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An Analysis of the Ontario Power Authority's Consideration of Environmental Sustainability in Electricity System Planning

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An Analysis of the Ontario Power Authority's Consideration of Environmental Sustainability in Electricity System Planning

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Executive Summary

This report focuses on the Ontario Power Authority's (OPA) consideration of environmental sustainability in the development of the proposed *Integrated Power System Plan* (IPSP). The research was centred on a comparison of what the OPA did with what should reasonably be expected of the OPA in meeting the requirement, contained in Ontario Regulation 277/06 (The IPSP Regulation), