaluations are based. Blair *et al.* (1994), for example, used the AHP to incorporate expert judgment in forecasting economic trends in the US economy, and Gholam-Nezhad (1985) applied the AHP to predicting future trends in world oil prices. This pairwise AHP approach is often used in combination with other cardinal MCE decision rules, particularly concordance methods, whereby an ordinal ranking of alternatives is derived based on the condordance-disconcordance evaluation set[4].

Continuous methods formulate options and actions in a continuous way, revealing values for all variables, and may encompass an infinite number of choice possibilities (Voogd, 1983). The numbers of alternatives are, in principle, infinite. Thus, comparisons among all elements of the choice set cannot be carried out manually and a detailed comparison of the pros and cons for each pair of alternatives is not feasible. Feasible alternatives are usually only implicitly defined in the case of continuous problems, but are explicitly known in the case of discrete problems (Voogd, 1983). 'Fuzzy expert systems' (FES), for example, is one approach to continuous MCE problems. Zimmermann (1991, cited in Gurocak and Whittlesey, 1998) notes that *fuzziness* can be found in many evaluation and decision problems. Fuzzy set theory, introduced by Zadeh in 1965, has been suggested in the MCE literature as a means to deal with imprecision in decision-making where real decision-makers are not required to arbitrarily assign weights (Gurocak and Whittlesey, 1998). The fundamental idea behind FES is the lack of a well-defined set of criteria to determine whether an object belongs or does not belong to a set (Blin, 1977)[5]. FES MCE is particularly useful for situations where the number of alternatives is large and cannot be simultaneously evaluated by individual decision-makers. Gurocak and

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[4] AHP, pairwise comparisons, and concordance decision rules are further discussed in Chapter Five.

Whittlesey (1998), for example, applied FES MCE to the Pacific Northwest Electric Power Planning and Conservation Act's Columbia River Basin Salmon Recovery Plan.

The plan was developed, in part, to address the impacts of hydropower development on salmon populations in the Columbia River Basin. The plan recommended a number of production alternatives in each sub-basin that, collectively, would double the salmon population. Gurocak and Whittlesey (1998) used this plan as a starting point for determining which variables should be included in the decision-making model. Overall, five variables and 4,060 possible alternatives were evaluated using FES MCE, out of a possible 27 variables and 20,000 alternatives identified in the plan.

The assessment in this research focuses upon a predetermined number of choice possibilities in the form of potential energy policy development alternatives, which are evaluated, through the use of an assessment panel, against a finite set of assessment criteria. Thus, discrete MCE methods are required, using both cardinal and qualitative approaches. It is important to note, however, that discrete and continuous methods are not necessarily mutually exclusive. Continuous MCE methods, for example, may be used to generate a set of feasible alternatives, which in turn may be evaluated by means of a discrete multi-criteria analysis.

Selecting the appropriate decision rule is an important problem as the alternative(s) that is identified as the preferred alternative(s) can depend on the particular decision rule used (Hobbs, 1986; Malczewski, 1999). There are several factors that should be considered when selecting the appropriate decision rule, notably the characteristics of the decision problem (number of criteria and alternatives, amount of uncertainty), the characteristics of

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[5] For additional reading on FES and MCE, see Blin, J., 1977. Fuzzy sets in multiple criteria decision making. *TIMS Studies in the Management Sciences*. 6:129-46.

the decision makers (abilities, experience, desire to participate) and the characteristics of the decision rule (ease of use, amount of work required of the decision-makers, time requirements) (Mollaghassemi and Pet-Edwards, 1997, cited in Malczewski, 1999: 259). To select an appropriate decision rule, "the characteristics of the decision problem and the decision makers must be studied against the characteristics of the decision rule, such that the best method(s) can be identified" (Malczewski, 1999: 197). In all cases, multiple methods are best in order to test the sensitivity of the outcome to the particular decision rule.

4.3.4 Uncertainty

The basic aim of MCE is "to investigate a number of choice possibilities in the light of multiple and conflicting objectives" (Voogd, 1983; 21). Policy, however, "...does not stand still...it may be inevitable that policy issues are not as precise as many people would wish" (House of Commons Environment Committee, 1986 – as quoted in Therivel and Partidario, 1996: 11). In light of changing policy conditions, combined with incomplete information and knowledge, uncertainty abounds in impact assessment, particularly at the policy level. Four key types of uncertainty, and the methods for dealing with such uncertainties are outlined in Table 4.3. Saaty's (1977) AHP, for example, introduced in Section 4.3.3, offers a conventional measure of assessment uncertainty by providing a single numerical index of consistency, the consistency ratio, indicating the randomness of assessment decisions and the reliability of the assessment data. The consistency ratio and its application are discussed in detail in Chapter Five, Section 5.2.4.

Due to the policy nature of this research, and the diverse interests involved, this assessment will require some form of sensitivity analysis in order to address assessment and priority uncertainty. In addition, confirmatory analyses are required in order to test for method uncertainty, such that the SEA outcome is *not* a product of the particular method(s) used. A number of approaches are available to address the sensitivity of the ranking of alternatives, including Butler and Olson's (1999) 'comparison of centroid' method, and more standard approaches, such as varying the individual weights of the criteria and alternatives (Insua, 1999). The two most important elements to consider in a sensitivity analysis are criterion weights and criterion values. Malczewski (1999) explains that sensitivity to criterion weights is perhaps the most important as criterion weights are the essence of value judgments and because they are subjective numbers about which decision-makers often disagree. A sensitivity analysis of criterion weights requires investigating the sensitivity of the rankings of alternatives to small changes in the value of those criterion weights. If the rankings remain unchanged as criterion weights are varied, errors in the estimation of criterion weights are considered insignificant. However, if the ranking of alternatives is sensitive to one or more adjustments in criterion weights, the accuracy of the weight estimates should be examined in detail.

Table 4.3. Uncertainty in MCE

Type of uncertainty	Methods for managing uncertainty
Assessment uncertainty	• probability functions for criterion scores; sensitivity analysis of adjustments to criterion scores; rescaling to a lower level of measurement; feedback to research, Saaty's AHP – consistency ratios
Criterion uncertainty	• cross-study comparisons; checklist evaluation against existing plans, documents, etc.
Priority uncertainty	• probability functions for individual weights; sensitivity analysis of weights; rescaling to a lower level of measurement; define alternative sets of priorities; feedback to research
Method uncertainty	• confirmatory analysis; delimit the number of criteria in each evaluation matrix; delimit the number of choice possibilities

Source: Voogd (1983).

4.4 Delphi Technique

The term "Delphi technique" was coined by Kaplan, a philosopher working with the Rand Corporation, who, in 1948, headed a research effort directed at improving the use of expert predictions in policy-making (Woudenberg, 1991). The name itself refers to the ancient Greek oracle at *Delphi*, where those who sought advice were offered visions of the future (Cassino, 1984). The Delphi technique, developed in its contemporary form during the 1950s and early 1960s by the Rand Corporation, is an iterative survey-type questionnaire which solicits the advice of a group of experts, provides feedback to all participants on the statistical summaries of the responses, and provides an opportunity for the experts to revise their opinions and reach consensus (Linstone and Turoff, 1975; Dalkey, 1969). "It relies on a structured, yet indirect, approach to quickly and efficiently elicit responses related to group learning and forecasting" (Gupta and Clarke, 1996: 186). "The heart of the Delphi is the structure that relates all the contributions made by the individuals in the group and which produces a group view or perspective. For this reason, this approach is particularly suitable for group decision-making problems" (Malczewski, 1999: 111-112).

Those who seek to utilize the Delphi technique "recognize a need to structure a group communication process in order to obtain a useful result for their objective(s)" (Linstone and Turoff, 1975: 5). The Delphi technique is "a systematic procedure for soliciting the advice of a number of experts, and forging a consensus from that advice" (Richey *et al.*, 1985: 136). It is designed for use in situations where, as in this assessment, the problem does not lend itself to precise analytical techniques, or where large data requirements and the lack of available quantitative data prohibit the application of traditional analytical approaches, but which can benefit from the subjective judgements of experts on a collective basis (Rowe *et al.*, 1991; Richey *et al.*, 1985; Linstone and Turoff, 1975; Dalkey, 1969). The Delphi technique is particularly useful when the individuals needed to contribute to the examination of such a complex problem have no history of communication, represent diverse perspectives and backgrounds with respect to experience or expertise, and are geographically dispersed (Linstone and Turoff, 1975). Thus, the Delphi technique captures a wide range of interrelated variables and multidimensional features common to most multicriteria, meta-problems (Gupta and Clarke, 1996).

4.4.1 Procedure and Applications

The Delphi technique is a structured, but adaptive group decision-making and forecasting technique often used in combination with a number of data collection, aggregation, and analytical procedures. It is primarily used as a data collection procedure, where a questionnaire is developed and sent to a number of expert respondents (the Delphi panel). The technique itself typically undergoes a number of distinct phases or survey 'Rounds' (Bonnell, 1997; Woudenberg, 1991; Richey *et al.*, 1985; Riggs, 1983; Linstone and Turoff, 1975; Turoff, 1970) (Figure 4.1):

The Delphi process typically begins with the exploration of the subject matter under consideration. This involves identifying the Delphi panel and the issues and components to be explored. In some cases this may involve a preliminary questionnaire, which introduces the panel to the issue(s), identifies individual's expertise, and provides an opportunity for the panel to add any new information, in the form of decision options or decision criteria, to the issue(s) under consideration.

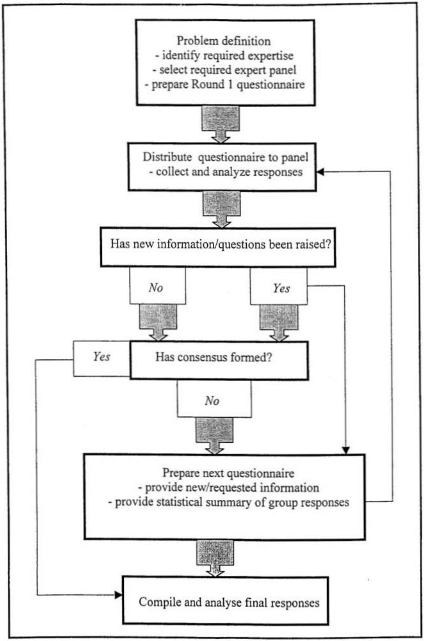

Figure 4.1. The conventional Delphi procedure (adapted from Richey et al., 1985 and Riggs, 1983).

The Delphi exercise consists of multiple iterations, or survey Rounds. In the first survey Round, an 'open-ended' questionnaire is sent to the panellists wherein each individual contributes additional information that they may feel is pertinent to the issue (Linstone and Turoff, 1975). In other cases, where the Delphi facilitator is seeking the opinion or the expert judgment of each individual regarding the issue(s) under consideration, a more structured questionnaire is appropriate (Woudenberg, 1991; Richey *et al.*, 1985). A more structured approach does not preclude panellists from contributing new information. Responses from Round I are collected and summarized statistically, and often incorporated into a number of analytical-based matrices. With this information at hand, the Delphi facilitator then compiles the Round two questionnaire.

The second, and subsequent, Round questionnaires typically include a reiteration of questions from the first questionnaire, where considerable discrepancies exist (e.g. conflict/non-consensus), and new questions, which represent issues and options raised by respondents during the first round. The process is repeated as many times as necessary until a desired level of consensus is reached. The typical Delphi procedure lasts only three survey Rounds, as consensus increases strongly over the first two survey rounds (Woudenberg, 1991). The final phase of the Delphi, once all previously gathered information has been analyzed, fed back for consideration, and a desired level of consensus has been formed, is the final evaluation of the group responses

Since its inception, the Delphi technique has received widespread application in a variety of disciplines, including, for example, the health care sector (e.g. Buck *et al.*, 1993; Bijl, 1992; Demi and Miles, 1987; Clark and Friedman, 1982), education studies (e.g. Chambers, 1992; Brooks, 1981; Copeland and Bame, 1979), and finance and economics (e.g. Delaney and Seldin, 1989; Cicarelli, 1984; Coopper *et al.*, 1981). With respect to resource analysis, Huylenbroeck and Coppens (1995) used a Delphi questionnaire, in conjunction with MCE methods, to evaluate alternative land-use scenarios in the Gordon District, Scotland. In the energy resource sector, Garde and Patel (1985) applied the Delphi technique to technological forecasting for power generation. At the policy level, Bardecki (1984) used the Delphi technique to evaluate wetland conservation policies in southern Ontario.

More in keeping with the context of this study, the Delphi technique has also received widespread application in a number of environmental assessment and monitoring studies. Bonnell (1997), for example, used the Delphi technique to solicit expert judgement regarding the potential cumulative environmental effects of proposed small-scale hydroelectric developments in Newfoundland, Canada; Mar *et al.* (1985) used the Delphi technique for assisting in the design of environmental monitoring programs to evaluate the effects of individual thermal electric power plants on aquatic ecosystems, and Vizayakumer and Mohapatra (1992) used the Delphi to collect opinions on the impacts of pollutions from coalfields in India. At the policy level, Freeman and Frey (1992) used a policy-type Delphi and simple additive models to evaluate the social impacts of alternative natural resource policies.

4.4.2 Effectiveness Characteristics

A primary reason for the continued popularity of the Delphi technique is its strengths as a planning, and decision-making tool (Gupta and Clarke, 1996). There are three key features of the Delphi: anonymity, iteration, and feedback, all of which are key to effective group decision-making (Rowe *et al.*, 1991; Woudenberg, 1991; Dalkey, 1969).

Anonymity

The Delphi technique allows the documentation of facts and the opinions of the experts, while avoiding the pitfalls of face-to-face interaction, particularly conflict and individual dominance. In the more traditional small-group or conference-style meeting, for example, "minority views sometimes receive less than adequate consideration because of the over-riding influence of dominant personalities" and, alternatively, "an outspoken minority can inflict its ideas on a weak majority group, even if these ideas are poorly founded" (Richey *et al.*, 1985: 137). Thus, by allowing panellists to formulate their responses anonymously, the Delphi excludes group interactions that may potentially decrease the accuracy and reliability of group judgment (Woudengerg, 1991). Although anonymity has been criticized for its potential negative effects, such as the possible lack of feeling of responsibility for the end result (e.g. Milkovich *et al.*, 1972), anonymity allows the individual to present a more personal, expert-based judgment rather than a cautious institutional position (Masser and Foley, 1987).

Iteration

The purpose of iteration in the traditional Delphi application is to have the 'least-informed' participants change their mind. The underlying premise is to have those with the 'least accurate' forecasts, or least consistent responses, shift their responses towards the opinions of those who are most accurate and consistent (Dietz, 1987). The number of iterations used in Delphi applications is quite variable. However, Woudenberg (1991) reviewed a number of Delphi applications and found that in nearly all studies, the largest increase in the accuracy and reliability of technical forecasts is found between the first and second rounds. Over four iterations, Delphi estimates often became slightly less accurate and reliable (Ford, 1975). In addition, where individual judgments fail to converge, the underlying reasons for such disagreement typically become evident after two to three iterations (Freeman and Frey, 1992).

Feedback

The idea behind providing feedback to panel members in the second and each subsequent Round, is to share the total information available to the group of individual experts. The premise is that those experts who find the composite group judgments or the judgments of deviating experts more compelling than their own, will subsequently modify their decisions (Woudenberg, 1991). Feedback typically is in the form of a statistical summary of the median group response as well as, in particular cases, the arguments of deviating panellists. Woudenberg (1991) reviewed several Delphi studies that reported a slight increase in accuracy and reliability through statistical feedback. However, statistical feedback typically induces only change toward the median rather than causing the median to change (Riggs, 1983; Scheele, 1975). In other words, while statistical feedback allows deviating judges to modify their choices in compliance with the group median, it does not ensure that the group median represents the most accurate, or reliable set of decisions. Thus, prior to providing statistical feedback of the group response, it is necessary to evaluate the quality (e.g. consistency of decision-making) of the group response.

4.4.3 Generating Consensus

The primary purpose of the conventional Delphi is to "obtain the most reliable consensus of opinion of a group of experts…by a series of intensive questionnaires … (and) controlled opinion feedback" (Dalkey and Helmer, 1963: 159). The Delphi technique is based on the Hegelian Principle of achieving 'oneness of mind' through a three-step process of thesis, antithesis, and synthesis (Mitroff and Turoff, 1975). Thesis and antithesis refer to establishing views and opposing views on a particular issue. Synthesis refers to bringing together these opposing views to form the new thesis.

Several authors have shown that the Delphi technique is extremely efficient in achieving consensus (e.g. Rohrbaugh, 1979; Scheibe, 1975; Salancik, 1973) and that statistical feedback of the group's response to the individual induces conformity (Dalkey, 1972). Woudenberg (1991) reviewed several studies that show that changes in an individual's responses over two Delphi Rounds are in the direction of the group response that has been fed back. However, Woudenberg also notes that changes in responses caused by feedback are primarily a result of group pressure to conformity, as opposed to the dissemination of new information.

The theory of the Delphi and the reality of the Delphi are quite different. The reality being that 'oneness of mind' does not actually occur, but only the illusion of 'oneness of mind' with those who refuse to conform being 'outliers' in the Delphi process. Group pressure to conformity does not reflect genuine agreement. Gutierrez (1989) suggests that the Delphi's goal should *not* be to arrive at a consensus, but simply to obtain high-quality responses and opinions on a given issue in order to enhance decision-making. Woudenberg (1991: 145) goes one step further, suggesting that "…consensus can never be the primary goal of a Delphi…consensus is neither a necessary nor a sufficient condition for high accuracy and reliability" and, furthermore, "this makes consensus in a Delphi suspect and in no way related to genuine agreement". As noted in Praxis (1988), forcing consensus is an exhaustive process, which often results in homogenised points of view and an inaccurate view of reality.

Generating consensus through the Delphi process does not necessarily mean generating better data. Woudenberg's (1991) review of Delphi applications shows that in several cases where the Delphi's objective was to measure the accuracy and reliability of quantitative forecasts, there was only a slight increase in accuracy over survey rounds, whereas consensus increased very strongly (Woudenberg, 1991). Dalkey (1969) notes at least one case where the accuracy and reliability of the group forecast actually decreased with multiple iterations as the group came to consensus. "The same lack of knowledge that produced the need for a study that relied on expert judgement virtually assures that a group of 'diverse experts' will disagree" (Stewart and Glantz, 1985). It is because of differing perceptions and insufficient knowledge that a lack of consensus exists (Gonzalez, 1992).

4.4.4 Policy Delphi and Consistency

Policy Delphi was designed to overcome some of the weaknesses associated with the conventional Delphi technique and its emphasis on group consensus, particularly when the issue, as in the case of this assessment, is of a qualitative nature. The policy Delphi is merely a structured approach for soliciting the views, expertise and information pertaining to a specific policy area and for allowing the respondents the opportunity to react and to assess differing viewpoints (Turoff, 1970). The goal is not so much to obtain a consensus as to expose all the differing positions in order to improve the effectiveness of the policy decision-making process. Turoff (1970:149-71) outlines that the purposes of the policy Delphi include: to ensure that all feasible options have been offered for consideration; to estimate the potential impact and consequences of any particular option, and; to examine and estimate the acceptability of each option. The policy Delphi rests on the premise that the decision-maker is not interested in having a panel generate the final decision, but, rather, having the panel present and evaluate all of the options such that the decision-maker or policy agency can make an *informed* decision (Turoff, 1970).

Given the nature of policy-level decisions and the diverse interests involved in this particular assessment, it is not anticipated that complete consensus will be reached regarding the potential environmental effects and the relative attractiveness of each energy development alternative, nor is it necessary. What is required, however, is that individual 'strategic assessments' emerging from the Delphi process, particularly when dealing with issues of potential interest to national energy policy, are not random decisions, but rather consistent, goal-oriented decisions. Thus, while consensus is not a necessary condition for SEA, and for informed policy choices in general, consistency in the decision-making process is.

The relationships in any assessment (including SEA) should provide a set of coherent and non-contradictory results (Nijkamp *et al.*, 1990). From a theoretical standpoint, consistency is a necessary condition for representing a real-life problem; however, it is not sufficient. Perfect consistency in measurement is particularly difficult when dealing with multiple decision-makers. Minimizing inconsistency does not mean getting an answer closer to the real-life solution, but that the ratio of estimates in the decision-process are closer to being logically related than to being randomly chosen (Saaty, 1977). While this is an important requirement for making informed decisions, it is rarely a topic of discussion in the impact assessment literature. The notion of consistency is explored in detail in the following Chapters.

Chapter Five

RESEARCH METHODS AND TECHNIQUES: APPLYING THE SEA FRAMEWORK

5.1 INTRODUCTION

This chapter outlines the specific research methods and techniques used in the development and application of the SEA methodological framework introduced in Chapter Two. These include the collection and evaluation of secondary sources, including literature reviews and analysis of government energy policy and electricity industry documents, and primary data collection and analysis through personal interviews with key government and industry representatives, and group responses through a multiple-round Delphi and multi-criteria analytical approach.

It is important to note that while the SEA framework is intended to set out a consistent methodology for SEA application at different tiers of decision-making and across different sectors, the particular methods and techniques employed here are context-specific, and designed in such a way so as to address the needs of higher-order, policy-level SEA decision-making as it applies to the Canadian electricity sector. The assessment framework is summarized in Figure 5.1 and discussed throughout this Chapter. Once again, the emphasis here is on the assessment process itself, rather than the specific case study results.

Phase I: Scope the Assessment Issue(s)

- Identify the PPP problem
- Determine the nature/purpose of the SEA required
- Develop a scoping framework
  - Identify key issues, actors and SEA requirements

Phase II: Describe the PPP Alternatives

- Determine the feasible range of alternatives that can be assessed
  - How will they be assessed?
- Formulate/identify/develop the PPP alternatives

Phase III: Scope the 'Assessment' Components and Actors

- Identify the assessment factors and assessment criteria
- Determine the assessment panel requirements
  - Required panel size and composition
- Select an assessment panel
  - Non-random, purposive panellist selection
- Send a panellist consent and information form
  - Panellists self-identify expertise
- Add any additional assessment factors

Are the panel size and panel composition satisfactory?

No | Yes

Draft Delphi Assessment Round I

- Perform pilot study

Is change recommended in the assessment documents/procedure?

Yes | No

Phase IV and V: Evaluate Potential Impacts and Determine Impact Significance

- *Commence Delphi Assessment Round I*

Matrix A
- Paired comparison assessment matrix

Matrix B
- Paired comparison significance matrix

Compile and analyze Delphi Round I results

- Calculate individual consistency ratios

Matrix A
- Consistency ratio ≤ 0.10

Matrix B
- Consistency ratio ≤ 0.10

Matrix A
- Panellist consistency ratio > 0.10

Matrix B
- Panellist consistency ratio > 0.10

Commence Delphi Assessment Round II
- Individual iteration of inconsistent responses

Compile and analyze results
- Calculate individual consistency ratios

Matrix A
- Consistency ratios > 0.10
- Consistency ratios ≤ 0.10

Matrix B
- Consistency ratios > 0.10
- Consistency ratios ≤ 0.10

Commence Delphi Assessment Round III
- Test expert versus non-expert assessment scores
- Calculate group median assessment scores
- Group feedback of 95% confidence interval for the median (Matrix A only)

Compile and analyze Round III data
- Test for inconsistencies
- Calculate median assessment scores by group, region and sector

Phase VI: Compare PPP Alternatives
- Analyze the assessment data
  1. Group assessment
     - unweighted assessment scores/ individual criterion performance
     - weighted (AHP) assessment scores and ordinal ranking
     - determine the source and effects of remaining inconsistencies (Moran's *I*)
     - determine within group similarity/ consensus (Cosine theta)
     - identify an appropriate 'threshold of consensus'
     - identify potentially conflicting individuals
  2. Disaggregate assessment
     - repeat analysis at regional level and by sector
  3. Present ordinal rank of energy policy preferences
     - group preferences
     - regional preferences
     - sector preferences

Phase VII: Identify the BPEO
- Determine a robust, interval ranking of alternatives
  - perform concordance analysis for weighted assessment scores
  - test the agreement of the ranking with the assessment data
  - scale the concordance matrix to allow cross-group comparisons
  - present visual interpretation of assessment outcome
- Determine the sensitivity of the SEA output with respect to:
  - inconsistencies
  - disagreements/conflicts
  - uncertainties
- Recommend the BPEO

Figure 5.1. Assessment framework.

5.2 The Assessment Framework

5.2.1 Phase I: Scope the Assessment Issues

The first step in any SEA is to scope the assessment issues, or 'problem identification'. In order to be able to identify the particular components and alternatives and to assess their potential impacts, it is necessary to set the context within which the assessment is to take place (Canter, 1977). The scoping process, introduced to environmental assessment in the early 1970s, involves developing a reference framework for the assessment and providing a general overview of the issues and region in question. In developing a reference framework, the aim is to identify the question(s) or problem(s) to be addressed, the type of SEA to be undertaken (Fig. 2.4) and the intended objectives of the assessment. The reference framework serves to highlight the SEA requirements at the outset. It presents an opportunity to identify the relevant interest groups, identify the availability and quality of data, and determine a set of appropriate methods and techniques to address the issue(s) at hand.

Hedo and Bina (1999: 271) in their review of the SEA of hydrological and irrigation plans in Spain, note that "better knowledge of the key characteristics...would have led to fewer conflicting objectives..." The scoping process is an integrated holistic[6] approach to reduce the amount of required data collection and analysis by identifying the key issues at the outset of the assessment process. While this may result in certain issues and concerns being excluded from the assessment, scoping not only makes the assessment more

[6] An *integrated* holistic approach is more focused and therefore more practical than a *comprehensive* holistic approach. The former focuses on the key issues and variables that can be affected, managed, or measured. The latter seeks to identify and understand all issues and assessment components, which often results in too many variables identified in only a general fashion.

efficient, but also more effective in terms of impact prediction (DEAT, 2000; Noble, 2000b; Barrow, 1997).

The scoping phase consisted of a number of person-to-person and telephone-based discussion-type interviews. Interviews were conducted with key individuals from various government departments and industry organizations, notably CEAA, NEB, Environment Canada, and NRCan. Informal discussions were also held with numerous other government departments, energy industries, consulting groups, and non-government organizations at the Alberta Association of Professional Biologists' *Cumulative Environmental Effects Management Workshop*, held in Calgary, Alberta (Nov. 1st-3rd, 2000), and at the 2000 *Policy Research Forum - Canada @ the World,* held in Ottawa, Ontario (Nov. 29th to Dec. 31st, 2000). The information gained from these interviews was used to identify other key individuals and organizations who, in the interviewee's opinion, were known to be experienced in or knowledgeable of the assessment issue, to identify key government and industry documents on energy and the environment, and to establish an appreciation of the future of Canada's electricity sector and the current state-of-the-art of SEA in Canada.[7]

Interviews were informal, but semi-structured in the sense that discussions were organized around a pre-designed set of topics (Table 5.1). This scoping framework served as a general guide for the interview process, but questions were left open-ended. The discussion-type interview is of particular value in geographic field research, and particularly scoping exercises. According to Lounsbury and Aldrich (1979) the technique

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[7] See Chapter Three for discussion on Canada's electricity sector and the state-of-the-art of SEA in Canada.

Table 5.1 Scoping framework for discussion interviews – issues explored

I. Canadian policy process and environmental considerations

- Type of policy formulation process most often followed
- Provisions for the integration of environmental considerations in policy development
- Perceived advantages and limitations of integrating environmental considerations into policy development
- Challenges facing the integration of environmental issues into the policy process
- Current state-of-the-art of SEA in Canada – recent practice, guidelines, experience
- Key areas for SEA research and development

II. Energy and the environment

- Organization's/department's goals/objectives/mandate (short-term and long-term) regarding energy resource use and development
- Current state of Canada's electricity sector – current electricity resources, demand and supply, potential developments, technologies, future directions
- Important government/industry documents and/or strategic plans for electricity policy and energy resource development
- Potential alternatives for addressing predicted increases in electricity demand
- Implications of the Kyoto protocol on Canada's energy policy and electricity sector

can prove useful in at least two situations: first, when the field researcher is seeking general information concerning the research area in order to set the context of the research problem(s), particularly, as in the case presented here, when the researcher is trying to acquire an overall perspective of the research problem to inform a more specialized and specific assessment, and; second, when the interview itself is directed to selected individuals who may possess information that is not commonly known to others. This may be the case when interviewing selected government officials or electricity industry representatives.

As discussed in Chapter Three, domestic electricity demand is expected to increase by approximately thirty percent by 2025. The principle objective of Canada's current energy policy is "to enhance the economic and environmental well-being of Canada by fostering the sustainable development and use of the nation's energy resources to meet the present and future needs of Canadians" (NRCan, 1998). One of the key goals of the forthcoming 2002-2005 energy plan reflects a similar objective and is "to achieve environmental and economic excellence." Any future energy policy must, therefore, balance electricity production with environmental protection, while maintaining a safe, secure, and economically competitive electricity supply for current and future generations. A strategic direction is required for the development of an energy policy to address this predicted increase in demand for electrical generation, within the guiding principles of environmental protection, energy security, economic growth, and socioeconomic equity.

The SEA problem is one of formulating a strategy to guide the development of energy policy based on the best practicable environmental option(s) - 'environment' broadly referring to both environmental and socioeconomic aspects. As previously discussed, the emphasis of this assessment is on SEA as a tool to *aid* decision-making in the policy process by identifying the potential environmental effects of possible energy policy-development alternatives. Thus, the assessment will require the use of expert opinion of those involved in the energy sector to evaluate alternative energy scenarios on the basis of particular assessment factors and constraints. The key strategic questions to be addressed include:

- What is the range of feasible alternative development paths that should be considered?
- What criteria should form the basis of this strategy (e.g. environmental, social, economic) and how much weight should be given to each?
- What are the potential environmental implications of each development path?
- What is the 'best practicable environmental option(s)'?
- What are the implications of the BPEO for energy policy development?

5.2.2 Phase II: Describe the Alternatives

Once the basic issues or problems are identified, the next step is to identify potential, feasible PPP alternatives. As discussed in Chapter Two, a key characteristic of SEA is the assessment of strategic alternatives. Depending on the nature of the SEA, one will identify alternatives to a proposed or existing PPP, or as in the case considered here, alternatives to identify a 'strategy for action'. Unless there is more than one potential and feasible way to proceed, there is no decision choice to be made and therefore no SEA is required. The alternatives represent the decision options, or decision variables, amongst which the decision maker(s) must choose. Alternatives can be developed using literature surveys and/or consulting with experts, as in the case of the SEA for the Somchem industrial complex at Krantzkop, Wellington (CSIR, 1998), through the use of computer models, such as the Commission of the European Communities high-speed train SEA (CEC, 1993), or as Tonn *et al.* (2000) suggest, "borrowed from other, somewhat familiar, situations."

In the case presented here, the decision alternatives are pre-determined. Feasible options for energy policy development for Canada are constructed based on NRCan's (1999) and the NEB's (1999) energy supply and demand forecast statistics for Canada to 2020 and 2025, respectively, and borrowed from NRCan's ETF project outlining feasible energy development scenarios for Canada to 2050. Through consultation with experts in the energy sector, government, academia and NGOs, the ETF project outlines a number of internally consistent, technologically feasible and logical scenarios of Canada's energy system three to five decades into the future. Each scenario discusses the energy system that could be used in Canada, including alternative fuel mixes, and each is relatively broad in comparison to alternatives at the plan or program level given the nature of policy-level decisions. The scenarios are focused on energy sources, energy carriers, and energy technologies, and are formulated based on the underlying assumption that the demand for electrical generation is expected to increase. The focus is on identifying a preferred, practicable energy mix to address the anticipated demand for electrical generation. While these scenarios are not the *only* possible future scenarios, they do represent a starting point for policy discussion and, for the purpose of this research, provide a realistic, consistent and logical set of alternatives to consider in the development and application of an SEA methodological framework. The five alternatives under consideration are summarized as follows:

A1: Continue on the existing path of energy development, the status quo, in anticipation that the demand for electrical generation will decrease.

A2: Meet the bulk of the demand with increases in nuclear energy, natural gas and refined petroleum products, supplemented with minor increases in hydro and coal.

A3: Introduce renewable energies as a major source of electricity supply, supplemented with major increases in natural gas and refined petroleum products, coal, and minor increases in nuclear and hydro.

A4: Maintain existing levels of hydro, phase out nuclear energy, and meet the bulk of the demand with significant increases in coal, supplemented with increases in natural gas and refined petroleum products.

A5: Meet the demand with increases in natural gas and refined petroleum products, supplemented with minor increases in coal and hydro, and the introduction of renewable energies in place of nuclear energy.

Number of feasible alternatives

The number of alternatives under consideration depends on the nature of the SEA, the particular issue(s) under consideration and how the alternatives will be assessed. For SEA at the plan and program level, as in the case of Kleinschmidt and Wagner's (1996) review of the SEA of German wind farm development, it may be possible to assess alternatives using GIS or other computer-based modelling systems. In such cases the feasible number of alternatives that can be considered is limited only by technical, financial and time constraints. On the other hand, for policy-related issues or for issues involving the use of expert opinion, such as Peters' (1985) social impact assessment of energy scenarios for the Jülich Nuclear Research Centre, Germany, the number of alternatives that can reasonably be considered is constrained by an individual's ability to evaluate and simultaneously compare decision options.

The Commission of the European Union's (1994) review of SEA practice recommends that the number of alternatives or scenarios under consideration be limited to ten or less clearly different options. However, Miller (1956) showed that an individual cannot simultaneously compare more than seven objects (plus or minus two). Saaty (1977) agrees, suggesting that limiting the number of choice possibilities to seven (plus or minus two) increases accuracy and consistency in responses in deciding among competing alternative options. The number of alternatives under consideration in this study is limited to five clearly defined electricity development scenarios. This is consistent with Miller's original findings, and with similar policy and plan assessments, such as the Institute for Applied Systems Analysis' assessment of four scenarios for alternative energy development systems (OECD, 1999), Huylenbroeck and Coppens' (1995), evaluation of five land-use planning scenarios in rural Scotland, and Peters' (1985) assessment of four nuclear energy scenarios in Jülich, Germany.

5.2.3 Phase III: Scope the Assessment Components

This step involves identifying the assessment panel and specifying the criteria that will be used to evaluate the potential environmental implications of the various energy policy alternatives. As noted in Chapter Three, a Delphi panel was deemed to be most appropriate for this particular assessment due to the lack of quantitative baseline data and given the forward-looking, policy nature of this research.

Select a 'panel of experts'

In its original context, the Delphi technique was designed to deal with technical issues and seek a consensus among homogeneous groups of experts. At the policy level, however, there is no such thing as an 'expert panel', but rather a 'panel of experts'. While each individual may be an expert with respect to a particular assessment component (e.g.

the implications of nuclear power with respect to public health and safety), in the context of the broader policy issue, each individual expert is best described as an 'informed advocate' or 'policy actor' (Hessing and Howlett, 1997).

Careful selection of the assessment panel is important to the quality of results generated by the assessment procedure (Sackman, 1975). However, there is no established method for identifying panel size and potential panel members (Linstone and Turoff, 1975). Panel size depends on what you want to know, the purpose of the inquiry, what's at stake, what will be useful, what will have credibility, and what can be done with given available time and resources (Patton, 1990). Turoff (1975) suggests that anywhere from ten to fifty people are sufficient for Delphi application. Bonnell (1997), for example, identified 123 potential panellists to serve on an expert panel to address the cumulative environmental effects of hydroelectric developments in Newfoundland, Canada, of which forty-nine agreed to participate. Mar *et al.* (1985) identified ninety-two panellists for the development of an aquatic ecological monitoring scheme, of which sixty-two agreed to participate, while Ludlow (1975) achieved a participation rate of thirty-three participants out of an initial list of fifty to address long-term resource management problems in Lake Michigan.

An underlying objective of this study is to develop and test a methodological framework for SEA application, bringing policy decision-making to a higher level by emphasizing consistency and accountability through sensitivity and confirmatory analysis of the policy decisions. Thus, while Turoff (1975) suggests that as few as ten panellists will often suffice in Delphi policy decision-making contexts, a minimum panel size of 25-30 was determined to be more appropriate in this particular case in order to incorporate the views of different regions and sectors and to illustrate the effectiveness of a combination of analytical methods within the SEA framework.

The panellist selection process typically does not take place in 'one shot', but rather is an iterative process where discussions with pre-determined panellists reveal other, previously unknown, panellists (Harrison and Qureshi, 2000). In this study potential panellists were selected using a purposive, non-probability, snowball sampling procedure (e.g. Bonnell, 1997; Huylenbroeck and Coppens, 1995). A random sample is not required for MCE, nor is it appropriate for this particular assessment given that particular types and combinations of panellists are desired in order to attempt to capture any potentially different perspectives on energy policy and environmental impacts.

Selecting the assessment panel involved first identifying a few key individuals within various government departments, industry, academia and non-government organizations, known to be involved in, or to have a vested interest in, the energy sector or the energy policy process, and asking them to identify others with similar knowledge, experience and interest. A total of 118 potential panellists were initially identified and mailed a *Panellist Consent and Information Form* (Appendix A), which: (1) identified the nature and objectives of the research and the tasks involved; (2) asked potential panellists to indicate their willingness to participate by signing the *Panellist Consent* form; (3) asked potential panellist to identify their affiliation and field of expertise; (4) provided a preliminary list of the types of factors that will be considered in the assessment; (5) asked potential panellists to identify the factors upon which they are most knowledgeable and comfortable commenting, and to suggest any additional factors which they feel should be considered;

and (6) asked potential panellists to identify others whom they feel might be qualified and interested in participating in the assessment.

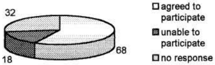
The panellist consent and information forms, as well as all subsequent mailings, were personally addressed to individual panellists and included a postage-paid return envelope, as recommended by Dillman *et al.* (1974). Eighty-six initial responses out of 118 were received (73%), and an additional eleven potential panellists were identified and contacted. The panellist identification process commenced on January 29th, 2001 and concluded on April 24th 2001, until no new potential panellists were identified (Table 5.2). In order to minimize the time required for panel compilation, additional panellists identified from initial and subsequent mailings were sent the *Panellist Consent and Information Form* either by fax or email. A total of 141 potential panellists were contacted, of which 102 individuals responded and 81 individuals (79%) agreed to participate (Table 5.2). Of the 21 potential panellists who indicated that they were unable to participate, nine indicated time and human resource constraints as their key reasons for declining, and three indicated a lack of knowledge and experience with regard to the subject matter. There was no geographic or sector bias with respect to non-participants. Ten panellists withdrew upon receipt of the first assessment round indicating time constraints, a perceived lack of required knowledge and experience to comment on potential impacts, and a dissatisfaction with the types of alternatives and assessment criteria presented. Panel size was sufficiently large enough such that those who withdrew from the assessment process did not bias the panel composition.

The overall response rate was satisfactory given that other Delphi studies in the resource and environmental sector, such as those conducted by Bonnell (1997), Mar *et al.*

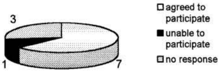
Table 5.2 Panellist response and participation rates

January 29th, 2001

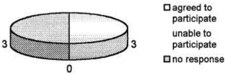
118 potential panellists contacted



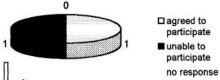
11 new potential panellists identified and contacted



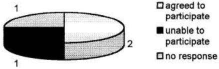
6 new potential panellists identified and contacted



2 new potential panellists identified and contacted



4 new potential panellists identified and contacted



0 new additional panellists identified

April 24th, 2001

(1985) and Ludlow (1975) for example, yielded participation rates of 40, 67 and 66 percent respectively. In addition, random mail questionnaires, which often draw upon a large population, typically do not exceed a 50 percent response rate (Kerlinger, 1973; cited in Dillman *et al.*, 1974). Given that in this particular assessment the population from which to solicit panellist was quite small as potential panellists were purposefully selected based on their known interest and/or involvement in the energy sector and based on the recommendation of other panellists, the participation rate was perhaps higher than normal. This may be due in part to a heightened awareness of 'energy and environment' and the coincidence of this assessment with recent proposals for a Canada-US continental energy policy, continued discussions on the Kyoto protocol, US initiatives to exploit energy reserves in Alaska, and Alberta's and Nova Scotia's increased interests in energy exports south of the border. A second factor contributing to a high panellist participation rate was persistent follow-up to the initial invitation to participate.

Dillman *et al.* (1974), in a four-state comparison of mail survey response rates, for example, notes strong evidence that an intensive follow-up is essential. Without follow-up, Dillman *et al.* (1974) found that the final probable response rate in their study would have been less than 50 percent for four of the five states surveyed. Heberlein and Baumgartner (1978), Scott (1961), and Ferriss (1951) similarly note the importance of questionnaire follow-up. In this case, all potential panellists were sent three follow-up notices within two, four, and six weeks of the initial mailing, where necessary, in order to ensure that they had received the invitation to participate, and to encourage their participation.

Panel composition

Scheele (1975) suggested that three kinds of panellists are required for creating a successful mix: experts, stakeholders, and facilitators. The proportion of panel experts, stakeholders and facilitators depends on the study objectives and is thus tailored for each individual situation. Given the nature of energy policy development and the energy resource sector in general, a predominance of experts may be best, since it is clear *who* has to act (i.e. energy policy decision-makers), but not clear *how* (i.e. the strategic direction), hence the importance of expertise in this context.

A concern regarding the use of an expert panel is that panellists may not have expertise in relation to all of the issues under consideration and that panellists are often knowledgeable of only very specific issues. However, as previously noted, there is no such thing as an expert panel at the policy level, rather it is best described as a 'panel of experts' comprised of individuals who have an applicable specialty or relevant experience, or who influence or are in part responsible for particular decisions. As previously noted, such a panel is perhaps best described as a panel of 'policy actors' (Hessing and Howlett, 1997). The principle actors included in the Canadian resource and environmental policy subsystem are representatives of state and, at least in theory, production-based business organizations, unions, environmental organizations, and other interest groups (Hessing and Howlett, 1997). In this regard, some experts may also be classified as stakeholders. Stakeholders are those who are or will be potentially affected by or have a particular interest in energy policy and energy resource development.

In this assessment panellists were selected from federal and provincial government departments involved in environmental assessment and energy resource issues; industries known to be involved in energy resource extraction, electrical generation and distribution, and energy markets and trading; consulting firms with a known involvement in environmental assessment, energy resources and energy economics; from non-profit environmental or energy organizations, and academia. It is not required that potential panellists be experts in energy resources, energy policy, or in any or all of the assessment factors presented but rather that, when provided with a description of the alternative energy development scenarios and assessment factors and criteria, their knowledge of their respective fields (e.g. renewable energy, economics, habitat management, policy analysis) would allow them to comment on the potential impacts. As there is no established method for defining an 'expert' (Delbecq *et al.*, 1975; Linstone and Turoff, 1975), potential panellists were asked to indicate their affiliation and self-identify their area(s) of expertise in relation to the proposed assessment factors (Fig 5.2). Any differences between expert and non-expert response can then be tested at a later stage.

Of the 141 potential panellists identified and contacted, 12 percent were private consultants, 17 percent federal public service workers and 23 percent provincial public service workers, including deputy ministers, policy directors and departmental directors, 21 percent from industry, and 29 percent from non-profit organizations and academia (Table 5.3a). Of the 81 panellists who agreed to participate (Table 5.3b), the highest rate of participation was from the provincial public service at 67 percent, with participation rates from consultants, industry, non-government organizations and the federal public service at 65, 59, 53 and 46 percent respectively (Figure 5.3a). The final panel was comprised of members of the provincial public service at 26 percent, non-government organizations and industry at 25 and 21 percent respectively, and private consultants and

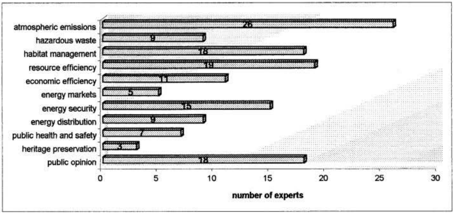


Figure 5.2. Areas of expertise as self-identified by study panellists. The highest number of areas in which a single individual claimed to have expertise is four. Five panellists identified themselves as 'generalists', with no expertise.

Table 5.3a. Potential panellists contacted by region and sector

	Western	Central	Eastern	Total
Consultant	9	2	6	17
Federal Government	5	14	5	24
Provincial Government	9	7	17	33
Industry	14	7	8	29
NGOs*	13	13	12	38
Totals	50	43	48	141

*NGOs refer to non-government organizations, excluding industry and consultants, such as non-profit environmental organizations.

members of the federal public service each accounting for 14 percent of the panel composition (Fig. 5.3b).

On a regional basis, 37 percent of panellists were from eastern Canada, including New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland, 33 percent from Ontario and Quebec, and the remaining 30 percent from Manitoba, Saskatchewan, Alberta, British Columbia and the Territories (Fig. 5.4a). The highest participation rate came from eastern Canada at 67 percent, followed by western and central at 52 percent and 47 percent respectively (Fig 5.4b). This reflects, in part, the high rate of participation from provincial public service employees, who were primarily from eastern Canada, and the comparatively low rate of participation of federal public service employees, who comprised a large number of the potential panellists identified in central Canada.

Table 5.3b. Agreed to participate by region and sector.

	Western	Central	Eastern	Totals
Consultant	6	1	4	11
Federal Government	1	8	2	11
Provincial Government	5	2	15	22
Industry	7	3	7	17
NGOs	6	8	7	20
Totals	26	20	32	81

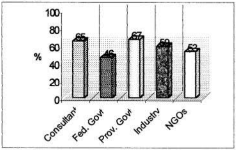


Figure 5.3a. Participation rate by sector.

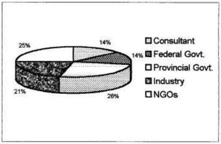


Figure 5.3b. Panel composition by sector.

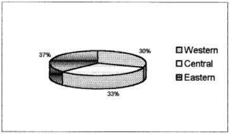


Figure 5.4a. Panel composition by region

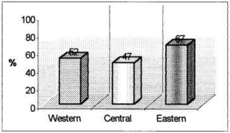


Figure 5.4b. Participation rate by region.

Conduct a pilot study

In order to ensure optimal design of the assessment exercise, a pilot study was conducted prior to commencing the Delphi. Richey *et al.* (1985) adopted a similar approach and found it quite useful in their application of the Delphi technique to develop an environmental monitoring program for the electrical generation industry. The pilot study allows an examination of the questionnaire structure and components and provides an opportunity to make any necessary adjustments prior to commencing the exercise.

Three panellists previously identified during the panellist selection process were asked to participate in the pilot study. In order to ensure an appropriate mix of comments and perspectives, one panellist was selected from government and was known to be involved with EA policy and procedure, a second panellist was selected who was known to be involved in mineral and energy resources consulting, and a third panellist was selected who was known to have previous experience with Delphi application in EA, particularly as it applies to the electricity generation industry.

Each pilot study panellist was sent a package containing the assessment documents[8] and an additional questionnaire asking them to comment on the time requirements, clarity of the instructions and assessment criteria, and to indicate any suggestions for improvement (Appendix B). Two of the panellists agreed to complete the impact matrices in advance of the main assessment panel and provide critical feedback on the content and assessment instructions. The third participant chose not to complete the assessment matrices, but did agree to provide feedback on the assessment procedure and contents of the assessment package. The results of the pilot study and suggestions of the pilot study participants are discussed in the following sections where appropriate.

Identify the assessment factors and criteria

Once the decision problem is identified, a set of factors and associated impact assessment criteria must be determined. The factors are the valued system components to be included in the environmental assessment of energy policy alternatives, such as public health and safety, habitat, air quality, and energy security. The criteria are the standards of

[8] The assessment documents and the procedures for completing the assessment matrices are discussed in detail in Section IV: Evaluating potential impacts and determining impact significance.

judgement or rules against which to evaluate potential impacts and test the desirability of the alternative options (Malczewski, 1999). Each factor, or valued system component, is defined by a measurable assessment criterion. Assessment factors and criteria can be identified in a similar fashion to the identification of assessment alternatives, including the use of information borrowed from similar assessments and from particular policies, plans and white papers. It is often the case, however, that assessment factors and criteria are not always explicitly known, and must be derived or translated from previously stated goals and objectives. For example, the objective of 'addressing climate change' and 'sustainable resource use' can be translated into assessment factors, such as 'atmospheric emissions' and 'resource efficiency.' Each factor can then be defined according to specific criteria against which each alternative is assessed, such as 'minimizes greenhouse gas and other atmospheric emissions' and 'generates the greatest electricity output for minimal non-renewable resource input.' Identifying the appropriate assessment factors and criteria involves identifying a comprehensive set of objectives that reflects all concerns relevant to the problem (Malczewski, 1999).

A preliminary list of the *types* of factors which might be included in the assessment were drawn from the broad policy goals stated in *Natural Resources Canada Business Plan 1997-2001*, from the strategic goals and objectives stated in NRCan's *Energy Sector Business Plan 1998-2001*, and from other, similar energy-related impact assessments (e.g. Peters, 1985). During the panellist selection phase, potential panellists were sent a preliminary list of potential assessment factors and asked to identify any additional factors that they felt were necessary to consider in the environmental assessment of energy policy alternatives. At this stage, as recommended by Tonn *et al.* (2000) in their framework for understanding and improving environmental decision-making, panellists were unaware of the exact nature of the energy policy alternatives. The identification of potential assessment factors preceded panellist's knowledge of the policy alternatives so as to avoid consciously or unconsciously favouring certain policy options in the identification of any additional assessment factors.

Based on panellist's feedback and policy goals and objectives contained in NRCan policy and planning documents, fifteen assessment factors were identified, and further refined based on the results of the pilot study (Table 5.4) (Appendix C). The pilot study panel reported a time of one-hour forty-five minutes to two-hours fifteen minutes to complete the assessment exercise. It was suggested by the pilot study panel that this time be reduced preferably to one-hour to one-hour thirty. It was also suggested that the number of criteria be reduced in order to minimize the time required to complete the assessment. There was agreement amongst pilot study panellists that it was reasonable to assume that all options are both technologically and institutionally feasible given the time frame under consideration to 2050. Furthermore, one panellist noted that such factors are normally addressed "after-the-fact." In other words, once the preferred action is identified, then the technological and institutional capacity to achieve the preferred strategy must be addressed. Thus 'institutional capacity' (C14) and 'technological capacity' (C15) were dropped from the list of assessment factors. It was also recommended that 'energy costs' (C6) and 'economic efficiency' (C7) be collapsed into a single assessment criterion in order to avoid 'double counting', as energy costs are reflected by measures of economic efficiency. Similarly, 'impacts on water quality and aquatic resources' (C2) and 'impacts on land and wildlife resources' (C3) were collapsed to 'minimizing habitat destruction.'

There were also suggestions that 'distributional equity' (C10) and heritage preservation (C12) be omitted from the study, as it was felt that all areas have equal access to electricity and that the environmental impacts of electrical development on heritage resources is negligible. However, it was decided by the researcher that both factors would remain as not all areas, particularly remote communities, have equal access to all forms of electrical generation and that, with respect to heritage resources, during the panellist selection process five panellists requested that the heritage preservation criterion be included in the assessment.

Table 5.4. Initial and revised[1] list of assessment factors

Initial list of factors	Revised list of factors
Environmental C1 Atmospheric emissions C2 Impacts on water quality and aquatic resources C3 Impacts on land and wildlife resources C4 Hazardous waste generation C5 Resource efficiency	Environmental C1 Atmospheric emissions C2 Hazardous waste generation C3 Habitat destruction C4 Resource efficiency
Economic C6 Energy costs C7 Economic efficiency C8 Market competitiveness	Economic C5 Economic efficiency C6 Market competitiveness
Social C9 Energy security C10 Distributional equity C11 Public health and safety C12 Heritage preservation C13 Public acceptability C14 Institutional Capacity C15 Technological Capacity	Social C7 Security of supply C8 Distributional equity C9 Public health and safety C10 Heritage preservation C11 Acceptability

[1]Revised list based on panellist's feedback.

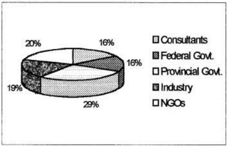
5.2.4 Phase IV and V: Evaluate Potential Impacts and Impact Significance

Impact and impact significance data were generated using a paired comparison assessment process. Delphi panellists were asked to conduct a pairwise assessment of the energy policy options against the set of assessment criteria, and to conduct a similar pairwise assessment to derive criterion weights, or impact significance. The Delphi process consisted of three assessment rounds, which are summarized below.

Delphi Round I

Round I of the Delphi technique commenced on 09 April 2001 and concluded on 30 September 2001, after which no new responses were included in the database. A total of 81 individuals were sent the assessment documents, of which 69 responses were received (Fig. 5.5, Table 5.5). Each panellist was sent three follow-up notices within two, four and six weeks of the initial mailing, where necessary, and a final notice within two weeks prior to the closing date for Round I responses. Upon receipt of Round I, seven panellists indicated that they had decided to withdraw from the assessment. Five of the seven indicated that they did not feel qualified to comment on the issues presented, while two panellists withdrew because they were not satisfied with the range of alternatives and types of criteria presented. An additional five panellists did not return their Round I assessment matrices (Table 5.6).

The Round I assessment documents and instructions for completion are included in Appendix C. It was suggested during the pilot study that the energy scenarios be labelled according to the predominant energy source. However, it was felt by the researcher that



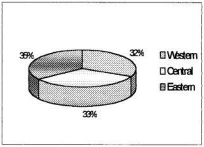


Figure 5.5a. Final Round I panel composition by sector   Figure 5.5b. Final Round I composition by region.

Table 5.5. Round I participation rates (%) by region and sector

	Consultant	Federal Govt.	Provincial Govt.	Industry	NGOs	Overall by region
Western	100	100	100	71	100	**96%**
Central	100	100	100	100	50	**85%**
Eastern	100	100	85	67	67	**80%**
Overall by sector	**100%**	**100%**	**91%**	**76%**	**70%**	

Table 5.6. Round I panellists that withdrew or non-response

	Consultant	Federal Govt.	Provincial Govt.	Industry	NGOs	Overall by region
Western	0	0	0	2	0	**2**
Central	0	0	0	0	4	**4**
Eastern	0	0	2	2	2	**6**
Overall by sector	**0**	**0**	**2**	**4**	**6**	

labelling the alternatives might introduce bias as each scenario incorporates a combination of energy sources. Panellists were asked to complete two matrices. The first matrix, the impact assessment matrix, asked panellists to indicate, based on their expertise, experience and knowledge, their relative preferences for each energy policy alternative on the basis of each individual assessment criterion. The second matrix, the impact significance or weights matrix, asked panellists to indicate the relative importance they would assign to each assessment criterion in the assessment of energy policy alternatives. Panellists were asked to return their responses in the postage-paid envelope provided at their earliest convenience. The assessment methods and rationale are outlined in the following sections.

Assessment methods:

The choice of evaluation and assessment methods depends on the nature of the data required and the particular questions to be asked, and can vary from simple matrices and checklists to planning balance sheets or monetary evaluation methods. The SEA of the Lancashire Structure Plan (Pinfield, 1992), for example, scored alternative policy statements in a simple Leopold matrix. The evaluation of environmental effects of a wind farm program in Germany (Kleinschmidt and Wagner, 1996) was based on the development of multiple suitability, exclusion and restriction criteria and the use of a GIS, while in the Sichuan Gas Development Plan SEA (DHV Consultants and Sichuan Petroleum Administration, 1993), weighted summation indices were used.

The method of choice adopted in this particular assessment is the 'pairwise comparison' approach developed by Saaty (1977). A key advantage of the pairwise approach, in comparison to ordinal ranking, simple rating, or assigning individual impact scores for example, is that it forces the decision-maker "to consider each individual trade-off", which contributes to better overall understanding of the decision-problem (Hajkowicz *et al.*, 2000). At the same time, it has an advantage over more direct trade-off methods, such as fixed point scoring, where decision-makers are required to make multiple, and often complex trade-offs simultaneously for the entire list of decision alternatives.

The paired comparison approach is based on Saaty's Analytical Hierarchy Process (AHP), which is a systematic procedure for representing the elements of any problem, hierarchically. The AHP organises the basic rationality by breaking down a problem into its smaller constituent parts and then guides the decision-maker through a series of pairwise comparison judgments to express the relative strength or intensity of impact of the elements in the hierarchy in ratio form from which decision weights are derived based on the principal eigenvector approach (Saaty, 1977). The eigenvector of a matrix is the linear combination of variables that consolidates the variance, or eigenvalues (Sheskin, 2000). In the assessment matrix, the eigenvalues indicate the relative strength (weight) of each of the derived assessment factors, where the larger the eigenvalue the larger the role the paired comparison plays in weighting the entire assessment matrix.

Central to this approach is the notion that for any pair of alternatives (or criteria) i and j out of the set of alternatives A for criteria set C, the individual decision-maker can provide a paired comparison A_{ij} of the alternatives under each criterion c from the set of criteria C on a ratio scale that is reciprocal, such that $a_{ji} = 1/a_{ij}$ for all $i, j \in A$. (Saaty, 1977; Saaty and Vargas, 1982; Golden *et al.*, 1989; Huylenbroeck and Coppens, 1995; Saaty, 1997; Malczewski, 1999). In other words, if energy policy alternative i is 'seven times' more preferred than alternative j in terms of minimizing atmospheric emissions c_x, then the reciprocal property must hold, that is alternative j must be seven times less preferred than alternative i on the same criterion c_x. Thus, in an n x n matrix, the individual decision-maker need only complete n (n-1)/2 comparisons. When a decision-maker compares any two alternatives $i, j \in A$, one alternative is never judged to be infinitely better than another for any $c \in C$. If such a case should arise where alternative i is infinitely better than j on criterion c, then no decision tool would be required. That is, if the measurements between two alternatives are too far apart to compare, then it is not really worthwhile to make the comparison directly (Saaty, 1997).

Decision-makers are presented with a nine-point decision scale ranging from '1', if both alternatives are equally preferred, '3' for a weak preference of alternative i over j, '5' for a strong preference and so forth[9]. If alternative j is preferred to i for any given criteria, the reciprocal values hold true – 1, 1/3 and 1/5 (Figure 5.6). The scale is standardized and unit free, thus there is no need to transform all measures, for example, into monetary units for comparative purposes.

There was one suggestion from the pilot study that the assessment scale be reduced to a traditional Likert scale ranging from 1-5 or 1-7 rather than the 1-9, as typically the rankings and ratings in a Delphi are done on a Likert scale (e.g. Leitch and Leistritz, 1984; Murray, 1979). An assessment scale should, however, represent, as much as possible, the complete range of opinions, feelings or judgments that a person may have. According to Miller (1956), an individual cannot simultaneously compare more than seven plus or minus two objects at one time. Thus, as explained by Saaty (1977), "using the fact that $x_1 = 1$ for the identity comparison, it follows that the scale values will range from 1 to 9." Using the

9 See Appendix C for detailed instructions.

1-9 scale captures the widest possible range of preferences and judgments, and the reciprocal property of the scale allows the generation of data at the ratio level.

Notwithstanding the advantages of paired comparisons over simple rating, ranking, and assigning individual impact scores, and more complex fixed-point scoring methods, Hajkowicz *et al*. (2000) and Malczewski (1999) found the paired comparison approach to rank relatively low on the 'ease-of-use' scale. The traditional approach to paired comparisons typically requires decision-makers to complete a paired comparison matrix for each individual criterion when comparing alternatives *i,* j and to enter reciprocal values where alternative *j* is preferred to *i.* (Figure 5.7). The traditional paired comparison approach was modified such that panellists entered all paired comparisons in a single impact matrix and implicitly indicated their reciprocal preferences without having to deal with the added complexity of entering reciprocal scores (Fig. 5.7). Rather, reciprocal values for *j, i* were implicitly indicated by checking the box next to the preferred alternative. Comments received during the pilot study and from a random sample (n = 10) of Round 1 participants indicated that the paired comparison assessment procedure was easily understood. Only one comment, received with the completed Round 1 assessment documents, indicated difficulty in understanding the assessment process.

The relative preference for energy policy alternatives $i, j \in A$ based on assessment criterion $c \in C$

1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1	2	3	4	5	6	7	8	9
extremely *preferred*		very strongly *preferred*		strongly *preferred*		moderately *preferred*		equally *preferred*		moderately *preferred*		strongly *preferred*		very strongly *preferred*		extremely *preferred*

j preferred to i — i preferred to j

The relative importance of assessment criterion $c_i, c_j \in C$ in the assessment of energy policy alternatives A.

1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1	2	3	4	5	6	7	8	9
extremely more imp.		very strongly more imp.		strongly more imp.		moderately more imp.		equally imp.		moderately more imp.		strongly more imp.		very strongly more imp.		extremely more imp.

c_j more important than c_i — c_i more important than c_j

Figure 5.6. Pairwise comparison scale (Based on Saaty, 1977).

Typical paired comparison matrices

C1 Atmospheric emissions

	A1	A2	A3
A1	1	1/4	1/2
A2	4	1	3
A3	2	1/3	1

C2 Hazardous waste generation

	A1	A2	A3
A1	1	7	9
A2	1/7	1	5
A3	1/9	1/5	1

Revised paired comparison matrix

	A1-A2	A1-A3	A2-A3
C1 Atmospheric emissions	A1 □ A2 ■ 4 (Intensity)	A1 □ A3 ■ 2 (Intensity)	A2 ■ A3 □ 3 (Intensity)
C2 Hazardous waste generation	A1 ■ A2 □ 7 (Intensity)	A1 ■ A3 □ 9 (Intensity)	A2 ■ A3 □ 5 (Intensity)

Figure 5.7. Typical and revised paired comparison matrices.

Impact significance (Phase V):

Once the potential impacts of each alternative are identified, it is necessary to determine impact significance. There are a variety of methods available from the EA literature, such as the traditional Batelle environmental evaluation system (Dee *et al.*, 1977), optimum pathway matrices, and additional weighting and scaling methods (e.g. Barnes *et al.*, 2000; Morris and Therivel, 1995; Canter, 1977). In this particular assessment, the decision-makers identify the potential impact significance of each alternative by assigning priority weights to the assessment criteria.

Considerable attention in the decision-making literature has been given to weighting criteria (e.g. Tonn *et al*, 2000; Nijkamp *et al.*, 1990; Voogd, 1983). A weight can be defined as a value assigned to an assessment factor that indicates its relative importance to other criteria. In this case, the assignment of factor weights helps determine the overall impact significance of each alternative by assigning a level of importance to each criterion. There are a variety of approaches available for assigning priority weights, including ranking, rating, trade-off analysis, pairwise comparisons, interactive estimation of weights, assigning weights based on previous choices, and fuzzy set theory or verbal estimation of weights (Malczewski, 1999; Voogd, 1983). Similar to the impact assessment procedure described above, Saaty's (1977) paired comparison approach was used to derive impact significance scores where each $c \in C$ were assessed on a pairwise basis. The procedure is outlined in detail in Appendix C.

Deriving alternative and criterion weights:

The actual impact scores and criterion weights are derived from the pairwise comparison matrices using the IDRISI© software, which contains functions specifically designed to support MCE decision-making, and normalizing the eigenvector associated with the maximum eigenvalue of the ratio matrix. This procedure produces a relative 'weight', indicating the impact scores (relative preference) of each alternative on each criterion, and the relative importance of each assessment criterion. This calculation can be approximated by hand by summing the values in each column (vector) of the paired comparison matrix, normalizing the matrix by dividing each cell in the matrix by the respective column total, and dividing the sum of the normalized scores for each matrix row (vector) by the number of criteria (Malczewski, 1999; Saaty and Kearns, 1985). From these eigenvectors, a ranking of the alternatives per criterion can be derived (Huylenbroeck and Coppens, 1995). Other approaches have been proposed for estimating weights from a paired comparison matrix where potential errors or inconsistencies in judgments may exist, of which the most notable approach is logarithmic least squares. However, as noted by Saaty (1977), Harker and Vargas (1987), Golden *et al.* (1989) and Fichtner (1986), the eigenvector approach is preferred in that it captures the question of consistency of responses by a single numerical index indicating the reliability of the data.

Delphi Round II

Therivel *et al.* (1992) highlight that one of the key objectives of a SEA system "to enable consistency to be developed across different policy sectors, especially where trade-offs need to be made between objectives." Perfect consistency in decision-making is particularly difficult when dealing with, often uncertain, policy issues. However, policy decisions, particularly when dealing with issues as far-reaching and as environmentally sensitive as energy futures, should not be internally contradictory. The relationships in any SEA system should provide, to the greatest degree possible, a set of consistent and non-contradictory results.

Consistency:

The principal eigenvector method of Saaty's AHP, discussed in the previous section, yields a natural measure for inconsistency – the consistency ratio (CR). The CR is one means of determining the panellist's knowledge of the subject, the ability of an individual to make consistent choices and tradeoffs, and the amount of thought dedicated to the panellist's decisions. The CR can be approximated by hand by using the weights (eigenvectors) derived from the paired comparison matrices in Round I. For example, the paired comparisons in an 'n x n' matrix can be presented as follows:

C_i	A_1	A_2	A_3
A_1	a_{11}	a_{12}	a_{13}
A_2	a_{21}	a_{22}	a_{23}
A_3	a_{31}	a_{32}	a_{33}

The weights for each alternative (w_i) are derived based on Saaty's AHP, as described above. The consistency vector (CV) for each alternative is calculated by multiplying the weight (w_i) by the paired comparison (a_{ij}) across each row, and dividing the row sum by the respective 'w_i' as follows:

$$CVa_1 = [(w_1)(a_{11}) + (w_2)(a_{12}) + (w_3)(a_{13})] / (w_1)$$

The average of CVa_1, CVa_2, CVa_3 is calculated to determine λ (*lambda*). Saaty (1977) notes that $\lambda \geq n$ for a positive reciprocal matrix, and $\lambda = n$ if the matrix is consistent. Thus $\lambda - n$ indicates a measure of matrix inconsistency. The consistency index (CI) can be normalized by $CI = \lambda\text{-}1/n\text{-}1$. By comparing the CI of the paired comparison matrix against CIs from randomly generated paired comparison matrices (CI_R), the consistency ratio (CR) can be determined by CI/CI_R. The CR is defined as the ratio of the CI to the random index and thus presents a measure of how any given matrix compares to a purely random matrix (Golden *et al.*, 1989). Random CI tables can be found in Saaty and Kearns (1985:34) and Malczewski (1999: 186).

The consistency ratio is designed in such a way that if the ratio is greater than 0.10, then the assessment matrix is indicative of inconsistent judgments (Malczewski, 1999). When deviations from consistency exceed the acceptable limits, there is a need for the panellists to re-examine their inputs into the matrix. In other words, if the CR = 0.12, then there is a 12 percent chance that the matrix was completed randomly. As the CR decreases, then there is less of a chance that the matrix was completed randomly. Improving consistency does not mean getting an answer that is closer to the *real* solution, but that the ratio estimates in the paired comparison matrices are closer to being logically related than to being randomly chosen (Saaty, 1977).

Questions about the theoretical nature of the consistency ratio and the arbitrariness of the 0.10 consistency limit have been raised (Barzilai, 1998). Golden and Wang (1989), for example, suggest that the cut-off limit should be a function of matrix size. The key, however, is to make the consistency limit explicit, and to examine the implications of inconsistent decisions on the final decision outcome.

The paired comparison matrices received from Round I were entered into an ASCII file. Consistency ratios for the assessment and weights matrices of each individual decision-maker were calculated using the IDRISI© software decision-support function (Fig. 5.8 and 5.9). The IDRISI© decision-support software generates a consistency matrix from the paired comparisons, which indicates how the individual paired comparisons would have to be changed to be perfectly consistent. For example, a measure of '-3' would indicate that the paired comparison for a_{ij} on $c \in C$ would need to move three points down the scale to be consistent.

Reiteration for consistency:

In Round II of the Delphi, panellists were asked to reconsider those choice combinations for which analysis showed some inconsistencies in the pairwise data. Panellists were sent the Round II assessment package (Appendix D) as each Round I was received and analyzed. Round II included only those alternatives and criteria for which the analysis indicated a CR > 0.10. Although it is possible to re-evaluate decisions until perfect consistency is achieved, there is little change in the weights once the CR drops below 0.10, and individuals with already consistent responses are unlikely to make any significant adjustments (Saaty, 1977). Panellists were asked to reconsider and revise, where they considered appropriate, those paired comparisons where some inconsistencies exist. Panellists were asked to return their completed matrices in the postage-paid envelope provided within one week of receiving the documents. Following a similar procedure to

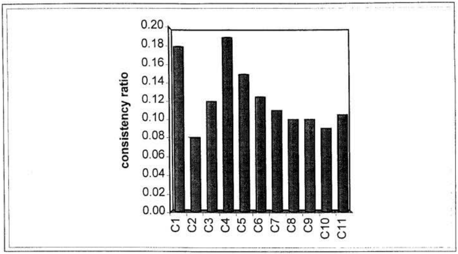


Figure 5.8. Round I median impact consistency ratios for alternatives A1-A5 by criterion.

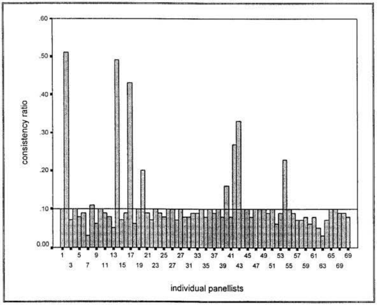


Figure 5.9. Round I impact significance (criterion weights) consistency measures by panellist.

Round I, follow-up notices were sent within two, four and six weeks of the initial mailings, where necessary, and a final reminder was sent two weeks prior to the closing date for the receipt of Round II responses.

Round II was an individual iteration procedure. Parente *et al.* (1984) in a series of experimental Delphi applications found that individual iteration, more so than group feedback, was the most important factor contributing to improvements in an individual's evaluation over rounds. Consistent with Bots and Hulshof (2000) and Saaty (1980), while panellists were asked to reconsider those assessments for which some inconsistencies existed they were not forced to revise their assessment, but rather given the opportunity to do so. Barzilai (1998) explains that the weights derived from the matrices are derived directly from the decision-maker's input and are a true representation of the individual's input regardless of the level of consistency. Forcing improvements in consistency may distort the individual's true answer, regardless of their understanding of the problem. Thus, inconsistent responses were presented to the decision-makers as feedback from the analysis. The decision-maker was given the opportunity to either confirm their initial assessment, regardless of inconsistency, or to revise based on the information presented.

Of the 69 responses received from Round I, 67 panellists were sent the Round II assessment asking them to reconsider particular alternative-criterion assessment scores for which some inconsistencies existed, of which 65 (97%) responded. An analysis of Delphi applications in natural resource policy issues by Leitch and Leistritz (1984) reported that Delphi findings are quite robust with respect to minor changes in panel size and composition. Only eight panellists were asked to reconsider the impact significance or weights matrix, in addition to the impact assessment matrix.

The number of inconsistent alternative-criterion combinations returned to individual panellists during Round II ranged from one to seven, with the majority of panellists asked to reconsider four alternative-criterion combinations. Two panellists were well within the acceptable limits of consistency (CR $\leq$ 0.10) on both the assessment and weights matrices, and were therefore not required to participate in the Round II assessment. These panellists were, however, provided with an opportunity to participate in Round III, and to make any adjustments to their evaluation in light of the group's response.

Fifty-six panellists revised their initial assessments, while six panellists made no changes. Several panellists responded with only minor adjustments to their initial evaluations, indicating that they "had made an error in scoring" during the initial evaluation causing their inconsistency. One panellist indicated that there was no reason to adjust their initial evaluation as they "had received no new significant information". An additional panellist responded by saying that they felt no need to change their initial evaluations and they would remain "consistently inconsistent". Of those 56 panellists whom did make revisions to their initial assessments, all but one panellist improved their level of consistency (Fig. 5.10 and 5.11).

Delphi Round III

Round III provided panellists with an opportunity to review their individual assessment scores in light of the group's responses. The purpose of this Round is to allow the researcher to gain a better understanding of the group response and of the responses of

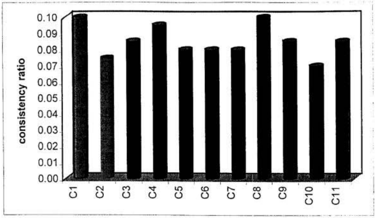


Figure 5.10. Round II median impact consistency measures (after individual reiteration) for alternatives A1-A5 by criterion.

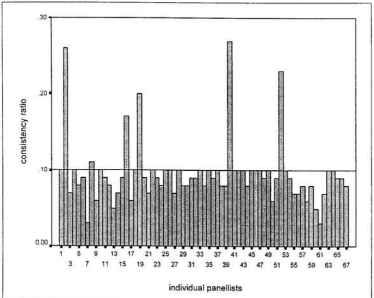


Figure 5.11. Round II impact assessment (criterion weights) consistency measures by individual panellist. Only those panellists above the 0.10 acceptability level in Round I were asked to reconsider their criterion weights matrix. Two of the panellists dropped out, while the other six remained inconsistent in their decisions.

those outside the normal range for the group who demonstrate a firm, consistent position and understanding of the issues. Sixty-seven panellists were sent the Round III assessment package on 27 August 2001, which included the panellist's individual assessment scores for each paired comparison and the upper and lower hinges of the group's median paired comparisons, or normal range for the group (Appendix E). Thirty-five panellists responded indicating changes to their initial evaluation in light of the group's scores.

Panellists were only provided with group scores for the impact assessment matrix, and not the criterion weights matrix. The impact assessment matrix is based on knowledge, expertise, and experience, and some degree of group consensus is preferred when predicting the environmental and socioeconomic impacts of energy alternatives. The assignment of criterion weights however, is simply based on the individual's values or political position with respect to the relative importance of each assessment criterion in the development of energy policy. In assigning criterion weights panellists were asked, for example, "Which is more important: minimizing atmospheric emissions, or minimizing economic efficiency?" On the other hand, for the assessment of alternative options, panellists were asked, based on knowledge, experience and expertise, to state the relative preference of one alternative over the other with respect to meeting the specified criterion. Asking panellists to reconsider their criterion weights in light of the responses of the panel, or a particular sector or region, may introduce bias into the data set. A public service worker, for example, may reflect similar values to those of an environmentalist, but may feel pressured by group feedback to come on board with the values of the public service. It was felt that no new, valuable information would be gained by feeding back group responses for the impact significance matrix. Consistency was the only requirement.

Group Consensus:

As discussed in Chapter Four, consensus through iteration and group feedback is typically a common goal of the traditional Delphi (e.g. Bryson and Joseph, 2000; Huylenbroeck and Coppens, 1995). However, as Woudenberg (1991) argues, consensus should never be the primary goal of the Delphi, particularly the policy Delphi. It is on the *consensus* issue where this study diverges from the traditional Delphi model. "An expert or analyst may contribute to a quantifiable or analytical estimation…but is it unlikely that a clear-cut (to all concerned) resolution of a policy will result from such an analysis (Turoff, 1970). The policy Delphi differs from the traditional Delphi in that when judgments diverge, even after extensive debate and compromise, the policy Delphi does not impose an artificial consensus by removing outliers from the calculation. Extreme judgments are allowed to stand to the heterogeneity of the group but within the requirements of tolerable inconsistency (i.e. $CR \leq 0.10$) (Saaty and Kearns, 1985). The resolution of a policy question "must take into consideration the conflicting goals and values espoused by various interest groups as well as the facts" (Leitch and Leistvitz, 1984). The policy-Delphi allows the organization and classification of the views of the various policy sub-actors. The goal of a Delphi exercise may not necessarily be that of consensus but, as in the case of this assessment, that of exploring alternatives.

It is important to note that providing feedback does not necessarily increase accuracy of impact prediction. (Parente *et al.*, 1984). Rowe *et al.* (1991) explain the reasoning behind providing aggregate group feedback based on the so-called "theory of errors." The assumption is that the aggregate of a group will provide an assessment that is generally superior to that of most of the individual assessments within the group. When the range of individual estimates excludes the true answer, then the median should be at least as close to the true answer as one half of the group. When the range of individual estimates includes the true answer, then the median should be more accurate than half of the group. This, of course, does not mean that the median is necessarily more accurate than the most accurate panellists. In this particular assessment, as is often the case for policy-based evaluations, the true answer is uncertain. The economic efficiency or security of supply of particular energy alternatives may be assessed with some degree of confidence, while other criteria, such as public acceptability, are much less certain.

Rowe *et al.* (1991) explain that individuals outside the group who are consistent in their decision-making are unlikely to make any adjustments to their initial evaluations. On the other hand, individuals outside the group who are inconsistent in assigning their assessment scores are more likely to adjust their evaluations to be "on board" with the group. Some might argue that this creates a false consensus due to group pressure to conform; however, it is important to note that only those inconsistent decision-makers are likely to adjust their initial responses towards the median. Furthermore, as Rowe *et al.* (1984) indicate, pressure to conform on those individuals outside the group is unlikely to cause the initial group response to change.

Experts versus non-experts:

Prior to providing group feedback, it is necessary to examine the assessment scores of the "experts." The notion of an "expert panel" lies at the heart of the traditional Delphi. Judd (1972) notes that one of the most challenging problems in selecting a Delphi panel is identifying who is an expert. Typically, as is the case in this assessment, panellists are asked to self-identify their area of expertise during the panellist selection process. Rowe *et al.* (1991), however, question the appropriateness of self-rating as a reflection of actual expertise, as it is likely that self-rating identifies those who merely believe themselves to be experts rather than the real experts *per se*.

Impact assessment scores received from Round II were analyzed to determine if any difference existed between the "expert" and non-expert assessment scores. Assessment scores derived from the paired comparison matrix were analyzed using a '95 percent confidence interval for the median'(Table. 5.7). If the intervals do not overlap, then the two population medians are deemed to be different. However, if the intervals do overlap, as is the case here, then it cannot be said at the 95 percent confidence level that there is a difference between the expert and non-expert median assessment scores.

"Intuitively it would appear that an expert's performance being better than a non-expert is almost tautological" (Murray, 1979:155). However, at the policy level issues are often multidisciplinary in nature. A chemist, for example, with a specialization in environmental toxicity, may have little expertise with regard to predicting the environmental toxicity implications of energy policy alternatives. On the other hand, an energy policy expert may have little knowledge of the environmental impacts of waste generated from alternative electrical production systems. Sackman (1974) suggests that the Delphi concept of an "expert" is often overstated. Parente *et al.* (1984: 180;), Armstrong (1978:86), Welty (1972) and Wise (1976) agree, noting that a linear relationship between accuracy of Delphi prediction and self-rated expertise has not been consistently reported, particularly at the policy level.

Table 5.7. Comparison of expert versus non-expert median assessment scores at the 95 percent confidence interval*.

Assessment Criterion	Expertise	A1		A2		A3		A4		A5	
		Median	95% CI	Median	95% CI	Median	95% CI	Median	95% CI	Median	95% CI
C1: Atmospheric Emissions	Experts	.445	.365-.506	.174	.128-.220	.259	.224-.293	.033	.028-.039	.078	.063-.094
	Non-experts	.412	.270-.508	.152	.112-.192	.246	.203-.288	.036	.030-.042	.095	.074-.116
C2: Hazardous Waste Generation	Experts	.168	.128-.293	.039	.038-.044	.096	.012-.179	.133	.031-.234	.422	.301-.543
	Non-experts	.174	.115-.233	.056	.040-.069	.111	.072-.150	.151	.074-.203	.292	.229-.354
C3: Habitat Destruction	Experts	.251	.170-.333	.193	.132-.253	.303	.237-.369	.064	.042-.086	.085	.049-.121
	Non-experts	.208	.145-.271	.205	.168-.242	.276	.226-.325	.091	.071-.111	.120	.095-.145
C4: Resource Efficiency	Experts	.248	.134-.362	.114	.082-.187	.281	.179-.382	.087	.059-.115	.092	.046-.139
	Non-experts	.231	.161-.302	.122	.099-.146	.350	.284-.416	.051	.043-.069	.129	.110-.149
C5: Economic Efficiency	Experts	.457	.311-.573	.088	.056-.121	.107	.059-.155	.145	.042-.247	.100	.058-.143
	Non-experts	.225	.126-.325	.111	.082-.141	.150	.112-.188	.240	.199-.281	.170	.136-.204
C6: Market Competitiveness	Experts	.224	.059-.389	.144	.085-.204	.137	.064-.209	.211	.039-.384	.213	.069-.357
	Non-experts	.074	.052-.096	.141	.109-.173	.239	.187-.292	.192	.148-.236	.216	.173-.258
C7: Security of Supply	Experts	.156	.084-.227	.200	.089-.311	.251	.162-.339	.155	.088-.223	.087	.052-.123
	Non-experts	.124	.067-.181	.165	.139-.190	.257	.206-.308	.095	.055-.136	.165	.115-.215
C8: Distributional Equity	Experts	.088	.034-.143	.110	.065-.155	.457	.341-.573	.107	.072-.142	.162	.108-.216
	Non-experts	.108	.083-.133	.118	.096-.139	.381	.323-.438	.127	.106-.149	.200	.165-.235
C9: Public Health and Safety	Experts	.113	.000-.292	.097	.000-.224	.238	.141-.336	.050	.000-.140	.261	.050-.472
	Non-experts	.240	.182-.297	.103	.083-.124	.228	.182-.275	.076	.055-.098	.206	.164-.247
C10: Heritage Preservation	Experts	.188	.153-.223	.200	.090-.310	.323	.219-.427	.087	.000-.180	.197	.126-.208
	Non-experts	.226	.181-.270	.215	.188-.242	.295	.250-.340	.107	.088-.126	.103	.078-.139
C11: Public Acceptability	Experts	.188	.141-.234	.072	.042-.102	.244	.168-.320	.100	.061-.140	.263	.189-.337
	Non-experts	.132	.097-.147	.062	.046-.079	.264	.195-332	.090	.066-.115	.251	.178-.323

* The 95% confidence interval for the median is a distribution free statistic. It is derived as follows: Upper and lower fence = median +/- (1.58 x (H-spread)/$\sqrt{n}$)
Where the H-spread is the difference between Tukey's upper and lower hinges, represented by the box and whisker plot,
and gives the range covered by the middle half of the data (approximately the 25th and 75th percentile) (Velleman and Hoaglin, 1981).

Information Feedback:

Feedback is typically presented in the form of a simple statistical summary of the group response (Rowe *et al.*, 1991). Bots and Hulshof (2000), for example, in their application of MCE methods to health policy, used the group average response and a colour scale to highlight where average responses differ from what the individual decision-makers had indicated. Vizayakumar and Mohapatra (1992) in an analysis of the socioeconomic impacts of coalfields in India used mean values and standard deviations to summarize the group response, and concluded, perhaps arbitrarily, that given a coefficient of variation less than 50 percent for most questions no additional Rounds were required.

There is no single method for feeding back a statistical summary of group responses. The nature of the feedback depends on the distribution of the data. For J-shaped distributions, as is the case with the data presented in this assessment, the median value or the geometric mean are suitable measures of central tendency. Feedback should be presented in the form of a measure of central tendency plus the upper and lower limits, such as the confidence intervals (Rowe *et al.*,1991; Parente *et al.*,1984). In most Delphi applications, however, Rowe *et al.* (1991) note that only the single group response is presented. By limiting the scope of feedback, we are limiting the amount of information available to assist the decision-maker in re-evaluating their initial assessment. By providing the group range, deviating responses or outliers are easily seen, but at the same time, a group range does not force deviating responses to conform to a single value. As illustrated by Figure 5.12, the median consistency ratio improved over rounds to be within the 0 to 0.10 range, however, not all panellists conformed with the group.

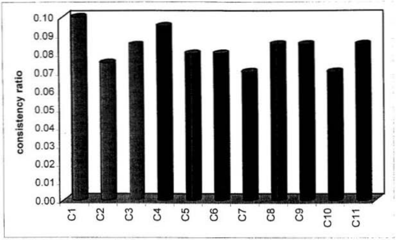


Figure 5.12. Round III median impact consistency ratios (after group feedback) for alternatives A1-A5 by criterion.

One approach to providing group feedback for skewed distributions is to provide the 95 percent confidence interval for the median for each paired comparison. However, as illustrated in Table 5.7, the confidence interval for the median is influenced by the sample size. Alternative-criterion combinations for which fewer panellists responded will thus be characterized by a larger confidence interval than for those combinations for which all panellists responded. In order to avoid the influence of sample size on group feedback, the upper and lower fence (Tukey, 1977) for the median of each paired comparison were provided. Individuals outside the upper or lower fences for the median values are considered to be outliers in the data set, or in conflict with the group. This does not mean that their assessments are not valid, rather that they be carefully evaluated for any inconsistencies. For alternative comparisons A1-A2 based on C3, for example, 60 percent of panellists outside the range of the group's responses displayed consistency ratios significantly greater than 0.10. For alternative comparisons A1-A3, 68 percent of panellists outside the normal range of the group's responses displayed consistency ratios indicative of inconsistent responses. There were cases, however, where an individual was well outside the median range but remained consistent. Few of these individuals made any adjustments to their assessments during Round III. This is consistent with the findings of Saaty (1977) and Dalkey (1975) in that least consistent or least knowledgeable panellists tend to be drawn toward the median, while the most consistent or most knowledgeable panellists will be more confident and so be less drawn toward the median.

5.2.5 Phase VI: Evaluate the Alternatives

This phase aims to statistically summarize the assessment scores presented in the assessment matrices and to structure this information according to the system of assessment criteria and decision-makers. Once the alternatives are assessed against the various assessment criteria and the impact significance, or criterion weights, are determined, the various alternatives must be compared in order to determine the preferred strategic option or PPP direction. The means by which alternatives are compared depends on the data collection procedure and assessment methods used in previous phases.

In order to properly compare the alternatives there is a need to rank each alternative with respect to each criterion weight and derive composite or global priorities, and to examine the robustness and sensitivity of this ranking with respect to assessment uncertainties, inconsistencies, and various regional and sectoral perspectives. There are several means by which this can be achieved (e.g. Kleinschmidt and Wagner, 1996; Huylenbroeck and Coppens, 1995; Saaty and Vargas, 1982; Sobral *et al.,* 1981; Saaty, 1997), including the extension of Saaty's AHP process, and more sophisticated multi-criteria evaluation techniques such as concordance analysis or preference functions. Huylenbroeck and Coppens (1995), for example, use pairwise matrices to develop a preference curve based on the AHP scale. Preference indicators for each alternative are calculated and compared within certain threshold values in order to determine if there is a strong preference for a certain alternative. The robustness of the decision is investigated by a 'Preference-Indifference-incompaRability' (PIR) filter developed by Roubens (1982) and Pastijn and Leysen (1989).

This research utilizes Saaty's analytical hierarchy process, and multi-criteria evaluation methods. However, given that the assessment data are derived from non-randomly selected panellists, and the distribution of assessment scores is J-shaped, most conventional statistical methods common to the Delphi technique are not suitable for this particular case study application. The central limit theorem allows us to make inferences about population means using the normal distribution no matter what the distribution of the population being sampled from. The majority of conventional, inferential statistical methods require a random sample of size n from a population where each element from the population is selected in such a way that each has the same probability of being sampled (Tabachnick and Fidell, 1996). Underlying most classical statistical tests then, is the assumption of normality derived from random, independent samples. Violating these assumptions may result in, for example, inflated or deflated correlations and therefore unreliable results (Sheskin, 2000; Tabachnick and Fidell, 1996)

In light of this, this research adopts a variety of alternative, perhaps even non-conventional analytical procedures, such as Moran's index for spatial autocorrelation, Cosine Theta measures of proportionate similarity, and matrix scaling operations. The particular methods used are discussed in greater detail in Chapter Six.

5.2.6 Phase VII: Identify the Best Practicable Environmental Option

The format of the assessment output depends on the type of methods used and analysis performed. For the AHP method or concordance analysis, for example, the output is presented in terms of a one-dimensional order of preference. As previously discussed, the output of SEA presents the decision-maker with a systematic analysis of PPP alternatives and the best practicable environmental option within the constraints of the particular assessment. This will, ideally, provide some strategic direction for action or a strategic option for a PPP. It is important to realize, however, that in SEA trade-offs must be made and that the final decision taken is not necessarily the optimal one based on individual criteria or interest group views. The best practicable environmental option represents an overall sense of direction based on the possible alternatives and evaluative criteria. It is the responsibility of the final decision-maker or decision-making agency to determine the final strategic course of action. The case study results and the particular methods used to determine and present the BPEO are discussed in the following Chapter.

Chapter Six

CASE STUDY RESULTS AND ANALYSIS: APPLIED PERSPECTIVE

6.1 INTRODUCTION

This chapter presents the results and analysis of the Delphi application. It first presents and examines the aggregate results of the assessment panel and the preferred ranking of energy policy alternatives, followed by the disaggregate or sub-group solutions. This is followed by a more detailed analysis of the group's assessment, including a sensitivity analysis of the overall preferred ranking of energy policy alternatives. Discussion at this stage is limited to the practical implications of the SEA framework, including its advantages and potential limitations, within the specific context of the case study application. The emphasis is on the *process* of determining the BPEO rather than the results of the case study *per se*.

6.2 GROUP AGGREGATE DATA

The final output of Delphi Rounds II and III included individual impact assessment and impact significance matrices, comprised of panellist's paired comparisons for alternative-criterion and criterion-criterion combinations. Assessment (preference) scores and criterion weights were derived for each individual panellist using the IDRISI decision support software based on Saaty's analytical hierarchy process, as discussed in Chapter Five. Median assessment scores and criterion weights were calculated for the aggregate group, as is the normal procedure for Delphi applications (Bonnell, 1997; Rowe *et al.*, 1991; Parente *et al.*, 1984), and entered into the summary matrix shown in Table 6.1.

Contrary to typical impact assessment matrices, where panellists are simply asked to assign an 'impact score', assessment criteria were formulated based on the min-max solution (i.e. selecting the alternative which minimizes potential negative impacts, or maximizes potential positive impacts) and, therefore, the higher the assessment score the more preferred is alternative i over i' on criterion j.

On the basis of these impact scores, localized, or unweighted preferences for each energy development alternative can be determined. The results are summarized in Figure 6.1(a-k). For example, alternative A1, the status quo, is the preferred energy alternative in terms of minimizing atmospheric emissions (Fig. 6.1a), but it is amongst the least preferred alternatives in terms of market competitiveness (Fig 6.1f) and distributional equity (Fig. 6.1h). Alternative A2, which emphasizes significant increases in nuclear energy supplemented with increases in natural gas, is the least preferred alternative in terms of minimizing the toxicity of hazardous waste produced during energy production and use (Fig. 6.1b), and is perceived as receiving minimal public support (6.1k). At the same time, A2 is amongst the most preferred alternatives with respect to energy security (Fig 6.1g) and ensuring the preservation of heritage resources (Fig 6.1j).

Table 6.1. Group aggregate assessment matrix from Delphi Round III, including CR>0.10.

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
C1	0.4193	0.1740	0.2361	0.0351	0.0870
C2	0.1906	0.0577	0.1110	0.1357	0.2902
C3	0.1587	0.2056	0.3010	0.0780	0.0911
C4	0.2325	0.1226	0.3340	0.0577	0.1185
C5	0.1618	0.1125	0.1268	0.2363	0.1522
C6	0.0877	0.1430	0.2299	0.1945	0.2000
C7	0.1297	0.1738	0.2637	0.0976	0.1201
C8	0.1007	0.1162	0.4185	0.1126	0.1945
C9	0.2396	0.1050	0.2488	0.0743	0.2000
C10	0.2000	0.2163	0.2849	0.0976	0.1041
C11	0.1459	0.0694	0.2615	0.0987	0.2583

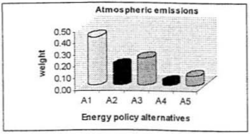


Figure 6.1a. Energy policy rankings by criterion C1: minimizing atmospheric emissions.

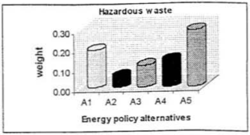


Figure 6.1b. Energy policy rankings by criterion C2: minimizing hazardous waste generation.

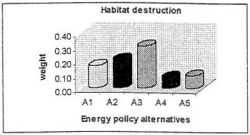


Figure 6.1c. Energy policy rankings by criterion C3: minimizing habitat destruction.

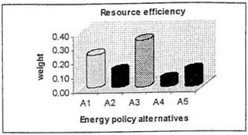


Figure 6.1d. Energy policy rankings by criterion C4: maximizing resource efficiency.

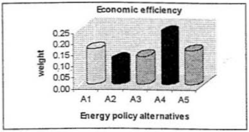


Figure 6.1e. Energy policy rankings by criterion C5: maximizing economic efficiency.

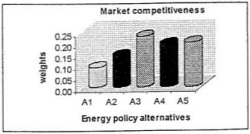


Figure 6.1f. Energy policy rankings by criterion C6: strengthening market competitiveness.

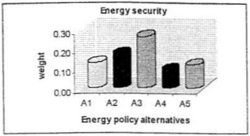


Figure 6.1g. Energy policy rankings by criterion C7: security of supply.

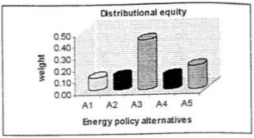


Figure 6.1h. Energy policy rankings by criterion C8: ensuring distributional equity.

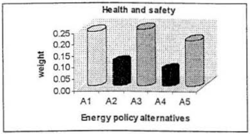


Figure 6.1i. Energy policy rankings by criterion C9: minimizing risk to public health and safety.

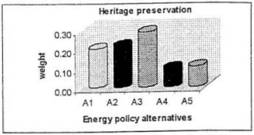


Figure 6.1j. Energy policy rankings by criterion C10: ensuring the preservation of heritage resources.

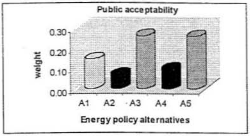


Figure 6.1k. Energy policy rankings by criterion C11: public acceptability.

Note: Energy policy rankings are based on 'unweighted' assessment criteria.

6.2.1 Weighted Preferences

The assessment scores presented in Table 6.1 do not account for the relative weight (i.e. significance) of each individual assessment criterion in the evaluation of energy policy alternatives. The distribution of criterion weights generated from Delphi Round II is summarized in Figure 6.2. These criterion weights represent the relative importance of assessment criterion i to i', and thus allow a ranking of the importance of each assessment criterion. The risk to public health and safety (C9) and atmospheric emissions (C1), for example, were deemed, not surprisingly, to be the most important factors to consider when evaluating the potential impacts of an energy strategy. The potential relationship between health and air quality helps explain the similarity in the weights of C9 and C1, with only a three percent difference. Strengthening Canada's competitiveness in energy export market opportunities (C6) was ranked as a relatively unimportant factor to consider when choosing an energy strategy.

All regions and sectors are statistically similar in their preferences for criterion weights at the 95 percent confidence interval for the median. The significance of this is addressed in detail in Chapter Seven.

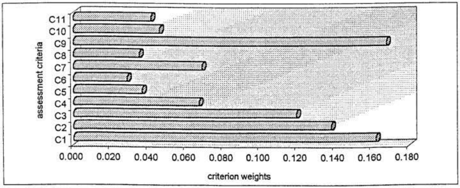


Figure 6.2. Criterion weights following Delphi Round II – aggregate group, including CR > 0.10.

"Evaluating the significance of predicted environmental effects is one of the most important steps in any EA" (Bonnell and Storey, 2000: 493). Much has been written on the topic of significance in the EA literature in recent years (e.g. Gibson, 2001; Glasson *et al.*, 1999), and determining measures of impact significance "has been a long standing subject of attention in environmental assessment theory and practice" (Gibson, 2001:2). Bonnell and Storey (2000: 493-494) note that due to the different types of environmental issues associated with the evaluation of PPP alternatives, it is often "difficult to compare the significance of environmental effects between these alternatives." Furthermore, Bonnell (1997) suggests that there is little or no guidance in the literature with respect to deriving a weighting scheme that reflects the relative importance of each criterion towards the overall assessment.

This is certainly the case with respect to the EA literature; however, much can be learned from the subject of multi-criteria evaluation in terms of determining impact significance. As discussed in Chapter Five, the paired comparison approach offers a potential solution to the problems associated with the comparison of different types of environmental issues at the strategic level. Combining the individual assessment scores in Table 6.1 to derive a single impact score results in each criterion contributing equally to the overall impact assessment. However, by using a paired comparison approach (Saaty, 1977), the relative significance of each individual assessment criterion can be determined. By standardizing the relative significance (weights) of each assessment criterion and multiplying these weights by the corresponding row cells of the assessment matrix, the 'weighted' assessment scores for each alternative-criterion combination can be determined, which takes into direct consideration the relative significance of the assessment scores.

The significance of standardizing the weights will become evident later in the analysis when a matrix scaling factor is applied.

The results of the weighting procedure are presented in Table 6.2. For the unweighted assessment scores (Table 6.1), for example, alternative A3, the renewables option, received a median group assessment score of 0.3340 on resource efficiency (C4) and 41 percent less weight (0.2361) on minimizing atmospheric emissions (C1). However, when criteria weights (i.e. impact significance) are taken into consideration (Table 6.2), A1 received 336 percent more weight on C1 than C4. Similarly, alternative A3, which involves the introduction of renewable energies as a major source of electricity, is ranked as the preferred option on the basis of distributional equity (C8). But when the relative importances of the assessment criteria are considered, alternative A3 ranks highest on minimizing atmospheric emissions (C1).

An aggregate ranking of alternatives for the group can be determined by summing the columns of the weighted assessment matrix. The aggregate group ranking, based on Saaty's AHP, is as follows: A3>A1>A5>A2>A4. At the aggregate level, alternative A3 (0.2433) is the preferred strategic direction to guide the development of energy policy. This is followed closely by alternative A1, the status quo, with an overall assessment score of 0.2252. Alternative A4, which emphasizes an increase in coal and natural gas, while maintaining hydro at current production levels, was the overall least preferred alternative with an assessment score of 0.0917. Given that these alternatives are derived on a ratio scale, and the weights assigned to each are based on paired comparisons, some sense of the magnitude of preferences for each alternative can be gained. For example, A3 and A1 are similar in their assessment weights, as are A2 and A5. However, A3 and A1 can be clearly differentiated as the most preferred alternatives, as they are of a magnitude of more than twice the assessment score of A4, the least preferred alternative (Fig. 6.3).

Applications of the AHP typically stop short of any further analysis once a decision preference is derived (e.g. Sobral *et al.*, 1983; Saaty and Kearns, 1985: 183-185). However, the robustness of the decision outcome is not clear at this stage of the analysis and, furthermore, neither is the sensitivity of the rank order of energy policy alternatives. The robustness and sensitivity of the energy policy preferences can be addressed by concordance and sensitivity analyses and are discussed in detail in Section 6.4.

Table 6.2. Group weighted aggregate assessment matrix from Delphi Round III, including CR>0.10.

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Weights	Standardized
C1	0.0746	0.0391	0.0420	0.0062	0.0155	0.1620	0.1779
C2	0.0289	0.0087	0.0168	0.0206	0.0440	0.1380	0.1516
C3	0.0208	0.0269	0.0395	0.0102	0.0119	0.1194	0.0131
C4	0.0171	0.0090	0.0246	0.0042	0.0087	0.0671	0.0737
C5	0.0065	0.0045	0.0051	0.0095	0.0061	0.0366	0.0402
C6	0.0027	0.0045	0.0072	0.0061	0.0063	0.0286	0.0314
C7	0.0098	0.0131	0.0199	0.0074	0.0091	0.0687	0.0754
C8	0.0039	0.0045	0.0161	0.0043	0.0075	0.0351	0.0385
C9	0.0441	0.0193	0.0458	0.0137	0.0368	0.1676	0.1841
C10	0.0101	0.0109	0.0144	0.0049	0.0053	0.0460	0.0505
C11	0.0066	0.0032	0.0119	0.0045	0.0117	0.0414	0.0455
	0.2252	*0.1357*	*0.2433*	*0.0917*	*0.1629*		

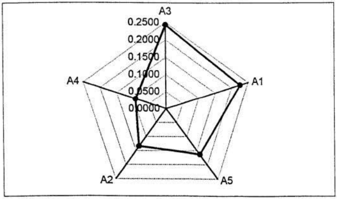


Figure 6.3. First order ranking of alternatives based on the analytical hierarchy process.

6.2.2 Effect of Inconsistencies

Clearly, there is some degree of subjectivity involved in the assignment of impact scores and criterion weights. This is unavoidable given the nature of the Delphi technique and policy-level assessment in general. Impact assessments that require the use of an assessment panel involve interpretation and the application of judgement, which may lead to biased or inconsistent responses. The potential effects of subjectivity with respect to biased or flawed responses are addressed in Chapter Seven. With respect to inconsistencies, such judgements can be rationalized in various ways in order to address, at least in part, the underlying structure of potentially inconsistent judgements and their effects on the overall decision outcome. Parkin (1992), cautions that inconsistent judgements made without the benefit of such analysis may distort the decision outcome.

Saaty's analytical hierarchy process, which includes a measure of inconsistency of judgements, introduces a more rational process of evaluation and assessment. Chapter Five, Figures 5.7 through 5.11 illustrate improvements in median consistency ratios over Delphi Rounds. Upon conclusion of Round III, the median consistency ratio for all assessment scores on all alternative-criterion combinations was within the acceptable 0.10 level. However, as illustrated in Figure 6.4, while the median consistency ratios are within the acceptable limit, several individual panellists remain inconsistent in their assessment. It is also interesting to note that 68 percent of these inconsistent panellists were outside the median range for the group assessment scores presented in Delphi Round III, and 71 percent of all inconsistencies across all criteria can be attributed to the assessments of only seven panellists. Furthermore, of the 62 outlying extreme CR values (Figure 6.4), 75 percent can be attributed to the assessments of only five panellists. These inconsistencies may be a result of the lack of complete knowledge of the issue under consideration, the lack of experience with respect to this particular type of assessment, a misunderstanding of the assessment instructions, or the misinterpretation of the information presented. A more detailed follow-up with individual panellists would be required in order to determine the exact nature of these inconsistencies. The issue here, however, is to determine the extent to which these inconsistencies affect the overall decision structure of the group. As noted previously, it is important that the final decision taken is based upon a consistent decision-making process, such that there are no internal conflicts in PPP choices.

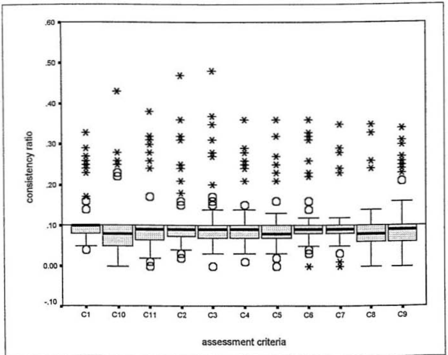


Figure 6.4. Round III impact assessment consistency measures (after group feedback) for alternatives A1-A5 by criterion. Note: Whiskers present for C1, C10, C11, and C2 but are too small to be resolved in the output.

In order to examine the overall effect of inconsistent judgments on the aggregate assessment scores, Moran's Index *(I)* was used to calculate a measure of similarity between the overall group assessment matrix, which *included* responses with CR > 0.10, and the consistent group matrix, which *excluded* responses with CR > 0.10. While other methods for measuring attribute similarity between matrices are available, such as the Geary Index (Bonham-Carter, 1994; Geary, 1968) or standardized Euclidean distance (Middleton, 2000), Moran's *I* is the preferred measure in this particular case as it provides a measure of autocorrelation that is similar in interpretation to the Pearson Product Moment correlation coefficient, where '+1' indicates a strong positive correlation, and '-1' indicates a strong negative correlation. A more detailed discussion of Moran's *I*, outlining its underlying assumptions and adaptations to this particular application, is included in Appendix F.

Assuming that each cell in the group assessment matrix (Table 6.2) and each corresponding cell in the matrix which includes only consistent responses (Table 6.3) are 'neighbors', an adaptation of Moran's Index can be applied to determine the degree of similarity, or dissimilarity between the two matrices (Equation 6.1). Matrices and cells are considered to represent the decision space of the group and the individuals. Given that each cell in the group matrix is assumed to have only one neighbor in the consistent matrix, all cells can be assigned equal weight. At this stage of the analysis, Moran's *I* indicates significant similarity ($I = 0.68$, $p = 0.0000$)[9] between the overall weights of the group matrix (Table 6.2) and the consistent matrix (Table 6.3). Similarly, at the cell-by-cell level for each alternative-criterion combination, Tables 6.2 and 6.3 are statistically similar with $p \leq 0.0001$ (Table, 6.4). This is illustrated graphically in Figure 6.5. With prob-values at zero to four decimal places, the likelihood of making an error in rejecting the null hypothesis of 'no similarity' and concluding group 'similarity' is extremely low.

(Equation 6.1) $I = \sum\sum w_{ij} c_{ij} / s^2 \sum\sum w_{ij}$

Where:

$s^2 = \sum (z_k - \text{z-mean})^2 / n$
k = range over all i and k = 1… n
$c_{ij} = (z_i - \text{z-mean})(z_j - \text{z-mean})$
n = total number of assessment weights in both matrices
i = an individual cell or decision space in the group matrix
j = the corresponding nearest neighbor in the consistent matrix
z_i = the value of the weight for cell *i*
c_{ij} = the similarity of *i*'s and *j*'s attributes
w_{ij} = the weights of *i* and *j* = 1

Therefore: $I = 2\sum_i c_{ij} / \sum(z_k - \text{z-mean})^2$

(Adapted from Bonham-Carter 1994 and Goodchild, 1986)

Table 6.3. Group weighted aggregate assessment matrix from Delphi Round III, excluding CR>0.10.

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Weights	Standardized
C1	0.0746	0.0293	0.0442	0.0063	0.0150	0.1620	0.1795
C2	0.0266	0.0083	0.0163	0.0215	0.0526	0.1351	0.1497
C3	0.0274	0.0257	0.0372	0.0095	0.0117	0.1169	0.1295
C4	0.0176	0.0091	0.0248	0.0043	0.0088	0.0671	0.0743
C5	0.0077	0.0042	0.0054	0.0102	0.0065	0.0381	0.0422
C6	0.0026	0.0046	0.0065	0.0063	0.0071	0.0292	0.0323
C7	0.0092	0.0133	0.0196	0.0087	0.0101	0.0693	0.0768
C8	0.0040	0.0045	0.0164	0.0046	0.0077	0.0355	0.0393
C9	0.0421	0.0190	0.0420	0.0138	0.0379	0.1662	0.1845
C10	0.0094	0.0101	0.0138	0.0051	0.0049	0.0423	0.0469
C11	0.0066	0.0029	0.0117	0.0046	0.0117	0.0408	0.0452
	0.2279	*0.1311*	*0.2380*	*0.0949*	*0.1740*		

[9] E(I) expected or critical value = -0.00917 for no autocorrelation; Z_I* calculated z-score = 4.67

Table 6.4. Cell-by-cell autocorrelation (Moran's *I*) for aggregate group with CR>0.10 removed and CR>0.10 included.

	A1	A2	A3	A4	A5
C1 Atmospheric emissions	I = 0.50 p = 0.0000	I = 0.48 p = 0.0000	I = 0.54 p = 0.0000	I = 0.54 p = 0.0000	I = 1.0 p = 0.0000
C2 Hazardous waste	I = 0.51 p = 0.0000	I = 0.52 p = 0.0001	I = 1.0 p = 0.0000	I = 0.75 p = 0.0000	I = 0.65 p = 0.0000
C3 Habitat destruction	I = 1.0 p = 0.0000	I = 0.46 p = 0.0000	I = 0.50 p = 0.0001	I = 0.52 p = 0.0000	I = 0.52 p = 0.0000
C4 Resource efficiency	I = 1.0 p = 0.0000	I = 0.52 p = 0.0000	I = 0.50 p = 0.0001	I = 0.43 p = 0.0000	I = 0.51 p = 0.0000
C5 Economic efficiency	I = 0.64 p = 0.0000	I = 0.54 p = 0.0001	I = 0.50 p = 0.0001	I = 0.50 p = 0.0000	I = 0.51 p = 0.0001
C6 Market competitive	I = 0.50 p = 0.0000	I = 0.48 p = 0.0000	I = 0.57 p = 0.0000	I = 0.46 p = 0.0000	I = 0.46 p = 0.0000
C7 Security of supply	I = 0.67 p = 0.0000	I = 0.52 p = 0.0000	I = 0.54 p = 0.0000	I = 0.52 p = 0.0000	I = 0.50 p = 0.0000
C8 Distributional equity	I = 0.50 p = 0.0000	I = 0.54 p = 0.0000	I = 1.0 p = 0.0000	I = 1.0 p = 0.0000	I = 0.50 p = 0.0000
C9 Health and safety	I = 0.46 p = 0.0000	I = 0.51 p = 0.0000	I = 0.46 p = 0.0000	I = 0.48 p = 0.0000	I = 0.52 p = 0.0001
C10 Heritage preservation	I = 0.67 p = 0.0000	I = 0.75 p = 0.0000	I = 1.0 p = 0.0000	I = 0.48 p = 0.0000	I = 0.52 p = 0.0001
C11 Public acceptability	I = 0.50 p = 0.0001	I = 0.50 p = 0.0001	I = 1.0 p = 0.0000	I = 0.52 p = 0.0001	I = 0.52 p = 0.0001

Table Legend: I = Moran's Index or measure of similarity (+) and dissimilarity (-) between assessment scores of group CR > 0.10 and group CR ≤ 0.10.
p (prob-value) = the probability of making a Type I error, rejecting the H_0 of 'no similarity when in fact Moran's *I* indicates H_1 group 'similarity.' Note that the prob-value is used here only as a confirmatory statistic. The key measure is the nature of the association (i.e. + or -) between criteria for each group.

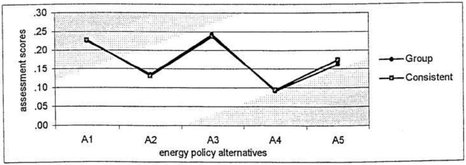


Figure 6.5. Group assessment scores for energy policy alternatives ('consistent' = CR>0.10 removed).

6.2.3 Within Group Consensus

There are a variety of ways to deal with the issue of consensus in Delphi applications. Huylenbroeck and Coppens (1995), for example, asked each Delphi sub-panel to find a decision consensus in order to avoid the aggregation of individual assessment scores. In many cases, however, particularly when dealing with policy issues, it is not appropriate to force consensus as there is a danger of distorting the true decision outcome. An advantage of using the policy Delphi to solicit assessment scores is that potential conflicts are not hidden by pressures to conform. At the same time, however, aggregating assessment data without examining individual differences may lead to a false sense of agreement. As a methodological principle, the inspection of individual differences should always precede any final decision analysis based on aggregation. "If the individuals differ systematically among themselves with respect to the variables of interest, then such information is lost upon aggregation…and there is always the danger of 'piecemeal' distortion" (Coxon, 1982: 15).

Consensus is secondary in this research to consistency. However, it is important for the final decision-maker to have some sense of the amount of agreement within the aggregate group. There are a variety of methods available for measuring within group similarity for random independent samples (e.g. Coxon, 1982: 17-32). The general approach is to concentrate attention initially on examining each subject's data structure (i.e. the decision outcome) and then compare the entire set of decision structures to the individual (Coxon, 1982). Moroney (1970) and Massam (1985), for example, highlight Kendall's coefficient of concordance as one measure of similarity across panellists. Leitch and Leistritz (1984) additionally suggest the chi-square test statistic as a means of measuring group consensus. While these methods are useful, they are too often indiscriminately applied to data where, as is the case in this assessment, judgments are solicited from panellists or steering committees that are non-randomly selected, thus presenting the danger of inflated or unreliable output.

Other measures, which are applicable to the given data, include the standardized Euclidean distance between samples and the Cosine Theta (costheta) measure of proportionate similarity. The costheta function is the measure of choice in this particular research (Equation 6.2). A key advantage of the costheta function is that it is sensitive to the relative proportions of the variables, similar to the 'index of dissimilarity', between distributions (Coxon, 1982: 28) but is not dependent on the scaling of the variables (Middleton, 2000). Cosine Theta is an appropriate measure when the magnitude of the individual paired comparisons is not as important as the similarity of the relative ordinal ranking of alternatives. In addition, the costheta function is a strong alternative to more conventional statistical methods for measuring consensus, such as the chi-square statistic, in that the costheta function is not sensitive to sparse cells and does not require data that are probabilistically sampled.

(Equation 6.2) $\text{cosine}\ \theta_{(ij)} = (\sum_k x_{ik} x_{jk}) / (\sqrt{\sum_k x^2_{ik} \sum_k x^2_{jk}})$

Where:

x_{ik} = score of panellist i in cell k of the alternative-criterion matrix

x_{jk} = score of panellist j in cell k of the alternative-criterion matrix

The costheta function was used to generate measures of consensus on the overall ranking of alternatives within the aggregate group. The results are presented in Table 6.5. This approach generates a matrix of paired scores, interpreted in the same way as the correlation coefficient where a strong positive costheta value (e.g. 0.90) is indicative of similarity between two panellists, but not perfect similarity (i.e. costheta = 1.0).

Determining the appropriate threshold values for consensus and identifying specific conflicting individuals can be particularly cumbersome and time consuming when large numbers of decision-makers are involved, as is the case in Table 6.5. Acceptable measures of similarity, or consensus, for the group's decisions can be determined by performing a simple scatter plot of costheta values by individual case number (Fig. 6.6). A sudden change in the slope of the costheta values is indicative of a sudden change in consensus. In this particular case the slope of the costheta curve is gradual from 1.00 to 0.80 (strong consensus), but falls sharply from 0.80 to 0.60 (consensus), and declines again following the 0.60 level (weak consensus).

Potentially conflicting individuals can be identified and mapped using SPSS software hierarchical cluster analysis. Hierarchical cluster analysis attempts to identify relatively homogenous groups of variables (panellists) based on their particular attributes (costheta) using particular similarity or distance (e.g. Euclidean distance) measures (Everitt, 1980). The advantage of this particular approach is that it provides the PPP decision analyst with a summary map of homogeneity, thereby allowing the visual inspection of dissimilar, or potentially conflicting panellists (Figure 6.7).

The key clusters of interest for the PPP decision analyst are those that cluster at a distance from the majority of the group. As illustrated in Figure 6.7, panellists 13, 02, 47, 51, 57, 22, and 29 are of particular interest[11]. Examining Table 6.5, it can be seen that approximately 80 percent of the costheta values associated with these seven panellists are less than 0.80. In addition, these seven panellists account for approximately 90 percent of all costheta values that are less than 0.80. It can be concluded then, that there is a strong consensus (costheta ≥ 0.80) on the overall ranking of alternatives within the aggregate group.

The costheta approach provides the policy decision-maker(s) with a detailed analysis of the group's decision structure and identifies potentially conflicting individuals. A closer analysis of the relationships within the costheta matrix, for example, reveals that the seven panellists characterized as having relatively low costheta values (<0.80) are of two types: those who are consistent in their assessment, and those who are inconsistent. Panellist 02, for example, ranks alternatives A2 and A4 as the preferred options for energy policy development. However, as illustrated in Chapter Five, Figure 5.10, this panellist is inconsistent in the assignment of impact significance scores (CR = 0.26), and consistency ratios for alternative A2 on criteria C1, C2, C3, and C11, for example, are 0.32, 0.48, and 0.39 respectively, well outside the 0.10 acceptable limit. Panellist 22 is consistent on the overall impact significance matrix (Chapter 5, Figure 5.10), but remains inconsistent on the assessment of the individual alternatives. Panellists 29, 47, and 51 are within the acceptable limits of consistency for both the assessment and impact significance matrices (Table 5.10). Their overall rankings of alternatives, however, disagree with the overall group. Panellist 47, for example, ranks alternatives A4 and A2 as the preferred energy

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[11] Panellist numbers in Table 6.5 do not correspond to the panellist identification numbers included in the Delphi application. Identification numbers have been recoded to ensure confidentiality.

Table 6.5.Cosine theta proportion of similarity between panellists.

	p1	p2	p3	p4	p5p	p6	p7	p8	p9	p10	p11	p12	p13	p14	p15	p16	p17	p18	p19	p20	p21	p22	p23	p24	p25	p26	p27	p28	p29	p30	p31
p1	1.00	0.73	0.86	0.94	0.93	0.96	0.80	0.93	0.89	1.00	0.90	0.89	0.82	0.88	0.89	0.95	0.97	0.84	0.80	0.86	0.86	0.77	0.96	0.92	0.89	0.96	0.96	0.84	0.80	0.87	0.85
p2		1.00	0.64	0.80	0.79	0.63	0.42	0.68	0.90	0.81	0.72	0.61	0.44	0.62	0.56	0.69	0.59	0.64	0.70	0.76	0.69	0.63	0.61	0.64	0.73	0.62	0.58	0.64	0.96	0.67	0.51
p3			1.00	0.80	0.85	0.96	0.93	0.94	0.75	0.88	0.90	0.93	0.95	0.96	0.95	0.88	0.83	0.95	0.81	0.87	0.81	0.71	0.85	0.86	0.92	0.97	0.95	0.91	0.80	0.81	0.96
p4				1.00	0.86	0.88	0.71	0.83	0.91	0.94	0.92	0.78	0.82	0.80	0.78	0.87	0.88	0.77	0.82	0.79	0.86	0.71	0.90	0.83	0.89	0.84	0.82	0.80	0.78	0.80	0.81
p5					1.00	0.91	0.81	0.83	1.00	0.88	0.91	0.95	0.79	0.90	0.87	0.98	0.90	0.86	0.98	0.98	0.94	0.61	0.81	0.96	1.00	0.90	0.90	0.93	0.79	0.96	0.84
p6						1.00	0.94	0.92	0.86	0.97	0.98	0.97	0.91	0.98	0.99	0.93	0.88	0.99	0.83	0.91	0.94	0.79	0.87	0.91	0.94	0.97	0.94	0.97	0.76	0.84	1.00
p7							1.00	0.90	0.68	0.53	0.86	0.85	0.97	0.94	0.95	0.80	0.81	0.95	0.79	0.80	0.81	0.56	0.80	0.75	0.91	0.92	0.88	0.85	0.82	0.79	0.97
p8								1.00	0.80	0.81	0.90	0.84	0.95	0.90	0.88	0.84	0.86	0.87	0.81	0.82	0.80	0.60	0.95	0.80	0.98	0.97	0.95	0.81	0.78	0.82	0.89
p9									1.00	0.98	0.89	0.86	0.77	0.85	0.86	0.92	0.84	0.85	0.93	0.95	0.93	0.79	0.80	0.89	0.85	0.82	0.80	0.88	0.79	0.88	0.88
p10										1.00	0.96	1.00	0.78	0.97	0.95	1.00	1.00	0.92	0.99	1.00	1.00	0.78	0.83	1.00	0.86	0.95	0.97	1.00	0.77	1.00	0.90
p11											1.00	0.93	0.79	0.97	0.89	0.92	0.83	0.96	0.83	0.91	0.94	0.77	0.86	0.89	0.95	0.93	0.93	0.95	0.76	0.82	0.95
p12												1.00	0.82	0.97	0.97	0.98	0.89	0.96	0.91	0.94	0.95	0.78	0.80	0.98	0.86	0.94	0.93	0.98	0.78	0.93	0.95
p13													1.00	0.90	0.90	0.78	0.78	0.90	0.90	0.71	0.68	0.51	0.89	0.72	0.92	0.94	0.91	0.93	0.65	0.82	0.93
p14														1.00	0.99	0.93	0.84	0.99	0.82	0.92	0.92	0.78	0.83	0.91	0.93	0.95	0.92	0.98	0.72	0.84	0.99
p15															1.00	0.92	0.86	0.99	0.80	0.87	0.92	0.77	0.84	1.00	0.90	0.95	0.93	0.96	0.66	0.83	1.00
p16																1.00	0.95	0.90	0.97	0.94	0.95	0.88	0.85	0.99	0.87	0.93	0.94	0.95	0.71	0.97	0.90
p17																	1.00	0.81	0.89	0.81	0.84	0.78	0.93	0.94	0.85	0.93	0.99	0.82	0.65	0.92	0.84
p18																		1.00	0.77	0.88	0.91	0.79	0.81	0.88	0.91	0.93	0.90	0.97	0.69	0.80	1.00
p19																			1.00	0.94	0.92	0.89	0.81	0.97	0.76	0.83	0.85	0.88	0.78	0.98	0.79
p20																				1.00	0.98	0.86	0.80	0.96	0.82	0.89	0.91	0.95	0.79	0.95	0.82
p21																					1.00	0.82	0.81	0.95	0.82	0.85	0.82	0.96	0.73	0.92	0.89
p22																						1.00	0.60	0.95	0.64	0.75	0.76	0.82	0.62	0.97	0.74
p23																							1.00	0.80	0.94	0.94	0.94	0.80	0.72	0.81	0.82
p24																								1.00	0.82	0.91	0.92	0.94	0.69	0.99	0.88
p25																									1.00	0.96	0.92	0.86	0.73	0.81	0.91
p26																										1.00	0.99	0.90	0.76	0.85	0.95
p27																											1.00	0.87	0.71	0.87	0.92
p28																												1.00	0.74	0.89	0.95
p29																													1.00	0.63	0.86
p30																														1.00	0.80
p31																															1.00
																															p32

	p32	p33	p34	p35	p36	p37	p38	p39	p40	p41	p42	p43	p44	p45	p46	p47	p48	p49	p50	p51	p52	p53	p54	p55	p56	p57
p1	0.92	0.97	0.97	0.94	0.95	0.89	0.97	0.81	0.82	0.98	0.99	0.93	1.00	0.96	0.91	0.70	0.94	0.91	0.91	0.80	0.93	0.99	0.88	0.96	0.95	0.72
p2	0.64	0.72	0.68	0.72	0.77	0.75	0.69	0.67	0.58	0.79	0.60	0.81	0.78	0.72	0.53	0.73	0.77	0.56	0.62	0.51	0.65	0.78	0.65	0.66	0.62	0.61
p3	0.80	0.92	0.94	0.91	0.89	0.87	0.80	0.82	0.87	0.85	0.85	0.85	0.84	0.86	0.98	0.62	0.88	0.82	0.95	0.68	0.81	0.85	0.80	0.90	0.93	0.67
p4	0.87	0.92	0.87	0.91	0.91	0.90	0.91	0.81	0.87	0.93	0.90	0.94	0.94	0.92	0.78	0.79	0.90	0.81	0.82	0.72	0.88	0.93	0.81	0.91	0.89	0.88
p5	0.96	0.93	0.96	0.91	0.99	0.87	0.83	0.80	0.80	0.96	0.92	0.94	0.83	0.99	0.84	0.68	0.99	0.93	0.94	0.78	0.80	0.96	0.07	0.95	0.92	0.76
p6	0.89	0.97	0.96	0.98	0.95	0.95	0.81	0.62	0.95	0.90	0.87	0.91	0.90	0.91	0.96	0.79	0.95	0.83	0.99	0.72	0.82	0.88	0.86	0.97	0.98	0.75
p7	0.81	0.90	0.85	0.91	0.80	0.89	0.73	0.79	0.95	0.80	0.81	0.82	0.85	0.78	0.96	0.73	0.80	0.67	0.91	0.55	0.62	0.81	0.67	0.87	0.91	0.50
p8	0.82	0.95	0.93	0.93	0.89	0.89	0.93	0.82	0.87	0.89	0.90	0.88	0.95	0.85	0.97	0.72	0.87	0.80	0.89	0.80	0.84	0.90	0.80	0.89	0.91	0.53
p9	0.90	0.90	0.88	0.91	0.95	0.91	0.80	0.84	0.95	0.94	0.84	0.96	0.87	0.92	0.80	0.78	0.96	0.81	0.87	0.79	0.80	0.92	0.90	0.90	0.87	0.54
p10	1.00	0.98	1.00	0.96	1.00	0.91	0.93	0.80	0.80	1.00	1.00	1.00	0.84	1.00	0.86	0.65	1.00	1.00	1.00	0.80	0.86	1.00	0.99	0.99	1.00	0.78
p11	0.94	0.95	0.96	0.91	0.93	0.89	0.81	0.81	0.97	0.90	0.85	0.98	0.94	0.88	0.90	0.82	0.96	0.80	0.96	0.71	0.80	0.88	0.85	0.96	0.97	0.73
p12	0.95	0.93	0.96	0.92	0.96	0.88	0.82	0.69	0.85	0.91	0.88	0.91	0.80	0.95	0.91	0.79	0.96	0.92	0.99	0.80	0.98	0.89	0.95	0.97	0.96	0.79
p13	0.68	0.89	0.86	0.88	0.79	0.84	0.79	0.78	0.89	0.80	0.80	0.81	0.88	0.81	0.98	0.67	0.77	0.78	0.86	0.52	0.75	0.79	0.82	0.83	0.88	0.44
p14	0.88	0.96	0.94	0.97	0.94	0.95	0.81	0.82	0.94	0.93	0.84	0.94	0.88	0.89	0.95	0.76	0.95	0.82	0.99	0.74	0.79	0.87	0.86	0.96	0.97	0.76
p15	0.89	0.95	0.93	0.96	0.91	0.93	0.80	0.86	0.94	0.86	0.84	0.96	0.85	0.88	0.95	0.73	0.92	0.84	0.99	0.76	0.70	0.84	0.82	0.84	0.89	0.74
p16	0.99	0.93	0.97	0.93	0.99	0.88	0.85	0.82	0.82	0.84	0.89	0.94	0.88	0.99	0.96	0.85	0.85	0.96	0.94	0.82	0.80	1.00	0.98	0.98	0.96	0.79
p17	0.94	0.92	0.91	0.96	0.97	0.80	0.93	0.84	0.83	0.95	0.99	0.96	0.84	0.97	0.92	0.56	0.90	0.96	0.90	0.79	0.92	0.99	0.91	0.94	0.93	0.75
p18	0.86	0.94	0.92	0.96	0.92	0.94	0.80	0.86	0.95	0.84	0.81	0.91	0.85	0.85	0.94	0.76	0.92	0.80	0.98	0.72	0.68	0.84	0.83	0.94	0.96	0.73
p19	0.96	0.86	0.92	0.83	0.95	0.91	0.80	0.91	0.79	0.95	0.90	0.88	0.80	0.98	0.81	0.56	0.95	0.95	0.88	0.86	0.82	0.93	0.98	0.90	0.86	0.86
p20	1.00	0.92	0.99	0.89	0.99	0.84	0.84	0.90	0.80	1.00	0.96	0.95	0.83	0.99	0.81	0.60	1.00	0.98	0.94	0.89	0.83	1.00	0.99	0.97	0.93	0.91
p21	0.96	0.91	0.90	0.93	0.95	0.92	0.80	0.96	0.86	0.90	0.83	0.95	0.84	0.92	0.80	0.77	0.97	0.94	0.89	0.92	0.52	0.87	0.95	0.96	0.93	0.90
p22	0.94	0.77	0.85	0.77	0.89	0.72	0.62	0.52	0.65	0.86	0.79	0.82	0.62	0.92	0.67	0.49	0.90	0.92	0.86	0.96	0.60	0.82	0.98	0.86	0.81	0.96
p23	0.81	0.94	0.92	0.91	0.87	0.85	0.98	0.89	0.84	0.90	0.95	0.86	0.94	0.85	0.93	0.69	0.84	0.80	0.86	0.67	0.93	0.92	0.80	0.90	0.92	0.52
p24	0.99	0.91	0.96	0.89	0.97	0.84	0.80	0.79	0.82	0.96	0.94	0.91	0.83	0.98	0.85	0.59	0.94	0.97	0.95	0.95	0.76	0.93	0.99	0.96	0.94	0.89
p25	0.80	0.98	0.93	0.97	0.92	0.96	0.91	0.81	0.93	0.90	0.88	0.94	0.98	0.87	0.95	0.78	0.91	0.81	0.92	0.62	0.80	0.91	0.87	0.91	0.92	0.58
p26	0.88	0.98	0.98	0.95	0.94	0.90	0.98	0.82	0.89	0.93	0.94	0.91	0.92	0.89	0.92	0.68	0.93	0.87	0.96	0.76	0.83	0.92	0.91	0.96	0.93	0.69
p27	0.89	0.95	0.98	0.92	0.93	0.85	0.92	0.86	0.83	0.93	0.96	0.92	0.89	0.86	0.95	0.60	0.94	0.90	0.98	0.79	0.86	0.91	0.93	0.94	0.89	0.70
p28	0.92	0.92	0.93	0.93	0.94	0.92	0.79	0.80	0.88	0.88	0.81	0.93	0.88	0.93	0.87	0.72	0.96	0.85	0.98	0.78	0.60	0.85	0.92	0.95	0.94	0.79
p29	0.67	0.79	0.78	0.78	0.76	0.80	0.76	0.82	0.72	0.79	0.72	0.81	0.84	0.76	0.70	0.80	0.79	0.59	0.74	0.50	0.68	0.80	0.67	0.74	0.73	0.80
p30	0.98	0.85	0.93	0.83	0.94	0.80	0.82	0.80	0.67	0.94	0.88	0.86	0.75	0.98	0.80	0.51	0.94	0.98	0.90	0.82	0.76	0.92	0.98	0.92	0.89	0.82
p31	0.86	0.94	0.92	0.95	0.89	0.93	0.80	0.91	0.95	0.83	0.83	0.90	0.86	0.85	0.96	0.73	0.90	0.80	0.98	0.71	0.64	0.82	0.83	0.94	0.97	0.69
p32	1.00	0.91	0.94	0.89	0.96	0.85	0.90	0.81	0.80	0.95	0.92	0.91	0.93	0.97	0.82	0.83	0.96	0.92	0.93	0.95	0.78	0.93	0.99	0.97	0.98	0.81
p33		1.00	0.97	0.99	0.97	0.97	0.90	0.87	0.93	0.95	0.93	0.97	0.96	0.93	0.95	0.79	0.97	0.85	0.97	0.76	0.78	0.95	0.87	0.98	0.98	0.72
p34			1.00	0.95	0.98	0.89	0.91	0.80	0.85	0.91	0.93	0.93	0.88	0.98	0.95	0.66	0.97	0.93	0.97	0.78	0.81	0.97	0.93	0.98	0.98	0.79
p35				1.00	0.96	0.99	0.92	0.81	0.96	0.92	0.89	0.98	0.96	0.96	0.93	0.78	0.96	0.80	0.97	0.73	0.76	0.91	0.85	0.97	0.98	0.71
p36					1.00	0.92	0.88	0.79	0.80	0.99	0.94	0.97	0.90	0.98	0.89	0.73	1.00	0.92	1.00	0.79	0.80	0.97	0.95	0.98	0.96	0.81
p37						1.00	0.80	0.78	0.80	0.97	0.82	0.98	0.99	0.85	0.93	0.86	0.94	0.80	0.93	0.85	0.69	0.86	0.80	0.94	0.94	0.68
p38							1.00	0.88	0.73	0.93	0.96	0.84	0.92	0.87	0.88	0.63	0.84	0.82	0.81	0.70	0.92	0.95	0.80	0.87	0.87	0.55
p39								1.00	0.78	0.93	0.94	0.86	0.81	0.98	0.83	0.51	0.94	0.98	0.93	0.92	0.80	0.91	0.92	0.93	0.91	0.88
p40									1.00	0.77	0.76	0.92	0.92	0.81	0.90	0.81	0.88	0.81	0.91	0.57	0.62	0.85	0.80	0.90	0.93	0.57
p41										1.00	0.97	0.94	0.90	0.98	0.87	0.68	0.97	0.93	0.92	0.76	0.83	0.99	0.93	0.95	0.93	0.72
p42											1.00	0.89	0.87	0.96	0.90	0.59	0.91	0.94	0.89	0.79	0.80	0.98	0.89	0.94	0.93	0.67
p43												1.00	0.95	0.92	0.86	0.80	0.98	0.82	0.94	0.76	0.76	0.93	0.88	0.96	0.95	0.78
p44													1.00	0.83	0.89	0.79	0.89	0.76	0.87	0.60	0.83	0.90	80.00	0.90	0.91	0.55
p45														1.00	0.87	0.60	0.97	0.97	0.94	0.78	0.80	0.98	0.97	0.96	0.94	0.78
p46															1.00	0.66	0.88	0.81	0.95	0.69	0.81	0.88	0.80	0.92	0.95	0.61
p47																1.00	0.75	0.45	0.72	0.38	0.52	0.66	0.56	0.75	0.75	0.45
p48																	1.00	0.88	0.92	0.76	0.73	0.91	0.91	0.93	0.92	0.77
p49																		1.00	0.88	0.84	0.82	0.85	0.97	0.92	0.89	0.77
p50																			1.00	0.82	0.72	0.90	0.91	0.98	0.99	0.78
p51																				1.00	0.71	0.84	0.97	0.86	0.81	0.91
p52																					1.00	0.92	0.81	0.80	0.80	0.53
p53																						1.00	0.91	0.94	0.93	0.75
p54																							1.00	0.93	0.90	0.84
p55																								1.00	0.99	0.79
p56																									1.00	0.76
p57																										1.00

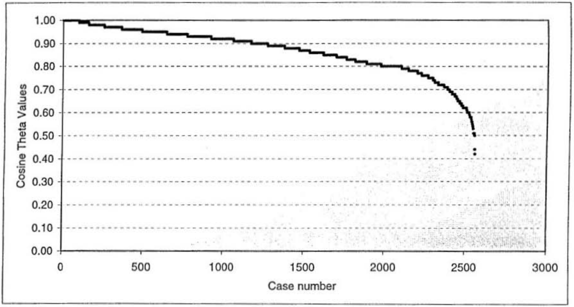

Figure 6.6. Scatter plot of costheta values of proportion of similarity by panelist alternative-criterion case number.

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Panellist     00    05    10    15    20    25
Label         +-----+-----+-----+-----+-----+
 p55          -+        Euclidean Distance
 p56          -+
 p34          -+
 p50          -+
 p06          -+-+
 p33          -+ I
 p35          -+ +-+
 p43          -+ I I
 p26          -+-+ I
 p27          -+   I
 p12          -----+
 p01          -+   I
 p53          -+-+ I
 p42          -+ I I
 p24          -+ I I
 p32          -+ I I
 p45          -+-+ I
 p16          -+ +-+-+
 p36          -+ I I I
 p48          -+-+ I I
 p41          -+ I I I
 p5P          ---+ I I
 p17          -----+ I
 p11          -------+
 p18          ---+---+
 p28          ---+   +-+
 p19          -+-+   I I
 p30          -+ +-+ I I
 p39          -+ I I I I
 p54          -+-+ +-+ +-+
 p50          -+   I   I I
 p20          ---+-+   I I
 p21          ---+     I I
 p10          ---------+ I
 p15          -----------+
 p04          ---+---+   +
 p09          ---+   +-+ I
 p23          -----+-+ I I
 p38          -----+   I I
 p03          -+-+     I I
 p46          -+ +-+   +-+
 p13          ----------------+---------+
 p25          ---+ I   I      I         I
 p08          ---+ I   I      I         I
 p44          ---+-+---+      I         I
 p02          ---+ I   I      I         +--------------------+
 p40          -----+   I      I         I                    I
 p14          ---------+      I         I                    I
 p47          -----------+----+---------+                    I
 p07          -----------+              I                    I
 p51          --------------------------+                    I
 p52          -----+                                         I
 p57          -----+---------------------------+             I
 p22          ---------------+                 +-------------+
 p37          -----------+---+                 I
 p29          -----------+   +-----------------+
 p31          ---------------+
```

Figure 6.7. Dendrogram of Cosine Theta values for panellist's assessments. Confirmatory analysis performed using median cluster analysis generated similar results.

policy options, whereas Figure 6.2 depicts A4 and A2 as the group's least preferred options overall. The policy decision-maker(s) may wish to explore the nature of these conflicts, particularly with respect to those who are consistent in their assessment and demonstrate a clear understanding of the decision problem, before any final decisions are taken.

The application of the costheta function and hierarchical cluster analysis is one means of determining group consensus thresholds and identifying specific areas of potential conflict in the strategic assessment process, and provides the researcher with the knowledge to explore in greater detail the nature of that conflict. While the sensitivity of the group's ranking of alternatives will be examined with costheta values in mind, a detailed analysis of potential conflicts within the group is outside the scope of this particular research. It is recognized, however, that such an analysis is an important component of SEA when real energy policy decisions are about to be taken.

6.3 Disaggregate Data

The discussion thus far has concerned the overall median responses of the group at the aggregate level. It is important, however, to examine the extent to which the aggregate assessment and ranking of alternatives reflects that of the various sub-groups involved. Coxon (1985) cautions that if any significantly different sub-groups do exist in the aggregate data set, then any averaged information will not reproduce the characteristics of either group accurately. This section focuses on assessment scores and alternative preferences of the various regional- and sectoral-based sub-groups depicted in Chapter 5, Figures 5.3 and 5.4.

6.3.1 Sector Disaggregation

Following the same procedure as for the aggregate data above, weighted AHP matrices were constructed for each sector represented in the assessment process. The weighted AHP matrices for each sector grouping are presented in Appendix G and summarized graphically in Figures 6.8 and 6.9. Moran's *I* for 'between group similarity' indicates that all sub-groups are statistically similar at the aggregate level on the basis energy policy preferences ($I = 0.52$, $p = 0.0000$) (Table 6.6). Aggregate decision outcomes may, however, hide minor differences between sub-groups contained within the decision set.

A scatter plot of Moran's Indices can be used to map the decision space for individual alternative-criterion assessments for various sectors and regional combinations. The public and private sector weighted assessment matrices, Figure 6.10a, for example, illustrates that the sectors are similar with regard to their overall energy policy preferences. Within the public and private sector groupings, however, significant dissimilarities can be identified at the individual alternative-criterion assessment level. Figure 6.10b illustrates particular points of dissimilarity or dissent between the provincial government and industry regarding the assessment of particular alternative-criterion combinations. Although these sectors are similar in terms overall preferences for energy policy ($I = 0.49$, $p = 0.0000$), there are significant dissimilarities at the individual alternative-criterion assessment level, as indicated in the decision space below the 0.00 reference line. For example, industry places considerably more emphasis on the status quo (A1) with respect to meeting the objectives of energy security (C7) than does the provincial government sector. The median assessment score of industry on A1 with respect to C7 is nearly threefold the median assessment score of the provincial government sector. Similarly, the federal public service sector and NGO sector (Fig. 6.10c) are similar at the aggregate level ($I = 0.23$, $p = 0.0226$), but significant dissimilarities exist at the paired comparison level. The median assessment score of the federal government on alternative A1 with respect to C7, for example, is 0.0039, approximately 86 percent less than the NGOs' median assessment score of 0.0280. In terms of minimizing the toxicity of hazardous waste, the federal government placed 60 percent less weight on alternative A4 than did the NGO sector.

Although it is not within the scope of this particular case study, the methods provide the policy analyst with the information required to explore, where necessary, the particular reasons behind these sector differences and the implications of sectoral and regional dissent for national energy policy. This will be returned to in Chapter Seven.

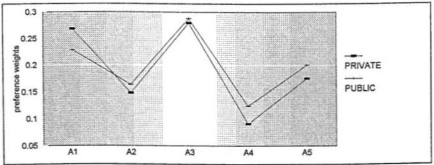

Figure 6.8. Public and private sector AHP energy policy rankings.

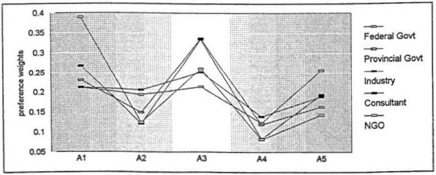

Figure 6.9. AHP energy policy rankings by sector.

Table 6.6. Between sector Moran's I measure of group similarity.

	Private Sector	Public Sector	Federal Government	Provincial Government	Industry	Consultants
Public Sector	0.52 0.0000 -0.00917 4.86					
Federal Government	0.71 0.0000 -0.00917 6.64	0.39 0.0004 -0.00917 3.62				
Provincial Government	0.43 0.0000 -0.00917 4.07	0.39 0.0004 -0.00917 3.86	0.37 0.0004 -0.00917 3.50			
Industry	0.55 0.0000 -0.00917 5.10	0.46 0.0000 -0.00917 4.29	0.51 0.0000 -0.00917 4.81	0.49 0.0000 -0.00917 4.41		
Consultants	0.43 0.0000 -0.00917 4.24	0.35 0.0008 -0.00917 3.33	0.36 0.0008 -0.00917 3.35	0.22 0.0366 -0.00917 2.09	0.30 0.0076 -0.00917 2.67	
NGOs	0.37 0.0004 -0.00917 3.40	0.26 0.0132 -0.00917 2.48	0.23 0.0226 -0.00917 2.28	0.29 0.0052 -0.00917 2.79	0.18 0.0750 -0.00917 1.78	0.35 0.0010 -0.00917 3.28

Table Legend

I	p		
I	p	I = Moran's Index	p = prob-value[1]
E(I)	Z_I*	E(I) = expected or critical value	Z_I* = calculated z-score

[1]Prob-value indicates the probability of making a Type I error: rejecting the H_0 of 'no similarity' because Moran's *I* test for group similarity indicates H_1 (similarity) when in fact there is no similarity.

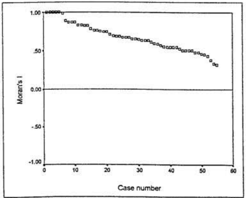

Figure 6.10a. Public and private sector Moran's *I* for individual alternative-criterion assessments.

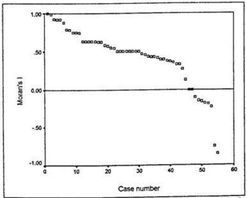

Figure 6.10b. Provincial govt. and industry Moran's *I* for individual alternative-criterion assessments.

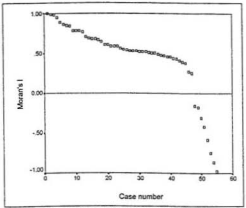

Figure 6.10c. Federal government and NGO Moran's *I* for individual alternative-criterion assessments.

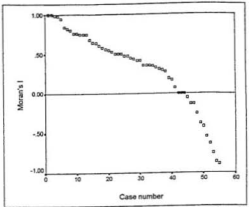

Figure 6.10d. Western and central public sector Moran's *I* for individual alternative-criterion assessments.

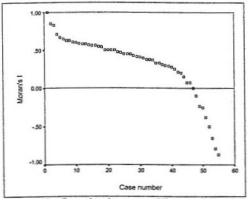

Figure 6.10e. Central and eastern public sector Moran's *I* for individual alternative-criterion assessments.

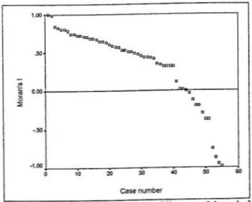

Figure 6.10f. Western and eastern public sector Moran's *I* for individual alternative-criterion assessments.

6.3.2 Regional Disaggregation

Following the same procedure as outlined above, variations in regional energy policy preferences can be explored. The weighted AHP matrices for regional groupings are presented in Appendix G, with the aggregate regional preferences presented in Figure 6.11. Moran's *I* for between group similarity suggests an overall agreement between regional groupings on the aggregate ranking of energy policy alternatives (Table 6.7). Seventy-five percent of the regional comparisons in Table 6.7 have prob-values less than any 'conventional' significance level, such as $\alpha = 0.05$, suggesting significant regional similarities in energy policy preferences. Few regional groupings are characterized by prob-values slightly above the $\alpha = 0.05$ significance level, with six regional comparisons above the $\alpha = 0.10$ level. Moran's *I* for the western and central private sectors, for example, is 0.10 with a prob-value of 0.3174. In other words, there is 31.74 percent likelihood of a Type I error in suggesting that the regions are similar in their overall preferences. At the aggregate level, however, Moran's *I* is positive for all regional comparisons, suggesting that there are no significant dissimilarities and that some degree of similarity does exists in the overall rankings between the various regions.

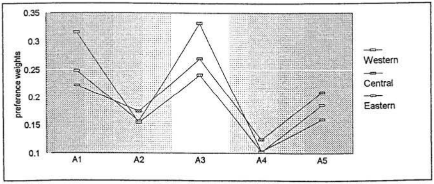

Figure 6.11. Regional AHP energy policy rankings.

Table 6.7. Between group correlation (Moran's I) by region.

	Western Region	Central Region	Eastern Region	Western Public Sector	Western Private Sector	Central Public Sector	Central Private Sector	Eastern Public Sector
Central Region	0.39 0.0002 -0.00917 3.73							
Eastern Region	0.35 0.0004 -0.00917 3.59	0.49 0.0000 -0.00917 4.67						
Western Public Sector	0.35 0.0010 -0.00917 3.27	0.34 0.0014 -0.00917 3.20	0.25 0.0188 -0.00917 2.35					
Western Private Sector	0.22 0.0113 -0.00917 2.28	0.15 0.1388 -0.00917 1.48	0.27 0.0102 -0.00917 2.57	0.13 0.1470 -0.00917 1.29				
Central Public Sector	0.40 0.0002 -0.00917 3.75	0.53 0.0000 -0.00917 4.98	0.49 0.0000 -0.00917 4.55	0.22 0.0394 -0.00917 20.6	0.22 0.0340 -0.00917 2.12			
Central Private Sector	0.20 0.0574 -0.00917 1.90	0.42 0.0000 -0.00917 3.94	0.37 0.0004 -0.00917 3.53	0.29 0.0048 -0.00917 2.82	0.10 0.3174 -0.00917 1.00	0.43 0.0000 -0.00917 4.07		
Eastern Public Sector	0.30 0.0018 -0.00917 2.92	0.31 0.0000 -0.00917 3.94	0.47 0.0002 -0.00917 3.83	0.14 0.1706 -0.00917 1.37	0.20 0.0524 -0.00917 1.94	0.23 0.0250 -0.00917 2.24	0.18 0.0784 -0.00917 1.76	
Eastern Private Sector	0.34 0.0014 -0.00917 3.21	0.44 0.0000 -0.00917 4.09	0.41 0.0000 -0.00917 3.90	0.21 0.0404 -0.00917 2.05	0.17 0.1032 -0.00917 1.63	0.25 0.0075 -0.00917 2.43	0.17 0.0950 -0.00917 1.67	0.40 0.0002 -0.00917 3.76

Table Legend

I p		I = Moran's Index	p = prob-value
E(I) Z_I*		E(I) = expected or critical value	Z_I* = calculated z-score

As in Section 6.3.1, regional preferences can be explored for dissimilarities that might exist at the individual alternative-criterion assessment level. For example, the western and central public sectors have similar energy policy preferences at the aggregate level (I = 0.22, p = 0.0394), but there are certain dissimilarities at the alternative-criterion paired comparison level (Fig. 6.11d), particularly in terms of alternative A4 on energy security (C7) (I = -0.47, p = 0.0004) and A3 on resource efficiency (C4) (I = -0.31, p = 0.0019). The central public sector assigned 30 percent less weight to alternative A3 with respect to resource efficiency and 80 percent less weight to alternative A4 with respect to energy security than did the western public sector. Similar disagreements exist between the central and eastern public sectors (Fig. 6.11e) on alternatives A1 and A5 with respect to habitat destruction (I = -0.28, p = 0.0564) and emissions (I = -0.31, p = 0.0004), and between the western and eastern public sectors (Fig. 6.11f) on alternative A3 with respect to distributional equity (I = -0.16, p = 0.1388), and alternative A4 with respect to energy security (I = -0.32, p = 0.0010) and public health and safety (I = -0.20, p = 0.0404).

It is important when devising a national energy policy that the policy decision-makers are aware of the potential implications of particular policy options and the extent to which energy policy preferences are a reflection of national energy policy interests or regional energy resource development trajectories. The methods demonstrated here allow a more detailed analysis of potential regional variations in energy policy perspectives, both at the aggregate level and at the individual alternative-criterion assessment level. The disaggregation procedure allows the policy analyst to explore the underlying factors contributing to potential dissimilarities at the regional level. In this particular case, the SEA sets the stage from which subsequent, more detailed regional analyses can be tiered.

6.4 Robust Ranking of Alternatives

Notwithstanding the individual differences within and between the various regions and sectors, as reflected by the Cosine Theta and Moran's I calculations, statistically, the aggregate group ranking of energy policy preferences is an accurate reflection of the various sub-group preferences (Table 6.8). All sector-based rankings, for example, are statistically similar to the aggregate group with prob-values ≤ 0.0002. The exception is the NGO sector, with a prob-value of 0.0028, which is still considerably lower than the conventional significance level of $\alpha = 0.05$. The regional sub-groupings are also statistically similar to the aggregate group, with 50 percent of the 'region to group' comparisons having prob-values ≤ 0.0002. Prob-values for the western public and private sectors and the eastern public and private sectors are well below $\alpha = 0.05$, at $p = 0.0102$, 0.0220, 0.0012, and 0.0006 respectively.

Thus far the analysis has focused only on the ordinal ranking of alternatives. This section explores in greater detail the robustness and sensitivity of the group's assessment with respect to inconsistencies (CRs), within group conflicts (costheta) and uncertainties in the factor weights. The procedure for generating an interval ranking of alternatives is described, and the preferred energy policy alternative(s) for the group and various regional and sectoral sub-groupings are presented. This is followed by a sensitivity analysis of the aggregate group's assessment.

Table 6.8. Moran's I for the aggregate group and regional and sectoral sub-groupings.

	Aggregate Group			Aggregate Group	
Regional Divisions	**I**	**Prob-values**	**Sector Divisions**	**I**	**Prob-values**
Western region	0.59	0.0000	Private sector	0.44	0.0000
Central region	0.49	0.0000	Public sector	0.48	0.0000
Eastern region	0.41	0.0002	Federal government	0.40	0.0002
Western public sector	0.27	0.0102	Provincial government	0.43	0.0002
Western private sector	0.24	0.0220	Industry	0.51	0.0000
Central public sector	0.49	0.0000	Consultants	0.39	0.0002
Central private sector	0.42	0.0002	NGOs	0.31	0.0028
Eastern public sector	0.35	0.0012			
Eastern private sector	0.36	0.0006			

6.4.1Concordance Analysis

Similar to Saaty's analytical hierarchy process, concordance analysis compares the preference for alternative i to i', for a particular criterion j. An advantage of the concordance approach, however, is that it directly accounts for tied sets of assessment scores, and allows a measure of the degree to which the ranking of alternatives represents the paired comparison data. Massam (1985) and Voogd (1983) explain that the information in a concordance analysis can be summarized as three sets:

i) the concordance set $C_{(ii')}$: plan i is strictly superior to plan i', with respect to j.

ii) the disconcordance set $D_{(ii')}$: plan i is strictly inferior to plan i', with respect to j.

iii) the tie set $T_{(ii')}$: plan i is equal to plan i', with respect to j.

Using Equation 6.3, concordance indices for the median group responses from Delphi Round III and the median criterion weights derived from Delphi Round II were calculated. The summary results are presented in Table 6.9. By summing the rows of the concordance matrix a ranking of alternatives can be derived. This ranking, A3>A1>A5>A2>A4, confirms the AHP ranking derived in Section 6.2.1.

(Equation 6.3) $c_{ii'} = \left(\sum_{j \in C(ii')} W_j + \frac{1}{2} \sum_{j \in T(ii')} W_j \right) / \left(\sum_{j=1}^{n} W_j \right)$

Table 6.9. Weighted group concordance matrix.

	A1	A2	A3	A4	A5	Row Sum
A1		0.673	0.369	0.889	0.733	2.665
A2	0.327		0.000	0.731	0.509	1.567
A3	0.631	1.000		0.808	0.808	3.247
A4	0.111	0.269	0.192		0.040	0.611
A5	0.267	0.491	0.192	0.960		1.905

In order to examine the extent to which the ordering of alternatives derived from the concordance matrix agrees with the paired comparison information contained within the matrix itself, an index of similarity can be calculated (Equation 6.4) (Massam, 1985; Massam and Wolfe, 1978).

(Equation 6.4) $S = d / [n(n-1)/2]$

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

Massam (1985) explains that in concordance matrix $C_{ii'}$, when $i > i'$ from the ranked order of alternatives, then if $C_{ii'} > 0.5$, a value of 1.0 is assigned to the paired comparison, and if $C_{ii'} < 0.5$, a value of 0 is assigned. When $S = 1.0$, perfect similarity exists. In other words, the ranked order is a perfect representation of the information contained in the concordance matrix. There are 10 comparisons in the rank order of alternatives derived from *A3>A1>A5>A2>A4*. These include: (A3>A1), (A3>A5), (A3>A2), (A3>A4), (A1>A5), (A1>A2), (A1>A4), (A3>A2), (A3>A4), and (A2>A4). From these comparisons, the index of similarity (S = 0.90) indicates a strong similarity between the overall ranking and the individual paired comparisons in the assessment matrix.

6.4.2 Matrix Scaling

An interval ranking of energy policy alternatives can be derived by scaling the concordance matrix. (Massam, 1985). Borg and Groenen (1997: 3-13) outline four purposes of scaling: (i) to represent dissimilarities between alternatives as distances for visual interpretation and comparison; (ii) to test if and how certain criteria by which an individual can distinguish among alternatives are mirrored in the empirical differences of these alternatives; (iii) to allow one to explore the dimensions that underlie judgements of dissimilarity between alternatives, and; (iv) to explain judgements of dissimilarity in terms of a distance function. The purpose of scaling in SEA matrices is to visually represent the group's decision space with respect to alternative preferences and to allow comparison of strategic decision outcomes across various sub-groups.

Voogd (1983: 157) notes that "the appealing feature of scaling models…in evaluation is the capability to treat qualitative information in a theoretically consistent way…without violating the nature of the measurement scales on which this information has been assessed." Massam (1985) and Massam and Wolfe (1978), for example, applied multi-dimensional scaling techniques to address transportation planning issues. Data from concordance matrices were re-scaled into a dissimilarity matrix to derive the two-dimensional distance between transportation decision alternatives. This particular approach, however, while suitable for many forms of MCE problems, is questionable when there is only *one* dimension to the data (i.e. a single order of preferences from best to worst).

In this particular case study, each energy policy option consists of combinations of energy alternatives, but the overall assessment objective is to determine the one-dimensional solution. While each alternative does consist of energy mixes that are comparable on a second dimension, the overall order of preference of policy options is a one-dimensional problem. By scaling the concordance matrix with a standardization score (Equation 6.5), a set of values is derived which represents measures of the distance between pairs of alternatives such that the weight of the absolute preferred alternative is '1' and the least preferred alternative is '0' (Voogd, 1983: 78). Given that the concordance data are derived based on paired comparison data, and the assessment scores are relative on an interval scale, the distance between alternatives can be measured and, furthermore, since all matrices are scaled using a standardization score, relative preferences between various sub-groups within the data set can be explored.

(Equation 6.5) standardized scaling parameter $i = (i - i_{min}) / (i_{max} - i_{min})$

Where: i = value of cell ii' of matrix I
i_{min} = minimum i of matrix I
i_{max} = maximum i of matrix I

While scaling the concordance matrix does result in the loss of some information, it does preserve the order of the rankings, and generates a measure of the magnitude of the difference between pairs of alternatives. This concordance and scaling procedure was followed for each of the five sub-sectors and three regional divisions. The one-dimensional decision map representing the interval order of energy policy preferences and

BPEOs for each sub-group is presented in Figure 6.12a,b. At the sector disaggregate level, the orders of preferences for energy policy alternatives are similar, with the exception of the NGOs, but the magnitude of the relative preferences (i.e. the distance between alternatives) varies across sectors. For example, the provincial government's ranking of A3>A1 at a distance (0.452) is nearly three times that of the federal government sector's ranking of A3>A1, suggesting a very distinct and strong preference (A3>>A1) amongst provincial government decision-makers for the renewables option with respect to the status quo. Additionally, the federal government ranks alternative A2, the second least preferred alternative, at a distance of 0.725 units from alternative A4, which is clearly defined as the least preferred alternative (A4<<A2). However, there is much less distinction between alternatives A2, A5 and A1, which are at distances of only 0.275, 0.24, and 0.16 units respectively from the preferred, strategic alternative A3. Similarly, at the regional level, the preference for alternative A5 over A2 is clearly defined by the eastern region, with a distance of 0.250, whereas for the central region this distinction is less clear with A2 indifferent to A5 (A2 *I* A5) at a distance of only 0.052.

The advantage of the proposed methodology is that it provides a means by which the relative preference for each alternative within the group's assessment outcome, and the relative preferences across regions and sectors, can be explored. This may be of particular importance when examining the effects of external forces, such as the changing price of oil, the discovery of new oil fields, or the signing of international environmental protocols, on the preferred strategic policy and the overall order of policy preferences.

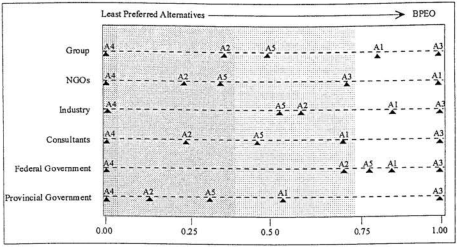

Figure 6.12a. Energy policy preferences by sector.

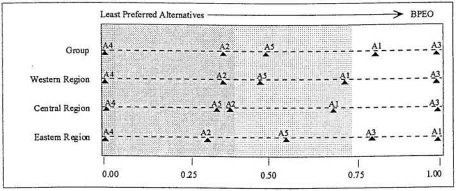

Figure 6.12b. Energy policy preferences by region.

6.4.5 Sensitivity Analysis

As discussed previously, the group's ranking of energy policy alternatives provides an accurate statistical representation of the various regional and sectoral perspectives. In order to determine the robustness of the order of the group's energy policy preferences, a sensitivity analysis can be performed. There are three key sensitivity issues to address in this research, notably the sensitivity of the output with respect to (i) inconsistencies in the assessment of alternatives, (ii) disagreements within the assessment group, and (iii) uncertainties in the assignment of criterion weights.

In terms of inconsistencies and disagreements, the sensitivity of the group's output can be examined by comparing the rankings of the assessment panel to the rankings derived with CR > 0.10 and costheta < 0.80 filtered from the assessment data. Through concordance and scaling analyses, Figure 6.13 illustrates that the group's ranking of energy policy alternatives is *not* sensitive to minor inconsistencies or disagreements within the data set. For example, the distance (i.e. preference) between A3 and A1 decreases by only 11 percent when inconsistent individuals are removed from the data set. When potentially conflicting individuals are excluded (costheta < 0.80), the distance between A3 and A1 (i.e. preference for A3>A1) increases by only 4 percent while the preference for A2 over A4 increases by only three percent. The aggregate order of preferences remains unchanged.

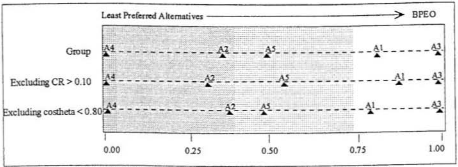

Figure 6.13. Sensitivity analysis of group's preferences to inconsistencies and disagreements.

Concerning criterion uncertainty, the preferred method of sensitivity analysis is to make minor adjustments to the criterion weights and examine the effect on the relative distance between policy alternatives. Uncertainty abounds in impact assessment, particularly when dealing with 'higher-order' assessment issues. Malczewski (1999) explains that uncertainty in criterion weighting is perhaps the most significant type of uncertainty to be explored in multi-criteria analysis, as criterion weights are subjective numbers about which decision-makers often disagree. By altering the values of criterion weights, the sensitivity of the ranking with respect to decision uncertainty can be evaluated.

For assessments with relatively large numbers of alternatives (e.g. more than 10), however, this can be a time-consuming exercise. Using a modification of Voogd's (1983) 'thresholding' approach, the particular alternatives at which to target the sensitivity analysis can be determined. By ordering the disconcordant pairs ($D_{ii'}$) in the concordance matrix in descending order and projecting onto a graph of paired comparisons, the threshold pair which separates the preferred alternatives from the least desirable ones can be identified (Fig 6.14). An examination of the concordance and AHP matrices indicates that A5 and A2 are similar in their assessment scores and, therefore, good indicators of the sensitivity of the ranking.

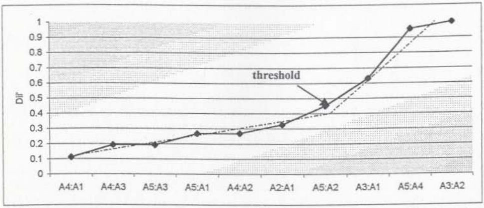

Figure 6.14. Threshold value for paired comparisons (relative distances) of energy policy alternatives.

Using A5:A2 as the threshold pair, the sensitivity of the ranking is examined. Figure 6.15 summarizes the sensitivity results for six different alterations in criterion weights. Attention was focused primarily on the environmental factors (C1-C4) and public health and safety (C9), as these factors were assigned the greatest weight in the impact significance matrix. The 95 percent confidence intervals of the median weights for criteria C1-C4 and C9 were determined, and the median percentage change between the upper and lower limits of the confidence intervals used as the basis for the sensitivity analysis (Table 6.10). In the first case, environmental factors C1-C4 and the public health and safety factor (C9) were each assigned a 25 percent increase in criterion weights, followed by a 25 percent decrease. As illustrated in Figure 6.15, the distance between the least preferred alternative (A4) and alternatives A5, the natural gas and refined petroleum option, and A1, the status quo, increases only slightly with a 25 percent increase in the weights of C1-C4 and C9. Alternative A2, which involves increases in nuclear energy as a major source of electrical generation, remains relatively unchanged when the weights of C1-C4 and C9 are increased by 25 percent. With a 25 percent decrease in the weights of the environmental factors C1-C4 and public health and safety (C9), preference for the nuclear option (A2) increases slightly by six percent with all else constant. A 50 percent change in the weights of criteria C1-C4 and C9 produces similar results, with the overall order of energy policy preferences remaining relatively unchanged.

Table 6.10. Sensitivity values as percentage change between the upper and lower 95 percent confidence limits for the median criteria weights.

	% change (95% confidence interval)	
Environmental factors		
C1	4%	median 25%
C2	20%	
C3	31%	
C4	30%	
Public health and safety		
C9	25%	

The sensitivity of the group's assessment to a 48 percent increase[12] in the economic criteria (C5 and C6), however, results in a 37 percent decrease in the status quo and a 60 percent increase in the natural gas and petroleum option, such that alternative A5 is now the second most preferred alternative with A2 and A4 ranked equally as the least preferred

[12] A '48 percent increase' is based on the percentage difference between the upper and lower 95 percent confidence limits for the median criteria weights for C5 and C6.

alternatives. The renewables option, alternative A3, remains the BPEO. Assuming only a 24 percent range of tolerable error in the assignment economic criteria weights, the overall order of energy policy preferences remains unchanged from that of the group's unadjusted ranking of alternatives.

Based on this analysis, it can be concluded that minor uncertainties (i.e. an approximate 25 percent range of tolerance) in the estimation of criterion weights appear to be insignificant with regard to the BPEO and the group's overall ranking of energy policy alternatives. Even when allowing for some minor degree of uncertainty in the assessment process, A3 consistently remains the 'best practicable environmental option' and A4 the least preferred energy policy alternative. The broader policy implications of these finding with respect to the SEA methodology are discussed in Chapter Seven, Section 7.2.2.

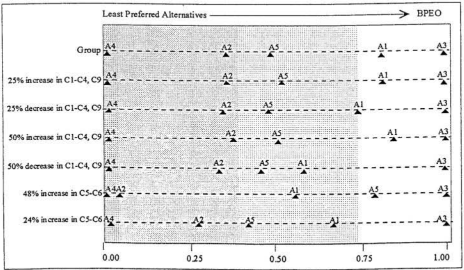

Figure 6.15. Sensitivity analysis of group's preferences to uncertainties in impact assessment.

6.5. SUMMARY OF RESULTS

The output of an SEA does not present the decision itself but rather the systematic evaluation of PPP alternatives such that the final decision-maker or decision-making agency can make an informed choice. In the context of this particular case study application, the assessment panel identified energy policy alternative A3, which emphasizes an increase in renewable energies, as the best practicable environmental option to guide energy policy development. The sensitivity analysis confirms that the group's ranking is robust with respect to minor uncertainties in the assessment process, minor inconsistencies in decision-making, and minor disagreements within the assessment group. Regional and sectoral rankings confirm that of the assessment panel, with the exception of NGOs and the eastern region. Both the NGO sector and the eastern region demonstrate a clear preference for A1, the status quo, but perhaps for different reasons. In the words of one NGO panellist, for example:

> Based on the given options, the status quo is the preferred one. While A3 attempts to introduce renewable energies, much more emphasis is needed if we are to become serious about environmental protection. It's not that the current situation is a good one…but is the best of the bunch….what is needed is a rethink of our options.

Whereas a panellist from Canada's eastern industrial sector suggested that:

> Increased hydroelectric development and offshore exploration…are key to meeting future energy needs and…there is unlikely to be much change from this trend given the vast amount of unexploited energy resources. Reducing emissions is clearly important, but this will be best achieved through…energy efficiency programs. I do not think that renewable energies will be able to meet energy demands.

When real-world energy policy decisions are about to be taken, it is important that the decision analyst explores potential areas of disagreement and identifies, where appropriate, the nature of such disagreements in order to identify potential areas of policy debate or future research or educational initiatives. The purpose of this chapter, however, was to illustrate SEA methodology through a case study application. Emphasis was placed on the assessment process; the case study results, while interesting, were secondary. A variety of methods and techniques were demonstrated, illustrating the need for good-practice SEA frameworks to be adaptive to the particular methodological requirements of each assessment situation. The following Chapter explores the lessons learned and issues raised from this research within the broader SEA and planning processes, as well as the policy implications of the proposed methodology.

Chapter Seven

Lessons Learned and Issues Raised

7.1 Introduction

The focus of this research is the development of an appropriate methodological framework for SEA application and, more specifically, the *process* of strategic impact 'assessment.' An SEA framework was proposed, and its application demonstrated through a case study assessment of Canadian energy policy alternatives. This chapter highlights a number of ongoing issues and offers a number of recommendations regarding 'good-practice' SEA methodology that have been identified in this thesis. The potential policy implications and the lessons learned from the SEA application are discussed, including the need for a strategic focus, a structured assessment process, an adaptive assessment framework, and a pragmatic methodology. This is followed by a discussion of potential methodological and policy issues that have emerged from this research, particularly issues concerning the identification of PPP alternatives and assessment criteria, the subjectivity inherent in 'higher-order' environmental assessment and decision-making, integrationary SEA, and the institutional requirements for SEA systems. This chapter concludes by outlining potential directions for future SEA research.

7.2. Lessons Learned

7.2.1 Strategic Focus

This thesis commenced by introducing the concept of a *strategic* environmental assessment. The nature of SEA was discussed and the characteristics of SEA that make it strategic and therefore different from other types of environmental assessment and appraisal were introduced. While there still exists considerable debate as to the nature of strategic environmental assessment, a number of common principles and characteristics emerge from the literature. It was argued at the outset that 'higher-order' assessments must reflect these basic principles and characteristics if they are to be labeled as strategic assessments. There are a number of 'higher-order' environmental assessment and planning frameworks presented in the literature, and a wide range of demonstrated applications. However, as illustrated in Table 2.2, not all assessments that carry the label 'strategic' are in fact strategic environmental assessments. Many [author-proclaimed] SEAs are no more than policy reviews (e.g. NAFTA SEA) or area-wide project assessments (e.g. Neiafu Master Plan SEA).

SEA is an 'objectives-led' assessment. The emphasis of SEA is on identifying an appropriate 'strategy for action', through the systematic evaluation of alternative options, rather than option alternatives, in order to select at an early stage the alternative(s) that poses the least damage, or most benefit to the environment. A strategic assessment framework serves to identify a strategy for action from which PPP decisions can be made and subsequent assessments can be tiered. The means by which a 'strategy for action' is determined, however, is often *ad hoc* and inconsistent at best, with no systematic evaluation of decision alternatives. The result, as illustrated in the Czech Republic energy policy SEA (Machac *et al*, 2000), is that SEA often falls short of its strategic objective.

The objective of the SEA framework, as demonstrated through the case study, is to arrive at the best practicable environmental option(s) within the context of particular goals, objectives, factors and constraints, in this case to guide the development of Canadian energy policy. A variety of energy policy alternatives were assessed, and the potential impacts of each alternative were evaluated and the alternatives compared, in order to systematically identify the energy policy option(s) that best meets specified goals and objectives while minimizing potential negative environmental effects. As previously discussed, the SEA methodology does not generate 'the answer'; rather it presents the systematic evaluation of policy alternatives. The case study application identified alternative A3, the renewables option, as the best practicable environmental option to guide energy policy development. This information provides the decision-maker(s) with a basis for action. However, it is important in real-world applications that there be a feedback mechanism to confirm with the SEA participants the strategic outcome, and what this outcome might imply for policy action. In this regard SEA sets the stage for policy analysis and debate.

7.2.2 Structured Assessment Process

Similar to project-level EIA, SEA requires a structured methodological framework. A fundamental problem with the development of recent SEA methodologies and recent SEA applications is the lack of 'repeatability' or verification of results. A structured framework is required in order to ensure that SEA maintains its strategic focus (Table 2.1), and to facilitate an accountable and replicable assessment process. A structured SEA methodology is supported by Wiseman (2000), who found that amongst the primary problems encountered in SEA application in South Africa is the lack of a structured SEA framework, and by Davey (1999), who suggests that one of the main reasons for the absence of legislative SEA frameworks in Canada is the lack of common SEA understanding and appropriate assessment methodologies. Partidario and Clark (2000: 8) agree, suggesting that "SEA, being an environmental assessment process, can only be effective if a consistent and systematic approach is in place."

While a structured SEA framework does not make the assessment process 'more objective', it does allow the break down of the basic rationality of the SEA problem, thereby providing a more systematic, accountable and replicable assessment process. Increasing the rationality of the assessment process, however, should not be confused with rational decision-making. A decision is considered rational if the process leading to it is based on perfect insight into the consequences of alternatives, the correct alternatives have been identified, and the selection follows the logic of choosing the alternative that is expected to unequivocally best achieve specific goals or objectives (Kornov and Thissen, 2000; Mitchell, 1997). The notion of a rational decision is straight-forward in well-structured situations in which there is ample base-line data and only a single class of assessment criteria. As illustrated in the case study application, however, SEA typically involves the assessment of alternatives against multiple environmental, economic and social criteria simultaneously. In addition, given the general nature of 'higher-order' environmental assessment, it is possible that an alternative course of action be preferable to those under consideration (although, not necessarily feasible). Thus, no choice between PPP alternatives can be said unequivocally to be the best and therefore rational (Radford, 1989).

A rational SEA process, on the other hand, is simply one that is based on the systematic and replicable evaluation of strategic alternatives. Smith and May (1980), for example, make note of the "artificial debate between rationalist and incrementalist models", in that even Lindblom's (1974) incremental approach follows a rational process as incremental decisions are made only as new information is gained. While individual decisions made at incremental points in time may not be rational *per se*, the assessment process itself should be rationalized (i.e. structured) if SEA is to systematically evaluate alternatives in a way that maintains its strategic focus and, ultimately, is accountable in the PPP decision-making process.

The SEA case study of Canadian energy policy serves to illustrate how subjective decisions can be rationalized in a systematic assessment framework. The assessment of the potential environmental implications of energy policy alternatives, for example, is subjective due to differences in panellist's experience, expertise, values, and personal or political preferences. Such decisions themselves are certainly not characterized as rational, as they are made without the advantage of a comprehensive set of baseline data, are based on uncertain energy futures and perhaps even an incomplete set of policy alternatives and assessment criteria, and are made by assessment panellists perhaps without a complete knowledge or understanding of all issues presented. This does not mean, however, that the assessment process itself should be subjective or should proceed in a relaxed or *ad hoc* fashion.

Partidario and Clark (2000: 8) argue that "given the varied planning systems that exist in the world, any attempts to rationalize SEA into highly contained perspectives, that only fit into some decision-making frameworks, is not helpful. Such dogmatic approaches limit the potential to influence decision-making." While the author agrees that SEA methodology should not be a 'straitjacket', some structure is required in the assessment process if SEA is to advance in acceptance and application. The fact that real-word PPP decisions do not appear to be characterized as rational does not mean that SEA methodology should not aim at increasing the 'rationality' of the assessment process. Rationalizing the SEA process within a structured, multi-criteria, methodological framework does not limit SEA application to particular types of problems or planning processes, rather it facilitates more widespread understanding and consistency in application, and ensures that applications at different tiers of decision-making and within different socio-political contexts reflect the underlying principles of a strategic assessment[12].

The output of an SEA application must be robust, accountable, and replicable, as it forms the basis from which subsequent assessments are tiered and PPP decisions are taken. This can be accomplished by formulating SEA as a structured and systematic assessment process commencing with scoping the SEA problem, followed by identifying the PPP alternatives, scoping the assessment components, evaluating the potential impacts, determining impact significance, comparing the alternatives, and, finally, identifying the best practicable environmental option – should one be identifiable.

A replicable assessment process allows the SEA analyst to examine the stability of the assessment results over time with respect to changing political, economic, social, technological, and resource environments. For example, by introducing new assessment criteria, or by adjusting the weights of existing assessment criteria, the SEA analyst can examine the potential effects of the changing price of oil or the development of new emission-reducing energy technologies on the overall order of energy policy preferences. The long-term robustness of the strategic decision can then be evaluated by analysing the

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[12] While the notions of rationality and rational decision-making beg a much larger issue concerning decision models in economic geography and the underlying nature of the decision process, such a discussion is not within the immediate scope of this thesis.

sensitivity of the ranking to adjustments in criteria weights and the introduction of new assessment criteria and constraints. An advantage of a structured assessment framework allows the repeatability of results and an examination of the sensitivity of the proposed policy action to changing environments.

7.2.3 Adaptive Framework

Enhancing SEA effectiveness requires that SEA be set within the context of an overarching, structured methodological framework, for which a variety of methods, techniques and adaptations are available. The dilemma is how to remain clear on the structure of SEA while at the same time allowing for enough flexibility to address a variety of PPP issues and at different tiers of decision-making. This requires an adaptive assessment framework.

Verheem and Tonk (2000: 177) argue for specific design for specific use to increase the effectiveness of SEA. Brown and Therivel (2000: 184) agree, in that the "techniques…for implementing SEA need to be tailored closely to the particular circumstances of the PPP under consideration." No one set of SEA methods and techniques will apply to all strategic actions in all assessment contexts, but rather we must think in terms of an array of SEA methods and techniques from which the appropriate ones can be selected to meet the needs of the particular circumstance.

SEA problems are essentially multi-criteria problems and thus require a multi-criteria approach to problem-solving. A multi-criteria problem arises when a decision-making process involves the simultaneous evaluation of multiple decision alternatives within the context of various assessment criteria. Thus, there is no single set of methods and techniques than can do all that is required in every PPP situation to address SEA problems. It is often the case that assessments are based on the qualitative judgements of a group of experts, such as the case study presented in this thesis, whereas other assessments might be based solely on quantitative data and computer-assisted decision-making, such as the SEA of wind farms in the Soest District, Germany (Kelinschmidt and Wagner, 1996)

The particular SEA methods and techniques selected and how they are used in the assessment process depends on the specific situation. It may be argued that the proposed framework is too general to address the environmental implications of each alternative, however, the purpose of a generic framework is to allow for flexibility for the specific issue at hand and to adopt the methods and techniques most appropriate. The SEA framework, unlike EIA frameworks, is not designed to assess the potential environmental effects of a proposed action, rather it is designed to determine the 'best practicable environmental option' for PPPs and alternatives. Thus, different types of SEA and different methods and techniques are required for different tiers of decision-making. Good-practice frameworks must be adaptable to meet these demands.

The case study application demonstrates the ability of the SEA framework to allow the analyst to adopt a variety of methods and techniques including, for example, the policy Delphi for impact data collection, concordance analysis for ranking the energy policy alternatives, and sensitivity analysis for determining the robustness of the assessment outcome. The objective here is not to discuss the advantages and disadvantages of the different assessment methods and techniques used, but rather to highlight the contributions of a few particular methods to the advancement of SEA data analysis and the implications for policy evaluation.

The use of a paired comparison assessment matrix, for example, offers a number of practical improvements over more traditional impact assessment matrices, particularly for higher-order decision-making where data are often of a qualitative nature. Paired comparison assessment matrices allow the SEA analyst to measure the level of consistency in decision-making. This is particularly important as alternatives and assessment criteria become large in number, since policy decisions should (ideally) be formulated on the basis of consistent and non-contradictory SEA results. When conflicts arise in assessment and decision-making (e.g. Table 5.6, Fig. 6.6), the consistency ratio provides the analyst with some insight as to the nature and significance of these conflicts. As illustrated in Figure 6.7, for example, the conflicts apparent in the evaluation of Canadian energy policy alternatives can be linked to only seven assessment panellists, four of which are inconsistent in their impact assessments. This information allows the SEA analyst to gain an overall understanding of the level of consensus amongst SEA decision-makers, and to address the issue of conflicting individuals and explore, where appropriate, the nature of the true (i.e. consistent) conflicting arguments.

Second, the case study demonstrates a number of perhaps 'non-conventional' assessment methods. Moran's Index of spatial autocorrelation and Cosine Theta of proportionate similarities, for example, are not common-place in environmental assessment practice, but such methods are of particular utility at the strategic level. In this particular assessment, as is the case in most all strategic assessments involving the use of an assessment panel, those providing the assessment information, judgements, or assessment scores are typically purposefully selected as SEA participants, and the number of participants involved varies from case to case. More conventional assessment methods that might be used to examine consensus or similarity between various assessment groups, such as Kendall's *Tau* or Pearson's *r*, for example, are suited only to data that are based on random, independent sampling and meet certain sample size requirements. The particular assessment methods demonstrated in this research have widespread SEA applicability, particularly when panellist selection and sample size become important issues in the analysis of the assessment data.

SEA is not constrained by a lack of methods and techniques. However, there is no set of methods and techniques that will do all that is required for SEA in every situation. Good practice SEA frameworks are adaptive to a variety of methods and techniques depending on the particular issue at hand, while at the same time maintaining methodological structure in order to ensure consistency in application. The methods and techniques simply provide the vehicle by which SEA is carried out according to the roadmap provided by the methodological framework.

7.2.4 Pragmatic Methodology

Not only must SEA methodology be adaptive to a variety of methods and techniques, but it must also be "adaptive to the existence of different agendas, actors, discourses, knowledge requirements…and bargaining styles within different…sectors" (Brown and Therivel, 2000: 185). A pragmatic SEA methodology will need to be sensitive to the type of policy, plan, or program under consideration, the time and financial resources available to conduct the SEA, the political sensitivity of the PPP issue, the level of confidentiality required, and the requirements or commitments to public involvement. For example, Article 4, S.1, p.8 of the UN (2001) *Draft Elements for a Protocol on Strategic Environmental Assessment* reads as follows:

> Each party shall…ensure timely and effective public participation…in a manner and to the extent *appropriate*[13] to the type of strategic decision and the procedural stage of the decision-making.

The UN protocol does not require explicit public participation with regard to, for example, national policy SEA, rather that in such circumstances the views of the public are (supposedly) represented implicitly through their members of government. As Verheem and Tonk (2000) explain, an SEA principle should not be that "public participation should be part of SEA" but rather "sufficient information on the views of the public affected is ensured". SEA planners should select the particular requirements of SEA that are practical for a specific PPP process.

Good-practice SEA frameworks must be operational and practical. SEA methodology must be broad enough to encompass assessments that require only very simple procedures, to assessments that require very comprehensive procedures and at large geographic scales (Verheem and Tonk, 2000). The SEA of a national waste management and restoration program (e.g. Webb & Sigal, 1996), for example, will be contextually different than the SEA of regional drinking water management and production plans (e.g. Verheem, 2000). SEA methodology must be broad enough to facilitate both the general and the specific within a single assessment framework.

Clearly the geographic scale and the number of participants involved in the SEA application demonstrated in this particular assessment is not likely to reflect real-world SEA practice. The purpose of such a widespread case study approach to the SEA of

[13] Emphasis added by author.

national energy policy was simply to demonstrate the ability of the SEA framework to address such an issue in this fashion. Using the policy Delphi as a data collection technique, the case study demonstrates the ability of the SEA framework to incorporate a variety of policy actors and sub-actors over a large geographic area. While the Delphi technique is equally applicable at a smaller-scale, involving fewer numbers of SEA panellists, and is particularly useful when anonymity is desired, a more pragmatic approach for smaller scale assessments may be to utilize focus groups as the primary method of data collection, or to follow-up the Delphi application with a series of round tables various perspectives can be explored and differences identified.

The scale of the SEA case study may not be pragmatic in a real policy situation, but there are a number of practical issues that emerge that demonstrate the utility of the assessment. First, the case study application demonstrates a particular set of assessment methods for systematically identifying potential conflicts and dissenting groups. The assessment outcome and final ranking of energy policy alternatives is generally consistent across all sectors, with the exception the NGO sector, which ranks the status quo as the preferred policy alternative. This dissimilarity raises an important question regarding SEA and policy implementation; that is 'what are the underlying factors causing this dissent?'

Using an adaptation of Moran's Index of spatial autocorrelation, the dissenting groups and the nature of such dissent can be identified and explored. Table 6.6, for example, indicates potential disagreements between the NGO sector and the federal government (I = 0.23, p = 0.0226). Plotting Moran's Indices in the decision space for these sectors at the individual alternative-criterion assessment level allows the analyst to identify the precise nature of the variation in overall energy policy preferences. The SEA analysis revealed considerable dissent between the NGOs and the federal government with respect to the status quo (A1) and meeting the objectives of energy security (C7). The federal government expressed considerably less preference (86 percent) for the status quo than did the NGOs, and placed more emphasis on the renewables option (A3) in terms of energy security. However, as illustrated by the comments of one NGO panellists noted in Chapter Six, Section 6.5, it is perhaps not that the NGOs are satisfied with the status quo, but rather that it is the best alternative given the range of options under consideration. This perhaps raises the issue of the need for a rethink of the options and resources available to meet energy security objectives and broader environmental policy and socioeconomic objectives in general. An advantage of the proposed SEA methodology is that it helps to systematically identify the concerns of the particular groups involved in the assessment process, such that additional research efforts or information programs to address these concerns can be initiated.

Second, as the assessment process did not force panellists to reach a (false) consensus on impact assessment, multiple methods (e.g. costheta proportion of similarity, and hierarchical cluster analysis) were demonstrated to identify areas of individual agreement and disagreement on both the SEA output and the individual assessment scores. Cosine theta is an adaptive method applicable in a variety of assessment situations; it is a distribution free statistic and does not depend on sample size. Costheta values were calculated and mapped using scatter plots (Fig. 6.6) and hierarchical cluster analysis (Fig. 6.7) to identify consensus thresholds and conflicting individuals. Based on these measures, it was determined that there was an overall strong consensus (costheta ≥ 0.80) on the aggregate ranking of energy policy alternatives. Several conflicting individuals were identified, as discussed above in Section 7.2.3, and the decision consistency of those individuals explored. This approach provides the SEA analyst with an opportunity to explore the nature of individual conflicts before any final PPP decisions are taken.

Third, using Moran's Index as the basis for comparison between regional perspectives provides the SEA analyst with the means to explore the extent to which the 'best practicable environmental option' is a reflection of true preferences for national energy policy, or a reflection of regional energy resource development initiatives. At the regional level, for example, the eastern region, similar to the NGOs, expressed an overall preference for the status quo alternative. An analysis of the various regional relationships indicated considerable dissent between the eastern public sector and the central public sector (Table 6.7), particularly in terms of the desirability of the status quo (A1) and the natural gas and petroleum alternative (A5) with respect to minimizing atmospheric emissions (A1). Similar dissent is evident between the eastern and western public sectors regarding minimizing the risk to public health and safety. The eastern public sector expressed a clear preference for the status quo, which may, as indicated by the comments of one panellist from Canada's eastern industrial sector (Chapter Six, Section 6.5) simply be a reflection of the economic growth of the oil and gas and hydroelectric industries in the eastern region.

The SEA methodology demonstrated in the case study allows a more detailed analysis of potential regional and sectoral variations in energy policy perspectives, both at the aggregate level and at the individual alternative-criterion assessment level. This provides the information necessary to explore, when necessary, the particular factors contributing to dissent. It is not the role of SEA to examine in detail the implementation issues that surround the BPEO. Whether a national energy policy can be effective with both regional and sectoral dissent is a matter of policy debate. SEA simply sets the stage from which subsequent regional or sectoral analyses, additional research efforts and assessments, or policy debates are tiered.

Finally, the use of assessment matrix concordance and scaling analysis provides an indication of the robustness of the final ranking of energy policy alternatives. This not only indicates the relative preferences for each energy policy option, but also allows some insight as to the implications of assessment uncertainty with respect to the derived policy preference. The analysis concludes, for example, that the group's ranking of energy policy preferences is not sensitive to minor inconsistencies or minor changes in criterion weights. However, as indicated in Chapter 6, Section 6.4.5, the order of energy policy preferences *is* sensitive to a 50 percent increase in the importance of the economic criteria, although alternative A3 remains consistently the BPEO. Such information allows the *policy* analyst to examination of the potential effects of changing energy environments on the strategic policy option.

"How the SEA process in a specific situation should be designed…is then dependent on its intended purpose, the level of decision-making and the traditional/cultural decision-making context" (Verheem and Tonk, 2000: 178). While the overall structure of SEA must remain consistent, the most effective form of the assessment process should be chosen according to the context within which it must operate. Notwithstanding the particular adaptation of the SEA process to meet particular decision-making and PPP contexts, SEA applications should still conform to an overarching methodological framework in order to ensure accountability in the assessment process and consistency in application. The scale of the assessment might change, as well as the assessment methods and techniques employed, but a structured framework for SEA implementation maintains methodological consistency. Thus, the nature of SEA methodology for a community waste-recycling program or an international climate change policy, for example, is consistent. The means by which the ends are achieved, that is the particular methods and techniques employed, and the scale at which the SEA is implemented will vary from case to case. However, a generic assessment framework is flexible to all situations and at all levels of PPP decision-making. A pragmatic approach involves structure in methodology, but flexibility in application.

7.3 Issues Raised

7.3.1 Identifying PPP Alternatives

> I am disappointed with the range of alternatives presented. Only one alternative gives any reasonable consideration to the role of renewable energies. Since I cannot support any of the proposed alternatives I am withdrawing from this exercise (SEA panellist).

Much has been written in the business management and planning literature regarding the identification of strategic PPP alternatives. As discussed previously, Bartlett (2001), for example, emphasizes a soft systems approach involving small group scoping exercises in the Kembla Grange, New South Wales, Australia, sustainability assessment. Similarly, Asplund and Rydevik's (1996) review of comprehensive land-use planning in Sweden illustrates the use of brainstorming sessions with local planners and consultants to identify plan alternatives. As emphasized throughout, the particular focus of this research is the assessment process of SEA. The case study application, therefore, 'jumped in' part way through the proposed SEA framework, with little attention to the formulation of PPP alternatives. Assessment alternatives in this case were pre-determined, borrowed from NRCan's ETF project and based on NEB energy supply and demand forecasts. The results of the case study application, however, raise a number of important issues regarding the identification and formulation of PPP alternatives in the SEA process.

First, there is the issue of participative democracy in the identification of PPP alternatives. Who should be involved and who wants to be involved in the formulation of the alternatives that will be incorporated into the assessment process? There is some argument that perhaps for more local SEA issues, such as municipal planning, that local interest groups and the general public should play a greater role in the identification of potential PPP alternatives. These views may be incorporated, for example, through a series of public forums or open houses. For more technical or larger-scale policy issues, a panel of experts, consultants, or special interest groups may identify the PPP alternatives.

While such issues are outside the scope of this particular research, it is important that the assessment alternatives are representative, to a degree, of various interests, perspectives, and opportunities present. Those who participate in the assessment process, for example, may indeed be separate from those who develop the PPP alternatives but, ideally, there must be agreement with respect to the range of alternatives presented. If the SEA decision-makers are dissatisfied with the range of alternatives, then the default alternative, the status quo, may prevail. This does not indicate that the status quo is the preferred strategic option, rather it is the preferred alternative amongst those presented. Perhaps the appropriate direction in such a case might be to reconsider the range of alternatives presented. Following the Round I assessment, for example, one panellist replied:

> My continued participation in this study does not reflect my personal preference for the direction of Canada's energy future, as I do not feel that any of the alternatives presented are the preferred ones.

Second, and closely related to the previous issue, is the nature of the PPP alternatives. The question to consider is 'should the PPP alternatives consist of only those that are technologically and institutionally feasible, or should a wider range of more 'goal-oriented' alternatives be considered?' For SEAs designed to address more immediate PPP problems, the strategic alternatives must certainly be operational. However, for longer-term policy and planning issues, such as identifying a strategic direction for potential energy policy development, perhaps the alternatives under consideration can be more wide-ranging and include options that require technological advancement and institutional change. Given the futuristic perspective of the SEA application demonstrated in the case study, a wider range of energy policy strategies might have been considered, rather than focusing solely on those that are considered likely or feasible given current circumstances. The problem, however, is that when using an assessment panel to identify the potential environmental implications of each alternative, the number of alternatives that can feasibly be considered is limited. This is also the case for assessments that are constrained by either time or financial resources or both.

There has been considerable attention directed towards such issues in the literature, however, more research on how PPP alternatives are developed and the implications posed for SEA is needed. Some higher-order questions that require attention in the broader development of SEA methodology include: Are different methods for the development of PPP alternatives required for different tiers of decision-making? Are there certain approaches that work best under particular situations?

7.3.2 Identifying Assessment Criteria and Assigning Criteria Weights

> The range of criteria presented does not consider…the potential impacts of energy development on archaeological and heritage resources (SEA panellist).

There has been much written in the multi-criteria evaluation literature with regard to the identification and selection of assessment criteria (e.g. Vickers, 1973; Keeny and Raiffa, 1976). Voogd (1983), however, suggests that there is no formal process that is best for the identification of decision criteria in MCE problems. The goal is simply to ensure that all relevant aspects of the choice problem are considered.

The process of identifying the appropriate assessment criteria in an SEA is similar to that of identifying the alternatives. Criteria can be borrowed from other, similar assessments, or derived from existing policies, plans or white papers. The Dutch Waste Management Council's SEA of a ten year program on waste management, for example, based their assessment criteria on the issues and indicators mentioned in the Dutch National Environmental Policy Program. (Verheem, 1996). Similarly, the SEA of Trans-European transport networks (Dom, 1993) included a set of assessment criteria based on the environmental issues identified as being of 'community interest' in the CEC's (1992) *Green Paper on Transport*.

In this particular case study, an initial list of assessment criteria was derived from previously stated NRCan and NEB energy policy goals and objectives. However, as illustrated by the panellist's comment at the beginning of this section, the initial list of factors was not comprehensive with respect to all of the valued system components that panellists felt should be included in the evaluation. Thus, all panellists were asked to identify any additional factors and criteria that they felt necessary to consider in the evaluation of energy policy alternatives.

Other approaches to criteria selection for more regional- or local-oriented SEAs might include, for example, the use of 'town hall meetings' or focus groups to identify those valued system components that are considered important in the local context of the strategic problem(s). For more technical issues, such as the SEA of wind farms in the Soest District of Germany (Kleinschmidt and Wagner, 1993), the assignment of criteria weights might be best left to those with a greater understanding of the technical issues and constraints involved, as well as existing PPP requirements. Alternatively, for SEAs that are more general and 'sustainability led', a generic list of assessment criteria might be used, such as Gibson's (2001) list of sustainability criteria prepared for the Canadian Environmental Assessment Agency. There is no single approach to the identification and development of assessment criteria for SEA. The types of criteria included in the assessment simply depend on the nature and objectives of the assessment issue(s) at hand. Who determines the significance of these criteria, however, is a key issue.

The selection of criteria weights is perhaps the most dynamic part of SEA decision-making, as the composition of the panel assigning those weights is important to determining the outcome of the SEA. An assessment panel comprised entirely of oil and gas industry representatives, for example, may derive a considerably different weighting scheme for energy policy assessment than a panel comprised entirely of environmentalists. The objective is to ensure an appropriate mix of panellists given the particular strategic issue(s) at hand, and to examine the effects of panel composition on the strategic outcome. For example, prior to aggregating the weights assigned to each assessment criterion in the case study, regional and sectoral sub-groups were examined for similarity in the distribution of weights about the 95 percent confidence interval for the median. Further disaggregation of the assessment results in Section 6.3 confirm any significant differences in criteria weighting which may exist amongst sectors and regional sub-groupings.

As already noted, there is considerable debate in the literature about the issue of consensus in group decision-making processes (e.g Woudenberg, 1991; Schebie, 1975; Dalkey, 1972). On the one hand, Huylenbroeck and Coppens's (1995), for example, in their evaluation of land-use alternative in Scotland, asked each sub-group involved in the decision-making process to find a consensus on their decision weights. On the other hand, as illustrated in this particular case study of Canadian energy policy alternatives, panellists were *not* asked to find consensus on the distribution of criteria weights, rather the issue was one of consistency. Criterion weights are subjective numbers about which decision-makers often disagree. Forcing panellists to agree on those weights, no matter what the panel composition, may result in a false consensus. The issue is to draw out differences of opinion, rather than subdue them under data aggregation, such that they can be further explored before policy decisions are taken.

7.3.3 Subjectivity

A structured and systematic assessment process does not ensure more objective assessment decisions. The environmental assessment literature (e.g. Weston, 2000; Kennedy, 1988) recognizes the subjective nature of the environmental assessment process, this not unique to SEA. As noted by Therivel *et al.* (1992), impact predictions at the strategic level may not be as specific as for project-level EIA.

There are at least two key issues of subjectivity in higher-order environmental assessments that are evident in this case study. First there is the issue of panel composition and how the 'experts' are identified. Sackman (1975) notes that careful selection of the assessment panel is important to the quality of the results. However, there is no established method for panel selection that is best suited for all situations. In the case study example potential panellists were selected using a non-probability, snowball sampling procedure where panellists were asked to self-define their area of expertise. There is a danger in relying too much on the 'expert' opinion, particularly when dealing with broad policy-level issues. In order to address the potential subjectivity that may arise when emphasis is placed on the 'expert' opinion, the expert's judgments were tested at the 95 percent confidence interval for the median against the non-expert's responses. As illustrated in Chapter Five, Table 5.7, there is no significant difference between the expert's and non-expert's assessment of energy policy alternatives.

Second, there is the issue of subjectivity in the impact assessment process. The case study demonstrates how the SEA analyst can address subjectivity in impact assessment, particularly subjectivity due to intentionally flawed responses, by examining the consistency ratios of each individual's assessment decisions. Subjectivity at the strategic level is unavoidable when the assessment relies on the values, judgments, expertise and experience of a panel of SEA decision-makers. The objective is to rationalize the assessment process such that even though the decisions themselves may be subjective, the final decision outcome is derived based on a rational, objective assessment process.

The SEA outcome is not unequivocally best, but is regarded as best under the conditions which subjective decisions are made. David Harvey perhaps summarizes this best in *The Urbanization of Capital*, in suggesting that fusing the technical understanding of a multi-criteria problem with the values and attitudes of the decision-makers "...produces a complex mix within the planning fraternity of capacity to understand and to intervene in a realistic and advantageous way and capacity to repress, co-opt and integrate in a way that appears justifiable and legitimate" (Harvey, 1985: 178).

7.3.4 Integration

Sheate *et al.* (2001: 77) suggest that 'integrationary' SEA is the optimum form of SEA. The effects of PPP decisions are almost always multidisciplinary and involve multiple levels of interests, ranging from political decision-makers to disciplinary specialists (Jones and Greig, 1985). The Council of Science and Technology Advisors (CSTA), an independent council established to provide the Canadian federal Cabinet Committee on Economic Union with advice on federal government science and technology issues that require strategic attention, note the importance of an interdisciplinary and interdepartmental approach to scientific research. In the CSTA (1999) report on *Science Advice for Government Effectiveness*, the council emphasizes an integrated, cross-disciplinary approach, enabling decision-makers and experts to identify and address horizontal issues, and to appreciate where, and in what form, their information is useful to others. The Canadian Government Policy Research Initiative's *Sustainability Project* (PRI, 1999) similarly reflects the growing awareness of the importance of ensuring that PPP development is based on horizontal research.

"Integration has become a favored means of increasing the effectiveness of environmental assessment..." (Kirkpatrick and Lee, 1999). Bell (2000) suggests the need for new types of collaboration within government and beyond, as no single institution has the competence, or resources to tackle horizontal meta-problems above the project level. The case study developed in this thesis attempts to illustrate an integrated approach to PPP assessment at the strategic level. A variety of interests, experts and policy actors and sub-actors were incorporated into the assessment and decision-making process. However, while increased integration and improved communications among agencies is required for improved policy decision-making, the means by which such a range of perspectives and expertise can be incorporated into the actual SEA process while maintaining a pragmatic approach to impact assessment remains to be addressed. How much integration is required for different tiers of assessment and at what stage of the SEA process does such integration become important?

7.3.5 Institutional Requirements

The institutional requirements for SEA were not the focus of attention of this thesis, important though they are. More attention needs to be directed towards the political and administrative barriers to formal SEA. Without the appropriate political and legal triggers for SEA, and without the necessary institutional capacity for its implementation, even the most effective SEA methodologies will have little significance for PPP processes. Section 1.0 of the Canadian *Cabinet Directive* on SEA (CEAA, 1999) requires, for example, that a SEA be undertaken (only) when:

1. a proposal is submitted to a individual Minister or Cabinet for approval and;
2. the implementation of the proposal may result in important environmental effects.

A SEA is not required for PPPs and alternatives that do not meet these requirements, such as the strategic assessment of alternative options to guide the development of energy policy.

Buckley (2000) suggests a non-exclusive list of government instruments to which SEA should apply, including:

- formal government policy documents and instruments under that name;
- any government documents which describe, set out or establish government policy or perspectives on any topic or issue;
- any Bill for legislation;
- any government document which defines a government intention, budget, trade agreement, or expenditure of funds;
- any government involvement in, or accession to, any international agreement; and
- any other document or component of government activity likely to have an effect on the environment.

An additional assessment trigger can be added to this list – "any government decision-making process that might result in a policy or policy-related strategy or course of action". The problem, however, as noted by Buckley (2000), is that governments are likely to object to such an inclusive definition of assessment triggers. On the other hand, any narrower set of triggers will simply allow governments to circumvent the SEA process for many PPP-related decisions. SEA must therefore be demonstrated in a variety of contexts and PPP-related situations such that the advantages of 'higher-order' assessment become more evident.

7.4 Research Opportunities

Strategic environmental assessment has received considerable attention in recent years from academics and practitioners alike. While there is considerable agreement on the need for the higher-order environmental assessment of PPPs and PPP-related decisions, there is much less consensus on an appropriate methodology to guide SEA application. SEA practice has been characterized by both failure and success. Several authors and case applications illustrate the need for a more consistent approach to SEA, but at the same time an approach that is able to meet the needs of PPP assessments in a variety of contexts and at different tiers of the decision-making process.

This thesis set out to develop and demonstrate a structured, generic methodological framework to guide SEA application. The SEA case study of Canadian energy policy demonstrated the proposed framework, and addressed a number of ongoing SEA methodological issues. If SEA is to receive widespread acceptance and understanding, and increased effectiveness and consistency in application, then SEA methodology must:

- demonstrate the basic principles and characteristics of a strategic environmental assessment;
- offer a systematic and structured, generic assessment framework;
- be adaptive to a variety of assessment methods and techniques in order to address a variety of PPP issues; and
- demonstrate a pragmatic approach that can be implemented for different scales of assessment and at different tiers of decision-making.

There are, in addition, a number of issues emerging from recent SEA literature that require research attention. For example, further direction is required on the means by which PPP alternatives are developed in SEA, and the implications this might pose for SEA practice. Additionally, there have to be specific institutional requirements and political and legal assessment triggers if there is to be effective SEA systems in different socio-political contexts.

In conclusion, this research attempts to move towards a structured approach to SEA. A structured methodological framework is required if SEA is to advance in application and effectiveness. The next step is to test the adaptiveness and pragmatism of the proposed framework within different planning contexts and at different tiers of decision-making. The final test, of course, will be to see whether the proposed framework is effective in a wide variety of SEA applications and to different PPP decisions.

APPENDIX A

Panellist consent and information forms

Memorial
University of Newfoundland

Department of Geography

29 January 2001

Dear ________:

My name is Bram Noble, and I am a Ph.D. candidate with the Department of Geography, Memorial University of Newfoundland. I am undertaking research which is aimed at developing a practical methodology for the environmental assessment of policy, plan and program alternatives - strategic environmental assessment (SEA). Specifically, my research focuses on evaluating the potential environmental impacts of alternative energy development scenarios for Canada's electricity sector.

I am gathering opinions on the potential environmental effects of alternative energy development scenarios through the use of an assessment panel. A number of individuals from across Canada are being contacted on the basis on their particular field of expertise. Given your knowledge of your particular field, I would like to request your cooperation in this study. It is not necessary that you be an expert in environmental assessment or Canada's energy resource sector, but rather that, if provided with a description of alternative energy scenarios and assessment criteria, your knowledge of your particular field would allow you to comment on the potential impacts.

The Energy Technology Futures Group of Natural Resources Canada has been working with the energy sector to develop a vision for a sustainable electricity industry based on long-term energy, environmental and socioeconomic goals. Building a sustainable electricity industry requires the consideration of new and existing energy alternatives to meet projected generation demands, the establishment of a framework to consider all of the potential impacts, and the development of sustainable energy policies. This makes a strong case for the application of SEA to identify the most practical and environmentally preferred energy alternatives to guide energy policy decision-making. However, while there is a widespread recognition of the need for SEA, there is much less consensus on how it can be effectively applied. Attention needs to be focused on the development of an appropriate framework, a set of guiding principles and tested methods. With your help, this research develops and demonstrates a practical and effective approach to SEA in the energy sector. The results will be set in a much broader context such that the approach can be applied across a variety of issues and sectors.

Your participation is essential to the success of this study. You are asked to please complete and return the *Panellist Consent & Information Form* and the *Supplementary Information Form* as an attached electronic file or by fax to 709-737-3119. Upon receipt of this information, I will forward an overview of the energy scenarios and assessment criteria and a structured questionnaire in which you will be asked to evaluate each scenario based on the criteria provided. Once completed, the responses of the panel as a whole will be compiled and sent to you along with a second round questionnaire. This second round questionnaire will provide you with a statistical summary of the group response. The purpose of this is to attempt to reach a consensus by allowing each individual panellist to reevaluate his/her responses in light of the group response. The questionnaire is structured so as to minimize the amount of time it will take to complete and return. It will be mailed to you in a self-addressed stamped envelope, enabling you to complete the questionnaire at a time of your convenience.

This research has been approved by the Ethics Research Council of Memorial University of Newfoundland. All individual responses will remain confidential, and panellists will not be personally identified in any reports or publications as a result of the information provided. Upon completion the raw data will be destroyed, or returned to the interviewee as requested. You are free to withdraw from the study at any time, however, your continued cooperation will help ensure the success of this research. All participants will receive an electronic copy of the final report.

I would appreciate it if you would return the completed forms within one week of receiving them. Should you have any questions, comments or concerns regarding this study, please feel free to contact me, or my supervisor, Dr. Keith Storey. Thank you for your cooperation, and I look forward to hearing from you soon.

Sincerely yours;

Bram Noble
Ph.D. Candidate
Department of Geography
Memorial University of Newfoundland
St. John's, Newfoundland, Canada, A1B 3X9
Tel. (709) 737-8998 (709) 782-3319(h)
Fax (709) 737-3119
Email: w37bfn@mun.ca

Dr. Keith Storey
Department of Geography
Tel. (709) 737-8987
Fax (709) 737-3119
Email: kstorey@mun.ca

Panellist Consent & Information Form

Study Title: Strategic Environmental Assessment of Alternative Options for Canadian Energy Policy

Principal Investigator: Bram Noble, Ph.D. Candidate
Memorial University, Department of Geography
St. John's, Newfoundland, Canada, A1B 3X9
Tel: (709) 737-8998 Fax: (709) 737-3119
Email: w37bfn@mun.ca

Research Supervisor: Dr. Keith Storey
Tel: (709) 737-8987 Fax: (709) 737-3119
Email: kstorey@mun.ca

Panellist Consent: I have read the enclosed documents and

☐ I consent to take part in this study

☐ I am unable/unwilling to take part in this study

Name:______________________________

Affiliation:______________________________

Job Title:______________________________

Area(s) of Expertise:________________________

Mailing Address:_________________________

____

____

Telephone:______________ **Email:**______________

If you have agreed to participate in this study, please continue to the next page. If you are unwilling or unable to participate in this study, please return this form.

Supplementary Information Form

Dear Panellist:

Thank you for agreeing to participate in this study. Please take a moment to complete this supplementary information form.

Section A

An initial list of the *types* of factors which will be used to evaluate alternative energy scenarios is presented below. It is not necessary that you be an expert in environmental assessment, energy resources or in all or any of the proposed factors, but rather that, if provided with a description of alternative energy scenarios and assessment criteria, your knowledge of your particular field (e.g. environmental assessment, public policy, environmental advocacy, energy resources, health and safety, etc.) would allow you to comment on the potential impacts.

1. If you feel you have *expertise* in an area *related* to any of the following assessment factors, please indicate by checking up to three of those areas upon which you would feel most comfortable commenting. For example, if you feel you have expertise in protected areas management or wildlife management/biology, then you might check 'visual impacts/aesthetics' or 'impacts on land & wildlife resources'.

☐ emissions (air/climate)	☐ economic efficiency	☐ public acceptability
☐ hazardous waste	☐ energy distribution (transmission/access)	☐ visual impacts/aesthetics
☐ impacts on water & water resources	☐ resource efficiency	☐ public health and safety
☐ impacts on land & wildlife resources	☐ energy security (supply)	☐ energy efficiency
☐ cultural/historic resources	☐ habitat management	☐ energy markets

2. Please indicate any additional factors, in which you have *expertise*, that you feel are important to consider when evaluating alternative energy development scenarios.

3. Please add any additional factors which you feel are important to consider when evaluating alternative energy development scenarios.

Section B

Please take a moment to indicate any other individuals who, in your opinion, may be qualified to participate in this study.

Name	*Affiliation*	*Contact Information*

Thank you for your cooperation. I would appreciate it if you would return the completed forms either by fax (709-737-3119) or in the postage-paid envelope provided within one week of receiving them. Thank you.

Sincerely yours,

Bram Noble

Appendix B

Pilot Study: Panellist's Evaluation Sheet

1. Total time required to complete both matrices: ____________

Comments on time and length: ____
____
____

2. Did you complete both matrices in one sitting? Y / N

3. Do you feel that it is necessary to complete both matrices in one sitting? Y/N

3. Are the instructions for performing the assessment clear and easy to understand? Y / N

Comments: ____
____
____

4. Are the factors/assessment criteria clearly defined? Y / N

Comments: ____
____
____

5. Are the energy development scenarios clearly defined? Y/N

Comments/suggestions for improvement: _______________________________________
____
____
____
____
____
____

Thank you for your comments. Please return this form along with the assessment matrices either by fax 737-3119 or in the postage-paid envelope provided by **30 March, 2000.**

APPENDIX C

Delphi Assessment Round I

Memorial
University of Newfoundland

Department of Geography

April 09, 2001

Dear______:

Thank you for agreeing to participate in my strategic environmental assessment study of alternative options for Canadian energy policy. Your contribution as an expert panellist is important to the completion of this research.

As indicated in my earlier correspondence, you are asked to evaluate energy development alternatives based on a list of assessment criteria. Please find enclosed the following documents:

Document A: Brief descriptions of the energy development alternatives.
Document B: Definitions of the factors and criteria upon which you are asked to evaluate the alternatives.
Document C: Instructions for performing the assessment procedure.
Document D: An impact matrix in which you are asked to enter assessment scores for each of the energy development alternatives.
Document E: A weights matrix in which you are asked to indicate the relative importance of each factor/criterion.

Much of the enclosed material is background information on the energy development alternatives, and the instructions for performing the assessment. The questionnaire itself (*Documents D and E)* is designed in the form of two impact matrices, so as to minimise the amount of time required to complete the exercise. You can expect to spend between thirty and fourty-five minutes to complete each matrix. It is not necessary that you complete both matrices in one sitting. However, I do ask that once you commence a matrix that you complete it in a single sitting. When completing the matrices, I recommend that you have Documents B (factors and assessment criteria) and D (scenario summaries) to hand for reference purposes.

I would ask that you please read the enclosed information and return the completed matrices (*Documents D and E*), either by fax (709-737-3119) or in the postage-paid envelope provided, at your earliest convenience. Please retain Documents A, B and C for future reference. Upon receipt and analysis of the completed matrices, I will forward you a statistical summary of the group responses and provide you with an opportunity to re-evaluate your individual responses in light of the group response. In order to ensure that panellists' responses are individual responses, you are asked not to discuss your responses with others.

Please be reassured that all information provided will remain confidential and, as indicated in my earlier correspondence, panellists will not be personally identified in any reports or publications as a result of the information provided. A summary of the study's findings will be made available to interested participants.

Should you have any questions, comments or concerns regarding this procedure, please feel free to contact me. I will follow-up this letter with an email to ensure that the instructions for the assessment procedure are clearly understood. Thank you for your co-operation, and I look forward to hearing from you soon.

Sincerely yours;

Bram Noble
Email: w37bfn@mun.ca

Document A – Alternative Energy Development Scenarios

Background

The continued growth of Canada's domestic electricity demand and export opportunities will require additional generating capacity. The Energy Technology Futures (ETF) group, an initiative of Natural Resources Canada (NRCan), has been working with representatives of the electricity sector to develop a vision for a sustainable electricity industry. Building a sustainable electricity industry to meet the projected increases in generation demand requires the consideration of new and existing energy alternatives, and the consideration of their potential environmental effects. The primary product of the ETF project is a set of internally consistent energy development scenarios, technological options, and fuel sources outlining possible energy development paths to the year 2050. While these scenarios do not reflect the current policy direction of NRCan, they do provide a series of possible energy development alternatives that could guide energy policy. Based on the ETF project, the five energy development alternatives (**A1**,...**A5**) under consideration in this study for electrical generation in Canada to 2050 are outlined below.

A1: ***Continue on the existing path of energy development, the status quo, in anticipation that the demand for electrical generation will decrease.***

Energy Scenario

Electrical generation in 2000 was predominantly hydroelectric supplemented with natural gas, coal and nuclear energy. By 2020 hydroelectricity remains the key source of electrical generation with shares of natural gas and refined petroleum products (RPPs) increasing, while coal and oil-fired generation declines. Hydro and gas-fired generation remains the preferred option for generation. The status quo approach will maintain this development path through to 2050. Emphasis is placed on managing energy end-use consumption. While wind generation increases in remote areas, alternative technologies and renewable fuels do not penetrate the main electrical grid.

A2: ***Meet the bulk of the demand with increases in nuclear energy, natural gas and refined petroleum products (RPPs), supplemented with minor increases in hydro and coal.***

Energy Scenario

In the early 2010s, nuclear power will start replacing coal and oil generation, and experience continued growth in the 2030s with hot gas reactors replacing the older deuterium uranium models. Up until 2040, when transmutation is expected to be viable, much of the nuclear waste generated will be handled by traditional concrete and water storage methods. Hydropower will benefit from better turbine design and generating mechanisms as larger-scale water diversion projects expanding hydroelectric capability. Natural gas usage in cogeneration becomes more popular as older systems are replaced with new units, used mostly in small or medium-sized, energy self-sufficient communities. Other electrical generation technologies include gasification as many municipalities use solid waste to run power generation facilities. Renewable energy contributes only a small percentage of electricity requirements in 2050. Technologies such as solar and wind power play a larger role primarily in remote, off-grid communities.

A3: *Introduce renewable energies as a major source of electricity supply, supplemented with major increases in natural gas and RPPs, coal, and minor increases in nuclear and hydro.*

Energy Scenario
Interest in nuclear, as a viable electricity source declines in the early 2000s. The growing use of natural gas and cleaner coal technologies will provide the electricity that would otherwise be produced from nuclear sources. The integration of renewable energy technologies is limited to situations where they are competitive with conventional generating sources. The focus of attention is on cost-effective means to diversify the generation mix and the use of improved fossil fuelled electrical generation technologies. By 2015, standalone electrical generating systems are replaced by more distributed coal-fired and biomass energy complexes, with onsite production meeting the needs of less intensive energy users. Renewable energy sources are well suited for these systems and photovoltaic systems, wind, and solid waste systems become widely used. By 2030, the larger portion of Canada's electrical generation is being produced from distributed facilities, and interest once again shifts to expanding Canada's nuclear capacity as Canada looks offshore for a supplier of high temperature gas-cooled reactors with increased overall system reliability and longer life expectancy.

A4: ***Maintain existing levels of hydro, phase out nuclear energy, and meet the bulk of the demand with significant increases in coal, supplemented with increases in natural gas and RPPs.***

Energy Scenario
Natural gas generation finds increased popularity through to about 2015 as larger industries invest in gas cogeneration facilities. By 2020 most hydroelectric power plants are refurbished with more efficient turbines replacing older units and more durable concrete dams. Around the same time, all potential new sites for run-of-river hydro become exhausted. Towards the early 2020s, utilities are making fewer investments in natural gas power
plants and decide to halt nuclear developments and decommission many existing nuclear power plants. By 2050,
40% of Canada's base-load electricity is generated from coal. Remote communities use a variety of off-grid sources to generate their power, such as liquid fuels, wind turbines, photovoltaics and micro turbine run-of-river hydro. However, by 2050, renewable energies, apart from large-scale hydro, provides only a small part of Canada's total electrical generation capacity.

A5: ***Meet the demand with increases in natural gas and RPPs, supplemented with minor increases in coal and hydro, and the introduction of renewable energies, as a minor contributor, in place of nuclear energy.***

Energy Scenario
Electrical generation is based on nuclear, with hydro, natural gas, clean coal technologies, co-generation and some renewable energy sources providing much of the remaining load. Hydroelectric is able to keep its share of production through improvements in turbines, and high voltage DC long distance transmission. Most potential hydroelectric sites are tapped by 2020. The nuclear program slowly comes to a halt in the early 2030s and coal and natural gas begin to fill the growing demand. Natural gas turbines secure a significant portion of the market in the mid-2030s. Natural gas becomes the most widely used non-renewable fuel. Renewable sources, other than hydro, grow to about 1% of electrical generation. The use of biomass for electricity generation increases slightly and renewable components become incorporated into distributed energy systems for remote communities as well as in a few locations with particular advantages for wind and solar generation.

Document B: Factors and Assessment Criteria

The following assessment factors and criteria were identified by study panellists, adopted from NRCan's *Energy Sector Business Plan for 1998-2001*, and from other, similar assessments.

Environmental factors ⇒ Assessment criteria

C1 – Atmospheric emissions ⇒ minimizes greenhouse gas and other atmospheric emissions during production, distribution and use

C2 – Hazardous waste generation ⇒ minimizes the toxicity of waste produced during production, distribution and use

C3 – Habitat destruction ⇒ requires minimal disturbance to land and water resources for production and distribution

C4 – Resource efficiency ⇒ offers the greatest amount of electricity production for the least amount of non-renewable energy resource input

Economic factors ⇒ Assessment criteria

C5 – Economic efficiency ⇒ generates the greatest electrical output while minimizing the financial costs of energy development, ensuring a competitively priced electricity supply to consumers

C6 – Market competitiveness ⇒ strengthens Canada's competitiveness in energy market export opportunities

Social factors ⇒ Assessment criteria

C7 – Security of supply ⇒ will ensure secure, reliable access to energy supply for current and future generations

C8 – Distributional equity ⇒ will meet the demands of the greatest number of energy users including off-grid, remote areas

C9 – Public health and safety ⇒ minimizes risk to public health and safety through emissions, noise, etc.

C10 – Heritage preservation ⇒ will pose minimal threat to cultural and historic/archaeological resources

C11 – Acceptability ⇒ will receive the broadest range of public support and minimize the potential for land use conflicts (e.g. first nations land claims)

Document C: Assessment Procedure

You are asked to evaluate pairs of energy development alternatives with respect to the factors and assessment criteria outlined in Document B, and indicate in the assessment matrix *(Document D)* your *relative preference*. The assessment scale is as follows:

Intensity of relative preference	**Definition of preference scale**	**Explanation** Based on the given criterion for each factor, your experience and judgement would conclude that:
1	Equally preferred	The two alternatives are *equally preferred*
3	Slightly preferred	One activity is *slightly preferred* over the other
5	Moderately preferred	One activity is *preferred* over the other
7	Strongly preferred	One activity is *strongly preferred* over the other
9	Extremely preferred	One activity is *extremely preferred* over the other
2,4,6,8	Intermediate values	Reflects preferences between the two adjacent judgements

An example of the assessment matrix is illustrated below. The pairs of alternatives that you are asked to evaluate are listed across the top, and the factors representing the assessment criteria are listed down the side.

- ➢ When evaluating two alternatives you are evaluating the *relative* preference on the basis of a particular criterion.
- ➢ For example, a strong preference for alternative A1 over alternative A2, based on criterion C1, does not mean that A1 is the overall preferred alternative, but that it is the preferred alternative relative to A2 with regard to C1.

	A1 - A2	A1 - A3	A1 - A4
C1 Minimizing atmospheric emissions	A1 ■ A2 □ 9 Intensity	A1 □ A3 □ ___ Intensity	A1 □ A4 □ ___ Intensity
C2 Minimizing toxicity of hazardous waste	A1 □ A2 ■ 3 Intensity	A1 □ A3 □ ___ Intensity	
C3 Minimizing habitat destruction	A1 □ A2 □ 1 Intensity		

Start at the left with the first pair of alternatives (**A1-A2**) and the first factor (**C1**), and then work your way to the bottom, completing one column at a time for each pair of alternatives. For example:

- If alternative A1 is *extremely preferred* to alternative A2 based on criterion C1 (atmospheric emissions), then you would check box A1 and enter a score of '9' in the matrix as illustrated.
- If alternative A2 is *slightly preferred* to alternative A1 based on criterion C2 (hazardous waste), then you would check box A2 and enter a score of '3' in the matrix.
- If alternative A1 is *equally preferred* to alternative A2 based on criterion C3 (habitat destruction), then you would simply enter a score of '1' in the matrix.

Document D: Scenario Summaries

Scenario Summaries

A1: Continue on the existing path of energy development, the status quo, in anticipation that the demand for electrical generation will decrease.

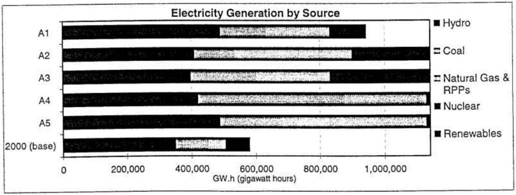
A2: Meet the bulk of the demand with increases in nuclear energy, natural gas and refined petroleum products (RPPs), supplemented with minor increases in hydro and coal.

A3: Introduce renewable energies as a major source of electricity supply, supplemented with major increases in natural gas and refined petroleum products (RPPs), coal, and minor increases in nuclear and hydro.

A4: Maintain existing levels of hydro, phase out nuclear energy, and meet the bulk of the demand with significant increases in coal, supplemented with increases in natural gas and refined petroleum products (RPPs).

A5: Meet the demand with increases in natural gas and refined petroleum products (RPPs), supplemented with minor increases in coal and hydro, and the introduction of renewable energies in place of nuclear energy.

Scenario Summary Comparisons



Document D: Assessment Matrix

	A1-A2	A1-A3	A1-A4	A1-A5	A2-A3	A2-A4	A2-A5	A3-A4	A3-A5	A4-A5
C1 Minimizing air emissions	A1 ☐ A2 ☐ ____ Intensity	A1 ☐ A3 ☐ ____ Intensity	A1 ☐ A4 ☐ ____ Intensity	A1 ☐ A5 ☐ ____ Intensity	A2 ☐ A3 ☐ ____ Intensity	A2 ☐ A4 ☐ ____ Intensity	A2 ☐ A5 ☐ ____ Intensity	A3 ☐ A4 ☐ ____ Intensity	A3 ☐ A5 ☐ ____ Intensity	A4 ☐ A5 ☐ ____ Intensity
C2 Minimizing toxicity of hazardous waste	A1 ☐ A2 ☐ ____ Intensity	A1 ☐ A3 ☐ ____ Intensity	A1 ☐ A4 ☐ ____ Intensity	A1 ☐ A5 ☐ ____ Intensity	A2 ☐ A3 ☐ ____ Intensity	A2 ☐ A4 ☐ ____ Intensity	A2 ☐ A5 ☐ ____ Intensity	A3 ☐ A4 ☐ ____ Intensity	A3 ☐ A5 ☐ ____ Intensity	A4 ☐ A5 ☐ ____ Intensity
C3 Minimizing habitat destruction	A1 ☐ A2 ☐ ____ Intensity	A1 ☐ A3 ☐ ____ Intensity	A1 ☐ A4 ☐ ____ Intensity	A1 ☐ A5 ☐ ____ Intensity	A2 ☐ A3 ☐ ____ Intensity	A2 ☐ A4 ☐ ____ Intensity	A2 ☐ A5 ☐ ____ Intensity	A3 ☐ A4 ☐ ____ Intensity	A3 ☐ A5 ☐ ____ Intensity	A4 ☐ A5 ☐ ____ Intensity
C4 Resource efficiency	A1 ☐ A2 ☐ ____ Intensity	A1 ☐ A3 ☐ ____ Intensity	A1 ☐ A4 ☐ ____ Intensity	A1 ☐ A5 ☐ ____ Intensity	A2 ☐ A3 ☐ ____ Intensity	A2 ☐ A4 ☐ ____ Intensity	A2 ☐ A5 ☐ ____ Intensity	A3 ☐ A4 ☐ ____ Intensity	A3 ☐ A5 ☐ ____ Intensity	A4 ☐ A5 ☐ ____ Intensity
C5 Economic efficiency	A1 ☐ A2 ☐ ____ Intensity	A1 ☐ A3 ☐ ____ Intensity	A1 ☐ A4 ☐ ____ Intensity	A1 ☐ A5 ☐ ____ Intensity	A2 ☐ A3 ☐ ____ Intensity	A2 ☐ A4 ☐ ____ Intensity	A2 ☐ A5 ☐ ____ Intensity	A3 ☐ A4 ☐ ____ Intensity	A3 ☐ A5 ☐ ____ Intensity	A4 ☐ A5 ☐ ____ Intensity
C6 Market competitiveness	A1 ☐ A2 ☐ ____ Intensity	A1 ☐ A3 ☐ ____ Intensity	A1 ☐ A4 ☐ ____ Intensity	A1 ☐ A5 ☐ ____ Intensity	A2 ☐ A3 ☐ ____ Intensity	A2 ☐ A4 ☐ ____ Intensity	A2 ☐ A5 ☐ ____ Intensity	A3 ☐ A4 ☐ ____ Intensity	A3 ☐ A5 ☐ ____ Intensity	A4 ☐ A5 ☐ ____ Intensity
C7 Security of supply	A1 ☐ A2 ☐ ____ Intensity	A1 ☐ A3 ☐ ____ Intensity	A1 ☐ A4 ☐ ____ Intensity	A1 ☐ A5 ☐ ____ Intensity	A2 ☐ A3 ☐ ____ Intensity	A2 ☐ A4 ☐ ____ Intensity	A2 ☐ A5 ☐ ____ Intensity	A3 ☐ A4 ☐ ____ Intensity	A3 ☐ A5 ☐ ____ Intensity	A4 ☐ A5 ☐ ____ Intensity
C8 Distributional equity	A1 ☐ A2 ☐ ____ Intensity	A1 ☐ A3 ☐ ____ Intensity	A1 ☐ A4 ☐ ____ Intensity	A1 ☐ A5 ☐ ____ Intensity	A2 ☐ A3 ☐ ____ Intensity	A2 ☐ A4 ☐ ____ Intensity	A2 ☐ A5 ☐ ____ Intensity	A3 ☐ A4 ☐ ____ Intensity	A3 ☐ A5 ☐ ____ Intensity	A4 ☐ A5 ☐ ____ Intensity
C9 Minimizing risk to public health and safety	A1 ☐ A2 ☐ ____ Intensity	A1 ☐ A3 ☐ ____ Intensity	A1 ☐ A4 ☐ ____ Intensity	A1 ☐ A5 ☐ ____ Intensity	A2 ☐ A3 ☐ ____ Intensity	A2 ☐ A4 ☐ ____ Intensity	A2 ☐ A5 ☐ ____ Intensity	A3 ☐ A4 ☐ ____ Intensity	A3 ☐ A5 ☐ ____ Intensity	A4 ☐ A5 ☐ ____ Intensity
C10 Heritage preservation	A1 ☐ A2 ☐ ____ Intensity	A1 ☐ A3 ☐ ____ Intensity	A1 ☐ A4 ☐ ____ Intensity	A1 ☐ A5 ☐ ____ Intensity	A2 ☐ A3 ☐ ____ Intensity	A2 ☐ A4 ☐ ____ Intensity	A2 ☐ A5 ☐ ____ Intensity	A3 ☐ A4 ☐ ____ Intensity	A3 ☐ A5 ☐ ____ Intensity	A4 ☐ A5 ☐ ____ Intensity
C11 Public acceptability	A1 ☐ A2 ☐ ____ Intensity	A1 ☐ A3 ☐ ____ Intensity	A1 ☐ A4 ☐ ____ Intensity	A1 ☐ A5 ☐ ____ Intensity	A2 ☐ A3 ☐ ____ Intensity	A2 ☐ A4 ☐ ____ Intensity	A2 ☐ A5 ☐ ____ Intensity	A3 ☐ A4 ☐ ____ Intensity	A3 ☐ A5 ☐ ____ Intensity	A4 ☐ A5 ☐ ____ Intensity

Intensity of relative preference	Definition of preference scale
1	Equally preferred
2	
3	Slightly preferred
4	
5	Moderately preferred
6	
7	Strongly preferred
8	
9	Extremely preferred
2,4,6,8	Intermediate values

Comments (continue over if necessary): ____________________

____

Document E: Factor Weights Matrix

Start here	C2 Minimizing toxicity of hazardous waste	C3 Minimizing habitat destruction	C4 Resource efficiency	C5 Economic efficiency	C6 Market competitive	C7 Security of supply	C8 Distribut-ional equity	C9 Minimizing risk to public health/safety	C10 Heritage preservation	C11 Public acceptability
C1 Minimizing air emissions	C1 □ ___ C2 □	C1 □ ___ C3 □	C1 □ ___ C4 □	C1 □ ___ C5 □	C1 □ ___ C6 □	C1 □ ___ C7 □	C1 □ ___ C8 □	C1 □ ___ C9 □	C1 □ ___ C10 □	C1 □ ___ C11 □
C2 Minimizing toxicity of hazardous waste		C2 □ ___ C3 □	C2 □ ___ C4 □	C2 □ ___ C5 □	C2 □ ___ C6 □	C2 □ ___ C7 □	C2 □ ___ C8 □	C2 □ ___ C9 □	C2 □ ___ C10 □	C2 □ ___ C11 □
C3 Minimizing habitat destruction			C3 □ ___ C4 □	C3 □ ___ C5 □	C3 □ ___ C6 □	C3 □ ___ C7 □	C3 □ ___ C8 □	C3 □ ___ C9 □	C3 □ ___ C10 □	C3 □ ___ C11 □
C4 Resource efficiency				C4 □ ___ C5 □	C4 □ ___ C6 □	C4 □ ___ C7 □	C4 □ ___ C8 □	C4 □ ___ C9 □	C4 □ ___ C10 □	C4 □ ___ C11 □
C5 Economic efficiency					C5 □ ___ C6 □	C5 □ ___ C7 □	C5 □ ___ C8 □	C5 □ ___ C9 □	C5 □ ___ C10 □	C5 □ ___ C11 □
C6 Market competitive						C6 □ ___ C7 □	C6 □ ___ C8 □	C6 □ ___ C9 □	C6 □ ___ C10 □	C6 □ ___ C11 □
C7 Security of supply							C7 □ ___ C8 □	C7 □ ___ C9 □	C7 □ ___ C10 □	C7 □ ___ C11 □
C8 Distribut-ional equity								C8 □ ___ C9 □	C8 □ ___ C10 □	C8 □ ___ C11 □
C9 Minimizing risk to public health/safety									C9 □ ___ C10 □	C9 □ ___ C11 □
C10 Heritage preservation (Finish here →)										C10 □ ___ C11 □

Intensity of relative importance	Definition of importance scale
1	Equally preferred
2	
3	Slightly preferred
4	
5	Moderately preferred
6	
7	Strongly preferred
8	
9	Extremely preferred
2,4,6,8	Intermediate values

Comments (continue over if necessary): ______________________________

APPENDIX D

Delphi Assessment Round II

Memorial
University of Newfoundland

Department of Geography

13 August 2001

Dear ________:

Thank you for participating in Round One of my SEA study of potential Canadian energy policy alternatives. The response rate has been encouraging. Your continued participation is important to the completion of this research and is very much appreciated.

The second phase of the research is now underway. Given the broad range of alternative scenarios and assessment criteria the possibility of "choice conflicts" arises. The first part of the analysis tested responses in terms of their overall internal consistency. Round Two, therefore, gives panellists the opportunity to review and revise, where they consider appropriate, those choice sets where the analysis indicates that some inconsistency may exist. These potential choice conflicts may be due to the way in which the alternatives and criteria are presented, or due to the way in which they were interpreted.

I ask that you please take a moment to reconsider your ratings for those criteria outlined in **Document A**. Please complete and return the re-evaluation matrix including any changes that you consider appropriate. I am enclosing copies of Documents B, C, and D for your reference. However, you may wish to refer to the Documents you received in Round One for additional information.

As you will see from Document A, the number of choice sets that you are asked to reconsider is small and thus this round will require much less of your time. Upon receipt and analysis of all panellists' responses, I will send you a summary of the group response as part of Round Three.

As indicated previously, all information provided will remain confidential and panellists will not be personally identified in any reports or publications resulting from this research. Please return the completed documents by **fax** to 709-737-3119 within **one week** of receiving them.

Please do not hesitate to contact me should you have any questions or require additional information. Thank you for your continued cooperation, and I look forward to hearing from you soon.

Yours sincerely,

Bram Noble

Document B: Factors and Assessment Criteria

The following assessment factors and criteria were identified by study panellists, adopted from NRCan's *Energy Sector Business Plan for 1998-2001*, and from other, similar assessments.

Environmental factors ⇒ Assessment criteria

C1 – ***Atmospheric emissions*** ⇒ minimizes greenhouse gas and other atmospheric emissions during production, distribution and use

C2 – ***Hazardous waste generation*** ⇒ minimizes the toxicity of waste produced during production, distribution and use

C3 – ***Habitat destruction*** ⇒ requires minimal disturbance to land and water resources for production and distribution

C4 – ***Resource efficiency*** ⇒ offers the greatest amount of electricity production for the least amount of non-renewable energy resource input

Economic factors ⇒ Assessment criteria

C5 – ***Economic efficiency*** ⇒ generates the greatest electrical output while minimizing the financial costs of energy development, ensuring a competitively priced electricity supply to consumers

C6 – ***Market competitiveness*** ⇒ strengthens Canada's competitiveness in energy market export opportunities

Social factors ⇒ Assessment criteria

C7 – ***Security of supply*** ⇒ will ensure secure, reliable access to energy supply for current and future generations

C8 – ***Distributional equity*** ⇒ will meet the demands of the greatest number of energy users including off-grid, remote areas

C9 – ***Public health and safety*** ⇒ minimizes risk to public health and safety through emissions, noise, etc.

C10 – ***Heritage preservation*** ⇒ will pose minimal threat to cultural and historic/archaeological resources

C11 – ***Acceptability*** ⇒ will receive the broadest range of public support and minimize the potential for land use conflicts (e.g. first nations land claims)

Document C: Assessment Procedure

You are asked to evaluate pairs of energy development alternatives with respect to the factors and assessment criteria outlined in Document B, and indicate in the assessment matrix (*Document D*) your *relative preference*. The assessment scale is as follows:

Intensity of relative preference	Definition of preference scale	Explanation Based on the given criterion for each factor, your experience And judgement would conclude that:
1	Equally preferred	The two alternatives are *equally preferred*
3	Slightly preferred	One activity is *slightly preferred* over the other
5	Moderately preferred	One activity is *preferred* over the other
7	Strongly preferred	One activity is *strongly preferred* over the other
9	Extremely preferred	One activity is *extremely preferred* over the other
2,4,6,8	Intermediate values	Reflects preferences between the two adjacent judgements

An example of the assessment matrix is illustrated below.

	A1 - A2	A1 - A3	A1 - A4
C1 Minimizing atmospheric emissions	A1 ■ A2 □ 9 Intensity	A1 □ A3 □ ___ Intensity	A1 □ A4 □ ___ Intensity
C2 Minimizing toxicity of hazardous waste	A1 □ A2 ■ 3 Intensity	A1 □ A3 □ ___ Intensity	
C3 Minimizing habitat destruction	A1 □ A2 □ 1 Intensity		

Start at the left with the first pair of alternatives (**A1-A2**) and the first factor (**C1**), and then work your way to the bottom, completing one column at a time for each pair of alternatives. For example:

- If alternative A1 is *extremely preferred* to alternative A2 based on criterion C1 (atmospheric emissions), then you would check box A1 and enter a score of '9' in the matrix as illustrated.
- If alternative A2 is *slightly preferred* to alternative A1 based on criterion C2 (hazardous waste), then you would check box A2 and enter a score of '3' in the matrix.
- If alternative A1 is *equally preferred* to alternative A2 based on criterion C3 (habitat destruction), then you would simply enter a score of '1' in the matrix.

Document D: Scenario Summaries

Scenario Summaries

A1: Continue on the existing path of energy development, the status quo, in anticipation that the demand for electrical generation will decrease.

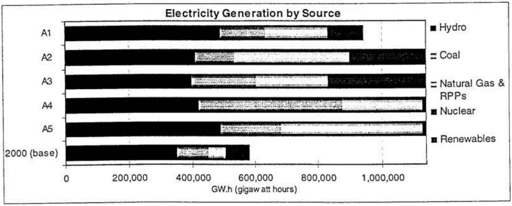
A2: Meet the bulk of the demand with increases in nuclear energy, natural gas and refined petroleum products (RPPs), supplemented with minor increases in hydro and coal.

A3: Introduce renewable energies as a major source of electricity supply, supplemented with major increases in natural gas and refined petroleum products (RPPs), coal, and minor increases in nuclear and hydro.

A4: Maintain existing levels of hydro, phase out nuclear energy, and meet the bulk of the demand with significant increases in coal, supplemented with increases in natural gas and refined petroleum products (RPPs).

A5: Meet the demand with increases in natural gas and refined petroleum products (RPPs), supplemented with minor increases in coal and hydro, and the introduction of renewable energies in place of nuclear energy.

Scenario Summary Comparisons



Document A: Assessment Matrix

007

Initial evaluation:

	A1-A2	A1-A3	A1-A4	A1-A5	A2-A3	A2-A4	A2-A5	A3-A4	A3-A5	A4-A5
C2 Minimizing toxicity of hazardous waste	A1 □ A2 □ ____ Intensity	A1 □ A3 □ ____ Intensity	A1 □ A4 □ ____ Intensity	A1 □ A5 □ ____ Intensity	A2 □ A3 □ ____ Intensity	A2 □ A4 □ ____ Intensity	A2 □ A5 □ ____ Intensity	A3 □ A4 □ ____ Intensity	A3 □ A5 □ ____ Intensity	A4 □ A5 □ ____ Intensity
C3 Minimizing habitat destruction	A1 □ A2 □ ____ Intensity	A1 □ A3 □ ____ Intensity	A1 □ A4 □ ____ Intensity	A1 □ A5 □ ____ Intensity	A2 □ A3 □ ____ Intensity	A2 □ A4 □ ____ Intensity	A2 □ A5 □ ____ Intensity	A3 □ A4 □ ____ Intensity	A3 □ A5 □ ____ Intensity	A4 □ A5 □ ____ Intensity
C4 Resource efficiency	A1 □ A2 □ ____ Intensity	A1 □ A3 □ ____ Intensity	A1 □ A4 □ ____ Intensity	A1 □ A5 □ ____ Intensity	A2 □ A3 □ ____ Intensity	A2 □ A4 □ ____ Intensity	A2 □ A5 □ ____ Intensity	A3 □ A4 □ ____ Intensity	A3 □ A5 □ ____ Intensity	A4 □ A5 □ ____ Intensity
C5 Economic efficiency	A1 □ A2 □ ____ Intensity	A1 □ A3 □ ____ Intensity	A1 □ A4 □ ____ Intensity	A1 □ A5 □ ____ Intensity	A2 □ A3 □ ____ Intensity	A2 □ A4 □ ____ Intensity	A2 □ A5 □ ____ Intensity	A3 □ A4 □ ____ Intensity	A3 □ A5 □ ____ Intensity	A4 □ A5 □ ____ Intensity

Re-evaluation:

	A1-A2	A1-A3	A1-A4	A1-A5	A2-A3	A2-A4	A2-A5	A3-A4	A3-A5	A4-A5
C2 Minimizing toxicity of hazardous waste	A1 □ A2 □ ____ Intensity	A1 □ A3 □ ____ Intensity	A1 □ A4 □ ____ Intensity	A1 □ A5 □ ____ Intensity	A2 □ A3 □ ____ Intensity	A2 □ A4 □ ____ Intensity	A2 □ A5 □ ____ Intensity	A3 □ A4 □ ____ Intensity	A3 □ A5 □ ____ Intensity	A4 □ A5 □ ____ Intensity
C3 Minimizing habitat destruction	A1 □ A2 □ ____ Intensity	A1 □ A3 □ ____ Intensity	A1 □ A4 □ ____ Intensity	A1 □ A5 □ ____ Intensity	A2 □ A3 □ ____ Intensity	A2 □ A4 □ ____ Intensity	A2 □ A5 □ ____ Intensity	A3 □ A4 □ ____ Intensity	A3 □ A5 □ ____ Intensity	A4 □ A5 □ ____ Intensity
C4 Resource efficiency	A1 □ A2 □ ____ Intensity	A1 □ A3 □ ____ Intensity	A1 □ A4 □ ____ Intensity	A1 □ A5 □ ____ Intensity	A2 □ A3 □ ____ Intensity	A2 □ A4 □ ____ Intensity	A2 □ A5 □ ____ Intensity	A3 □ A4 □ ____ Intensity	A3 □ A5 □ ____ Intensity	A4 □ A5 □ ____ Intensity
C5 Economic efficiency	A1 □ A2 □ ____ Intensity	A1 □ A3 □ ____ Intensity	A1 □ A4 □ ____ Intensity	A1 □ A5 □ ____ Intensity	A2 □ A3 □ ____ Intensity	A2 □ A4 □ ____ Intensity	A2 □ A5 □ ____ Intensity	A3 □ A4 □ ____ Intensity	A3 □ A5 □ ____ Intensity	A4 □ A5 □ ____ Intensity

Comments (continue over if necessary): ____

____

APPENDIX E

Delphi Assessment Round III

Memorial
University of Newfoundland

Department of Geography

27 August 2001

Dear __________:

Thank you for participating in my strategic environmental assessment study of potential alternatives for Canadian energy policy. In this **final** assessment Round, I am enclosing a summary of the group's assessment scores for your information, and to provide you with an opportunity to make any final adjustments to your own assessment scores that you consider necessary.

Document A indicates the upper and lower quartiles for the group's median response for each alternative, along with your individual assessment scores. For your information, I have highlighted those cells where your individual assessment falls outside the interquartile range of the group's median response for the alternative which you have selected. Please refer to **Document B** for instructions for making any final revisions to your assessment scores.

I would ask that you review Document A and fax any revisions that you make to 709-737-3119 within the next **two weeks**. Please return the original copy in the postage-paid envelope provided. Even if you do not wish to make any revisions please return Document A in the envelope provided.

Upon receipt and analysis of all data, I will forward you a statistical summary of the results and the conclusions and provide you with an opportunity to comment. A full report of the study's findings will be made available to all interested participants near the end of 2001. As indicated in previous correspondences, only aggregate data will be reported and panellists will not be identified in any reports or publications as a result of the information provided.

Should you have any questions, comments or concerns regarding this final assessment Round, please do not hesitate to contact me. I appreciate that this exercise has required considerable effort on your part, and for this I am grateful. Thank you for your co-operation, and I look forward to hearing from you soon.

Sincerely yours,
Bram Noble
Email: w37bfn@mun.ca
Tel: 709-782-3319

Document A: Group Assessment Matrix

	A1 — A2			A1 — A3			A1 — A4			A1 — A5			A2 — A3		
	Group Assessment	Your Assessment	Revised Assessment	Group Assessment	Your Assessment	Revised Assessment	Group Assessment	Your Assessment	Revised Assessment	Group Assessment	Your Assessment	Revised Assessment	Group Assessment	Your Assessment	Revised Assessment
C1 Minimizing air emissions	A1 ■ 4-6 A2 ■ 2-4	A1 □ ___ A2 □ ___	A1 □ ___ A2 □ ___	A1 ■ 3-5 A3 ■ 2-5	A1 □ ___ A3 □ ___	A1 □ ___ A3 □ ___	A1 ■ 6-9 A4 □ ___	A1 □ ___ A4 □ ___	A1 □ ___ A4 □ ___	A1 ■ 4-7 A5 ■ 2-5	A1 □ ___ A5 □ ___	A1 □ ___ A5 □ ___	A2 ■ 2-5 A3 ■ 2-4	A2 □ ___ A3 □ ___	A2 □ ___ A3 □ ___
C2 Minimizing toxicity of hazardous waste	A1 ■ 6-8 A2 ■ 1-4	A1 □ ___ A2 □ ___	A1 □ ___ A2 □ ___	A1 ■ 2-4 A3 ■ 3-6	A1 □ ___ A3 □ ___	A1 □ ___ A3 □ ___	A1 ■ 4-7 A4 ■ 2-5	A1 □ ___ A4 □ ___	A1 □ ___ A4 □ ___	A1 ■ 2-4 A5 ■ 4-6	A1 □ ___ A5 □ ___	A1 □ ___ A5 □ ___	A2 ■ 1-2 A3 ■ 4-6	A2 □ ___ A3 □ ___	A2 □ ___ A3 □ ___
C3 Minimizing habitat destruction	A1 ■ 1-4 A2 ■ 4-6	A1 □ ___ A2 □ ___	A1 □ ___ A2 □ ___	A1 ■ 2-5 A3 ■ 3-5	A1 □ ___ A3 □ ___	A1 □ ___ A3 □ ___	A1 ■ 4-6 A4 ■ 2-5	A1 □ ___ A4 □ ___	A1 □ ___ A4 □ ___	A1 ■ 3-5 A5 ■ 2-4	A1 □ ___ A5 □ ___	A1 □ ___ A5 □ ___	A2 ■ 1-3 A3 ■ 2-5	A2 □ ___ A3 □ ___	A2 □ ___ A3 □ ___
C4 Resource efficiency	A1 ■ 4-6 A2 ■ 2-5	A1 □ ___ A2 □ ___	A1 □ ___ A2 □ ___	A1 ■ 2-5 A3 ■ 2-5	A1 □ ___ A3 □ ___	A1 □ ___ A3 □ ___	A1 ■ 4-7 A4 ■ 1-4	A1 □ ___ A4 □ ___	A1 □ ___ A4 □ ___	A1 ■ 3-5 A5 ■ 2-4	A1 □ ___ A5 □ ___	A1 □ ___ A5 □ ___	A2 ■ 2-4 A3 ■ 4-6	A2 □ ___ A3 □ ___	A2 □ ___ A3 □ ___
C5 Economic efficiency	A1 ■ 2-5 A2 ■ 2-4	A1 □ ___ A2 □ ___	A1 □ ___ A2 □ ___	A1 ■ 3-5 A3 ■ 1-4	A1 □ ___ A3 □ ___	A1 □ ___ A3 □ ___	A1 ■ 3-4 A4 ■ 2-4	A1 □ ___ A4 □ ___	A1 □ ___ A4 □ ___	A1 ■ 2-4 A5 ■ 2-4	A1 □ ___ A5 □ ___	A1 □ ___ A5 □ ___	A2 ■ 2-5 A3 ■ 2-4	A2 □ ___ A3 □ ___	A2 □ ___ A3 □ ___
C6 Market competitiveness	A1 ■ 1-6 A2 ■ 3-6	A1 □ ___ A2 □ ___	A1 □ ___ A2 □ ___	A1 ■ 1-3 A3 ■ 3-6	A1 □ ___ A3 □ ___	A1 □ ___ A3 □ ___	A1 ■ 2-5 A4 ■ 4-6	A1 □ ___ A4 □ ___	A1 □ ___ A4 □ ___	A1 ■ 2-4 A5 ■ 2-5	A1 □ ___ A5 □ ___	A1 □ ___ A5 □ ___	A2 ■ 1-3 A3 ■ 3-5	A2 □ ___ A3 □ ___	A2 □ ___ A3 □ ___
C7 Security of supply	A1 ■ 3-5 A2 ■ 4-6	A1 □ ___ A2 □ ___	A1 □ ___ A2 □ ___	A1 ■ 3-5 A3 ■ 4-7	A1 □ ___ A3 □ ___	A1 □ ___ A3 □ ___	A1 ■ 2-4 A4 ■ 2-4	A1 □ ___ A4 □ ___	A1 □ ___ A4 □ ___	A1 ■ 3-6 A5 ■ 2-5	A1 □ ___ A5 □ ___	A1 □ ___ A5 □ ___	A2 ■ 4-7 A3 ■ 3-5	A2 □ ___ A3 □ ___	A2 □ ___ A3 □ ___
C8 Distributional equity	A1 ■ 1-2 A2 ■ 2-4	A1 □ ___ A2 □ ___	A1 □ ___ A2 □ ___	A1 ■ 1-3 A3 ■ 4-7	A1 □ ___ A3 □ ___	A1 □ ___ A3 □ ___	A1 ■ 2-4 A4 ■ 2-5	A1 □ ___ A4 □ ___	A1 □ ___ A4 □ ___	A1 ■ 1-3 A5 ■ 2-5	A1 □ ___ A5 □ ___	A1 □ ___ A5 □ ___	A2 ■ 1-3 A3 ■ 4-7	A2 □ ___ A3 □ ___	A2 □ ___ A3 □ ___
C9 Minimizing risk to public health and safety	A1 ■ 3-6 A2 ■ 2-4	A1 □ ___ A2 □ ___	A1 □ ___ A2 □ ___	A1 ■ 2-5 A3 ■ 3-6	A1 □ ___ A3 □ ___	A1 □ ___ A3 □ ___	A1 ■ 4-6 A4 ■ 1-4	A1 □ ___ A4 □ ___	A1 □ ___ A4 □ ___	A1 ■ 2-5 A5 ■ 2-5	A1 □ ___ A5 □ ___	A1 □ ___ A5 □ ___	A2 ■ 2-3 A3 ■ 4-7	A2 □ ___ A3 □ ___	A2 □ ___ A3 □ ___
C10 Heritage preservation	A1 ■ 2-4 A2 ■ 2-5	A1 □ ___ A2 □ ___	A1 □ ___ A2 □ ___	A1 ■ 2-4 A3 ■ 2-4	A1 □ ___ A3 □ ___	A1 □ ___ A3 □ ___	A1 ■ 3-5 A4 ■ 1-2	A1 □ ___ A4 □ ___	A1 □ ___ A4 □ ___	A1 ■ 2-4 A5 ■ 1-2	A1 □ ___ A5 □ ___	A1 □ ___ A5 □ ___	A2 ■ 1-2 A3 ■ 2-4	A2 □ ___ A3 □ ___	A2 □ ___ A3 □ ___
C11 Public acceptability	A1 ■ 3-6 A2 ■ 1-3	A1 □ ___ A2 □ ___	A1 □ ___ A2 □ ___	A1 ■ 4-7 A3 ■ 1-6	A1 □ ___ A3 □ ___	A1 □ ___ A3 □ ___	A1 ■ 5-7 A4 ■ 2-4	A1 □ ___ A4 □ ___	A1 □ ___ A4 □ ___	A1 ■ 1-5 A5 ■ 4-6	A1 □ ___ A5 □ ___	A1 □ ___ A5 □ ___	A2 ■ 1-2 A3 ■ 4-7	A2 □ ___ A3 □ ___	A2 □ ___ A3 □ ___

	A2 --- A4			A2 --- A5			A3 --- A4			A3 --- A5			A4 --- A5		
	Group Assessment	Your Assessment	Revised Assessment	Group Assessment	Your Assessment	Revised Assessment	Group Assessment	Your Assessment	Revised Assessment	Group Assessment	Your Assessment	Revised Assessment	Group Assessment	Your Assessment	Revised Assessment
C1 Minimizing air emissions	A2 ■ 5-8 A4 ■ 1-6	A2 □ ___ A4 □ ___	A2 □ ___ A4 □ ___	A2 ■ 2-4 A5 ■ 2-5	A2 □ ___ A5 □ ___	A2 □ ___ A5 □ ___	A3 ■ 5-8 A4 □ ___	A3 □ ___ A4 □ ___	A3 □ ___ A4 □ ___	A3 ■ 4-7 A5 ■ 2-4	A3 □ ___ A5 □ ___	A3 □ ___ A5 □ ___	A4 ■ 1-3 A5 ■ 4-7	A4 □ ___ A5 □ ___	A4 □ ___ A5 □ ___
C2 Minimizing toxicity of hazardous waste	A2 ■ 2-5 A4 ■ 3-6	A2 □ ___ A4 □ ___	A2 □ ___ A4 □ ___	A2 ■ 2-5 A5 ■ 4-7	A2 □ ___ A5 □ ___	A2 □ ___ A5 □ ___	A3 ■ 2-5 A4 ■ 2-5	A3 □ ___ A4 □ ___	A3 □ ___ A4 □ ___	A3 ■ 3-5 A5 ■ 4-7	A3 □ ___ A5 □ ___	A3 □ ___ A5 □ ___	A4 ■ 1 A5 ■ 3-6	A4 □ ___ A5 □ ___	A4 □ ___ A5 □ ___
C3 Minimizing habitat destruction	A2 ■ 3-5 A4 ■ 1-3	A2 □ ___ A4 □ ___	A2 □ ___ A4 □ ___	A2 ■ 3-5 A5 ■ 1-8	A2 □ ___ A5 □ ___	A2 □ ___ A5 □ ___	A3 ■ 4-7 A4 ■ 1-3	A3 □ ___ A4 □ ___	A3 □ ___ A4 □ ___	A3 ■ 4-7 A5 ■ 1-3	A3 □ ___ A5 □ ___	A3 □ ___ A5 □ ___	A4 ■ 1-3 A5 ■ 2-5	A4 □ ___ A5 □ ___	A4 □ ___ A5 □ ___
C4 Resource efficiency	A2 ■ 2-4 A4 ■ 1-2	A2 □ ___ A4 □ ___	A2 □ ___ A4 □ ___	A2 ■ 2-4 A5 ■ 2-5	A2 □ ___ A5 □ ___	A2 □ ___ A5 □ ___	A3 ■ 4-6 A4 ■ 1-3	A3 □ ___ A4 □ ___	A3 □ ___ A4 □ ___	A3 ■ 4-7 A5 ■ 2-4	A3 □ ___ A5 □ ___	A3 □ ___ A5 □ ___	A4 ■ 1-3 A5 ■ 2-4	A4 □ ___ A5 □ ___	A4 □ ___ A5 □ ___
C5 Economic efficiency	A2 ■ 2-5 A4 ■ 3-6	A2 □ ___ A4 □ ___	A2 □ ___ A4 □ ___	A2 ■ 2-5 A5 ■ 2-5	A2 □ ___ A5 □ ___	A2 □ ___ A5 □ ___	A3 ■ 2-5 A4 ■ 2-4	A3 □ ___ A4 □ ___	A3 □ ___ A4 □ ___	A3 ■ 2-5 A5 ■ 2-5	A3 □ ___ A5 □ ___	A3 □ ___ A5 □ ___	A4 ■ 2-5 A5 ■ 2-5	A4 □ ___ A5 □ ___	A4 □ ___ A5 □ ___
C6 Market competitiveness	A2 ■ 2-5 A4 ■ 2-5	A2 □ ___ A4 □ ___	A2 □ ___ A4 □ ___	A2 ■ 1-4 A5 ■ 2-5	A2 □ ___ A5 □ ___	A2 □ ___ A5 □ ___	A3 ■ 2-5 A4 ■ 1-4	A3 □ ___ A4 □ ___	A3 □ ___ A4 □ ___	A3 ■ 4-7 A5 ■ 1-3	A3 □ ___ A5 □ ___	A3 □ ___ A5 □ ___	A4 ■ 1-3 A5 ■ 2-5	A4 □ ___ A5 □ ___	A4 □ ___ A5 □ ___
C7 Security of supply	A2 ■ 3-5 A4 ■ 1-3	A2 □ ___ A4 □ ___	A2 □ ___ A4 □ ___	A2 ■ 2-4 A5 ■ 2-5	A2 □ ___ A5 □ ___	A2 □ ___ A5 □ ___	A3 ■ 3-6 A4 ■ 2-5	A3 □ ___ A4 □ ___	A3 □ ___ A4 □ ___	A3 ■ 3-6 A5 ■ 1-3	A3 □ ___ A5 □ ___	A3 □ ___ A5 □ ___	A4 ■ 2-5 A5 ■ 2-5	A4 □ ___ A5 □ ___	A4 □ ___ A5 □ ___
C8 Distributional equity	A2 ■ 1-2 A4 ■ 1-2	A2 □ ___ A4 □ ___	A2 □ ___ A4 □ ___	A2 ■ 1-2 A5 ■ 2-4	A2 □ ___ A5 □ ___	A2 □ ___ A5 □ ___	A3 ■ 3-5 A4 ■ 1-2	A3 □ ___ A4 □ ___	A3 □ ___ A4 □ ___	A3 ■ 3-6 A5 ■ 1-3	A3 □ ___ A5 □ ___	A3 □ ___ A5 □ ___	A4 ■ 1 A5 ■ 1-3	A4 □ ___ A5 □ ___	A4 □ ___ A5 □ ___
C9 Minimizing risk to public health and safety	A2 ■ 2-5 A4 ■ 1-3	A2 □ ___ A4 □ ___	A2 □ ___ A4 □ ___	A2 ■ 2-4 A5 ■ 1-3	A2 □ ___ A5 □ ___	A2 □ ___ A5 □ ___	A3 ■ 3-5 A4 ■ 1	A3 □ ___ A4 □ ___	A3 □ ___ A4 □ ___	A3 ■ 2-5 A5 ■ 2-5	A3 □ ___ A5 □ ___	A3 □ ___ A5 □ ___	A4 □ ___ A5 ■ 3-6	A4 □ ___ A5 □ ___	A4 □ ___ A5 □ ___
C10 Heritage preservation	A2 ■ 2-4 A4 ■ 1	A2 □ ___ A4 □ ___	A2 □ ___ A4 □ ___	A2 ■ 3-4 A5 ■ 1-3	A2 □ ___ A5 □ ___	A2 □ ___ A5 □ ___	A3 ■ 2-5 A4 ■ 1	A3 □ ___ A4 □ ___	A3 □ ___ A4 □ ___	A3 ■ 2-4 A5 ■ 1	A3 □ ___ A5 □ ___	A3 □ ___ A5 □ ___	A4 ■ 1-3 A5 ■ 1-3	A4 □ ___ A5 □ ___	A4 □ ___ A5 □ ___
C11 Public acceptability	A2 ■ 1-3 A4 ■ 2-4	A2 □ ___ A4 □ ___	A2 □ ___ A4 □ ___	A2 ■ 1-5 A5 ■ 4-7	A2 □ ___ A5 □ ___	A2 □ ___ A5 □ ___	A3 ■ 4-7 A4 ■ 2-5	A3 □ ___ A4 □ ___	A3 □ ___ A4 □ ___	A3 ■ 2-5 A5 ■ 2-4	A3 □ ___ A5 □ ___	A3 □ ___ A5 □ ___	A4 ■ 1 A5 ■ 4-7	A4 □ ___ A5 □ ___	A4 □ ___ A5 □ ___

Comments (continue over if necessary): ______________________________

Document B: Instructions for Revisions

Assessment scale:

Intensity of relative preference	Definition of preference scale	Explanation Based on the given criterion for each factor, your Experience and judgement would conclude that:
1	Equally preferred	The two alternatives are *equally preferred*
3	Slightly preferred	One activity is *slightly preferred* over the other
5	Moderately preferred	One activity is *preferred* over the other
7	Strongly preferred	One activity is *strongly preferred* over the other
9	Extremely preferred	One activity is *extremely preferred* over the other
2,4,6,8	Intermediate values	Reflects preferences between the two adjacent judgments

The upper and lower hinges (approximately the 25th and 75th percentiles) for the groups' median responses are indicated in the first column for each pair of alternatives, followed by your individual assessment in the second column. If you wish to adjust your individual assessment in light of the upper and lower range of the groups' response, then please indicate your 'revised assessment' in the shaded column. *For your convenience, I have highlighted those cells where your individual assessment score deviates from the upper and lower hinges of the groups' median response for the alternative which you have selected.* However, please feel free to make any additional adjustments that you feel necessary. You are asked to only enter those scores for which make revisions.

	Alternatives A1 ---- A2		
	Group Assessment	Your Assessment	Revised Assessment
C1 Minimizing air emissions	A1 ■ 3-5 A2 ■ 7-9	A1 □ ____ A2 ■ 3	A1 □ ___ A2 □ Intensity

In the example shown above, the first column indicates the two median ranges for the groups' response. Some panellists expressed a *slight* (3) to *moderate* (5) preference for A1 over A2 in terms of minimizing greenhouse gases and other atmospheric emissions. Others expressed a *strong* (7) to *extreme* (9) preference for A2 over A1 in terms of minimizing emissions.

The second column indicates that your initial assessment reflects a *slight* (3) preference for A2 over A1. This cell is highlighted since your score falls outside the range of the groups' median score on alternative A2.

Should you choose to revise your initial assessment on A2 in light of the groups' assessment, please indicate your new choice/score in the shaded column.

Appendix F

Moran's *I* Statistic of Spatial Autocorrelation

Spatial Autocorrelation

Griffith (1987) suggests that 'autocorrelation' can be loosely defined as 'self-correlation'. In other words, autocorrelation involves only a single variable and refers to the correlation between pairs of observations based on that particular variable. Spatial autocorrelation then, is simply autocorrelation applied over space. When data are mapped, the map contains not only information about the values of the variables but also information on how those variables are arranged in space. Spatial autocorrelation statistics provide summary information about this arrangement: a measure of spatial dependence (Getis, 1995; Odland, 1988). Spatial autocorrelation is consistent with a comparison of two types of information: similarity of location and similarity among attributes. If features which are similar in location also tend to be similar in attribute, then the pattern as a whole is said to show positive spatial autocorrelation (Goodchild, 1986).

Moran's Index

Moran's index (Moran, 1948) provides a measure of spatial autocorrelation for data that are of an interval or ratio scale. Moran's *I* consists of the same components that define any correlation coefficient, whereby the numerator contains an expression of autocovariance which is standardized by the denominator measure of attribute variance. Spatial autocovariance measures the relation among nearby values of a point x_i, where 'nearby' is defined by the weight, or relative distance between nearest neighbours (Odland, 1988). For example, the weight for a pair of points might be '1' if the points are neighbors and '0' otherwise.

Equation

The basic equation for Moran's *I* is as follows:

$$I = \sum\sum w_{ij} c_{ij} / s^2 \sum\sum w_{ij}$$

Where:

$s^2 = \sum (z_i - \text{z-mean})^2 / n$
$c_{ij} = (z_i - \text{z-mean})(z_j - \text{z-mean})$
n = total number of location points
i = individual map location or coordinates
j = the corresponding nearest neighbor
z_i = the value of the weight for cell i
c_{ij} = the similarity of i's and j's attributes
w_{ij} = the weights of i and j

(Adapted from Bonham-Carter, 1994 and Goodchild, 1986)

I is negative for negative spatial autocorrelation and positive for positive spatial autocorrelation with measures of no autocorrelation at (-1/(n-1)). To test whether a derived measure of *I* differs significantly from the expected value, the variance of *I* can be calculated:

$$\text{var}(I) = [(n^2S_1 - nS_2 + 3S_0^2) / (S_0^2(n^2-1))] - (-1/(n-1))^2$$

Where: $S_0 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}$

$$S_1 = \sum_{i=1}^{n}\sum_{j=1}^{n} (w_{ij} + w_{ji})^2 / 2$$

$$S_2 = \sum_{i=1}^{n} (w_{i.} + w_{.i})^2$$

And the *z*-score test statistic is determined by:

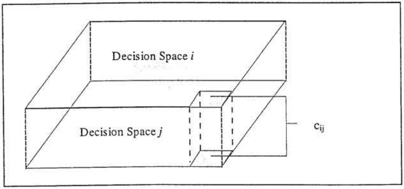
$$z_{I^\bullet} = (I - (-1/n-1)) / \text{var}(I)$$

Assumptions

The distributions of Moran's *I* can be obtained under a sampling assumption of either normality or randomization. As discussed in Chapter Five, assessment scores derived in the case study are not based on random sampling procedures. Rather, assessment data are collected using purposive, non-probabilistic sampling. However, the data are characteristic of independent samples drawn from a normal distribution. As the sample size increases, the distribution approaches normality. Thus, the *z*-score can be used as a test of significance.

Adaptation

This research proposes an adaptation of Moran's *I* to meet the requirements of the data presented. Individual cells in the assessment matrices can be assumed to represent decision points, or coordinates on a map. The assessment matrix itself can be assumed to represent the decision space of the assessment panel (i.e. the regional map).



Assuming that each cell in matrix *i* and each corresponding cell in matrix *j* are 'nearest neighbours', and that each cell in matrix *i* has only one neighbour, an adaptation of Moran's *I* can be applied to determine the degree of similarity, or dissimilarity between the decision spaces represented by each matrix. Given that each cell in matrix *i* is assumed to have only one nearest neighbour in matrix *j*, all cells can be assigned an equal weight of '1'. Thus, for two matrices consisting of 55 decision cells each:

$$I = \sum\sum w_{ij} c_{ij} / s^2 \sum\sum w_{ij}$$

Where:

$s^2 = \sum (z_k - \text{z-mean})^2 / n$
k = range over all i where k = 1… n.
$c_{ij} = (z_i - \text{z-mean}) (z_j - \text{z-mean})$
n = 110
i = an individual decision cell in the group decision space
j = the nearest neighbor of decision cell *i* in decision space *i*
z_i = the value of the weight for cell *i*
c_{ij} = the similarity of *i*'s and *j*'s attributes
$w_{ij} = 1$

A positive Moran's *I* is indicative of positively autocorrelated decision space, or 'decision similarity', whereas a negative Moran's *I* is indicative of negatively autocorrelated decision space, or 'decision dissimilarity'.

APPENDIX G

AHP Matrices

Private Sector

Criteria	Weights	Normalized	A1W	A2W	A3W	A4W	A5W
C1	0.16710	0.18801	0.07814	0.02720	0.04661	0.00647	0.01559
C2	0.12470	0.14030	0.03747	0.00760	0.01588	0.01651	0.04537
C3	0.13520	0.15212	0.03913	0.02784	0.04593	0.00959	0.01374
C4	0.06660	0.07493	0.01756	0.00903	0.02509	0.00387	0.00937
C5	0.03010	0.03387	0.00500	0.00436	0.00364	0.00677	0.00677
C6	0.01950	0.02194	0.00209	0.00385	0.00457	0.00238	0.00439
C7	0.06870	0.07730	0.01434	0.01253	0.01813	0.00880	0.00846
C8	0.03430	0.03859	0.00274	0.00429	0.01535	0.00550	0.00762
C9	0.16430	0.18486	0.04943	0.01958	0.04405	0.01085	0.02640
C10	0.04110	0.04624	0.01084	0.00925	0.01319	0.00434	0.00406
C11	0.03720	0.04185	0.00837	0.00290	0.01006	0.00359	0.01041
		Sum	0.26511	0.12843	0.24250	0.07867	0.15218

Public Sector

Criteria	Weights	Normalized	A1W	A2W	A3W	A4W	A5W
C1	0.14050	0.15198	0.06652	0.03404	0.03365	0.00547	0.01427
C2	0.14755	0.15961	0.02686	0.01053	0.01670	0.02402	0.04616
C3	0.10135	0.10963	0.01413	0.02366	0.02836	0.00997	0.00999
C4	0.06775	0.07329	0.01704	0.00924	0.02448	0.00479	0.00838
C5	0.04215	0.04559	0.00813	0.00440	0.00682	0.01245	0.00648
C6	0.03075	0.03326	0.00241	0.00424	0.00900	0.00913	0.00656
C7	0.06235	0.06745	0.00506	0.01342	0.02228	0.00636	0.00865
C8	0.04035	0.04365	0.00535	0.00522	0.01878	0.00409	0.00722
C9	0.18845	0.20385	0.03001	0.01897	0.05578	0.01717	0.04243
C10	0.05055	0.05468	0.00915	0.01304	0.01556	0.00598	0.00679
C11	0.05270	0.05701	0.00714	0.00386	0.01633	0.00719	0.01558
		Sum	0.19180	0.14062	0.24774	0.10662	0.17251

Consultants

Criteria	Weights	Normalized	A1W	A2W	A3W	A4W	A5W
C1	0.17420	0.19048	0.06299	0.02396	0.06560	0.00587	0.01958
C2	0.14275	0.15609	0.04022	0.00691	0.02577	0.01434	0.05896
C3	0.13895	0.15193	0.03908	0.01873	0.05503	0.00854	0.01382
C4	0.04970	0.05434	0.01203	0.00641	0.02466	0.00268	0.00605
C5	0.02600	0.02843	0.00419	0.00380	0.00305	0.00569	0.00569
C6	0.02415	0.02641	0.00189	0.00329	0.00494	0.00233	0.00809
C7	0.07165	0.07834	0.01130	0.00803	0.01988	0.01020	0.01886
C8	0.03770	0.04122	0.00278	0.00544	0.01074	0.00599	0.00157
C9	0.16770	0.18337	0.04394	0.01390	0.04878	0.00774	0.02206
C10	0.04665	0.05101	0.00897	0.01093	0.02003	0.00531	0.00281
C11	0.03510	0.03838	0.00336	0.00237	0.00943	0.00330	0.00922
		Sum	0.23075	0.10377	0.28791	0.07199	0.16671

Federal Government

Criteria	Weights	Normalized	A1W	A2W	A3W	A4W	A5W
C1	0.15805	0.17281	0.06893	0.03802	0.03692	0.00597	0.01499
C2	0.15135	0.16548	0.02785	0.01182	0.01402	0.03394	0.06980
C3	0.13880	0.15176	0.01646	0.04309	0.02886	0.01354	0.01326
C4	0.04975	0.05440	0.01265	0.00766	0.01195	0.00301	0.00774
C5	0.03600	0.03936	0.00675	0.00513	0.00512	0.01279	0.00533
C6	0.02125	0.02323	0.00150	0.00288	0.00661	0.00708	0.00363
C7	0.05010	0.05478	0.00393	0.00882	0.01962	0.00390	0.01463
C8	0.04780	0.05226	0.00584	0.00635	0.01820	0.00372	0.01677
C9	0.17060	0.18653	0.02718	0.02921	0.03046	0.01360	0.05670
C10	0.04875	0.05330	0.01233	0.01607	0.00876	0.00513	0.00670
C11	0.04215	0.04609	0.00546	0.00333	0.01065	0.00694	0.01884
		Sum	0.18888	0.17238	0.19117	0.10962	0.22839

Industry

Criteria	Weights	Normalized	A1W	A2W	A3W	A4W	A5W
C1	0.10175	0.12085	0.04302	0.03128	0.02729	0.00436	0.00769
C2	0.10680	0.12685	0.02396	0.00691	0.01353	0.02291	0.04386
C3	0.11930	0.14169	0.01869	0.03700	0.04265	0.00973	0.01090
C4	0.06620	0.07863	0.01714	0.00989	0.02751	0.00396	0.00994
C5	0.06885	0.08177	0.01029	0.01624	0.01029	0.02574	0.02075
C6	0.02825	0.03355	0.00273	0.00766	0.00727	0.00431	0.00503
C7	0.10790	0.12815	0.01994	0.03502	0.02394	0.02827	0.01239
C8	0.03250	0.03860	0.00233	0.00496	0.01066	0.00413	0.00772
C9	0.12085	0.14354	0.03281	0.01888	0.03257	0.01067	0.02871
C10	0.04170	0.04953	0.00991	0.01134	0.01599	0.00426	0.00440
C11	0.04785	0.05683	0.00894	0.00440	0.01320	0.00582	0.01793
		Sum	0.18976	0.18358	0.22490	0.12416	0.16932

NGOs

Criteria	Weights	Normalized	A1W	A2W	A3W	A4W	A5W
C1	0.17600	0.19060	0.09682	0.02095	0.04500	0.00652	0.01851
C2	0.15420	0.16699	0.06974	0.00858	0.01853	0.01378	0.02974
C3	0.11300	0.12237	0.04329	0.01799	0.02965	0.00954	0.01167
C4	0.07970	0.08631	0.04041	0.00911	0.01734	0.00481	0.01117
C5	0.02800	0.03032	0.01247	0.00203	0.00307	0.00438	0.00374
C6	0.01950	0.02112	0.00411	0.00286	0.00662	0.00253	0.00264
C7	0.06290	0.06812	0.02802	0.00844	0.02222	0.00743	0.00428
C8	0.04460	0.04830	0.00688	0.00520	0.02467	0.00615	0.00615
C9	0.18060	0.19558	0.07675	0.02177	0.04088	0.00915	0.02544
C10	0.03370	0.03650	0.01366	0.00648	0.00730	0.00387	0.00381
C11	0.03120	0.03379	0.00845	0.00363	0.00927	0.00248	0.00643
		Sum	0.40060	0.10704	0.22455	0.07064	0.12358

Provincial Government

Criteria	Weights	Normalized	A1W	A2W	A3W	A4W	A5W
C1	0.13625	0.14610	0.06509	0.03273	0.03419	0.00564	0.01372
C2	0.14095	0.15114	0.02621	0.00989	0.03141	0.02037	0.03116
C3	0.09465	0.10149	0.01507	0.02189	0.03218	0.00923	0.01145
C4	0.07840	0.08407	0.01622	0.01058	0.02951	0.00667	0.00718
C5	0.05005	0.05367	0.00957	0.00442	0.00803	0.01220	0.00814
C6	0.03220	0.03453	0.00343	0.00440	0.00860	0.00755	0.00681
C7	0.07315	0.07844	0.00713	0.01693	0.02416	0.01217	0.00771
C8	0.03255	0.03490	0.00475	0.00410	0.01703	0.00404	0.00469
C9	0.19115	0.20496	0.04712	0.01675	0.08105	0.01891	0.04071
C10	0.05055	0.05420	0.00821	0.01175	0.01797	0.00606	0.00641
C11	0.05270	0.05651	0.00787	0.00330	0.02258	0.00604	0.01150
		Sum	0.21067	0.13674	0.30671	0.10888	0.14948

Central Region

Criteria	Weights	Normalized	A1W	A2W	A3W	A4W	A5W
C1	0.14625	0.16005	0.05674	0.02821	0.03478	0.00575	0.01189
C2	0.14665	0.16048	0.02622	0.01146	0.01496	0.02898	0.06477
C3	0.09335	0.10216	0.01347	0.01952	0.02654	0.00947	0.00855
C4	0.04975	0.05444	0.01350	0.00674	0.01619	0.00329	0.00586
C5	0.03450	0.03775	0.00536	0.00496	0.00437	0.00904	0.00515
C6	0.03195	0.03496	0.00336	0.00699	0.00851	0.00660	0.00600
C7	0.06345	0.06944	0.00943	0.01341	0.01747	0.00609	0.00846
C8	0.05055	0.05532	0.00537	0.00992	0.01851	0.00578	0.01122
C9	0.18845	0.20623	0.03001	0.02594	0.05232	0.01481	0.02139
C10	0.04770	0.05220	0.00987	0.01125	0.01299	0.00543	0.00596
C11	0.06120	0.06697	0.00977	0.00571	0.01611	0.00728	0.02334
		Sum	0.18310	0.14411	0.22275	0.10252	0.17259

Eastern Region

Criteria	Weights	Normalized	A1W	A2W	A3W	A4W	A5W
C1	0.17480	0.19520	0.08917	0.04372	0.03467	0.00650	0.02171
C2	0.14100	0.15745	0.04205	0.00810	0.02168	0.02113	0.03351
C3	0.11495	0.12836	0.03624	0.02620	0.03123	0.01035	0.01551
C4	0.06910	0.07716	0.01941	0.00807	0.02654	0.00427	0.00975
C5	0.03335	0.03724	0.00664	0.00359	0.00476	0.00927	0.00706
C6	0.02560	0.02859	0.00269	0.00339	0.00620	0.00604	0.00588
C7	0.06470	0.07225	0.01012	0.01293	0.01859	0.00788	0.01024
C8	0.03440	0.03841	0.00447	0.00441	0.01614	0.00524	0.00585
C9	0.16515	0.18442	0.05911	0.01712	0.03771	0.01367	0.04404
C10	0.03855	0.04305	0.01108	0.00937	0.01016	0.00363	0.00527
C11	0.03390	0.03786	0.00504	0.00232	0.00998	0.00428	0.00884
		Sum	0.28602	0.13922	0.21766	0.09226	0.16766

Western Region

Criteria	Weights	Normalized	A1W	A2W	A3W	A4W	A5W
C1	0.14120	0.15535	0.06790	0.02247	0.03972	0.00555	0.01035
C2	0.12470	0.13720	0.02472	0.00755	0.02317	0.01977	0.03151
C3	0.14220	0.15645	0.02294	0.03349	0.05619	0.00844	0.01009
C4	0.09560	0.10518	0.01971	0.01602	0.03513	0.00607	0.01203
C5	0.05020	0.05523	0.00820	0.00750	0.00886	0.00750	0.00939
C6	0.01960	0.02156	0.00153	0.00279	0.00551	0.00342	0.00444
C7	0.06930	0.07625	0.00706	0.01217	0.02430	0.01336	0.00840
C8	0.03270	0.03598	0.00267	0.00392	0.01644	0.00318	0.00699
C9	0.14330	0.15766	0.04343	0.01406	0.03840	0.01208	0.03171
C10	0.05100	0.05611	0.00997	0.01230	0.02103	0.00627	0.00392
C11	0.03910	0.04302	0.00654	0.00339	0.01840	0.00354	0.00946
		Sum	0.21467	0.13566	0.28715	0.08918	0.13829

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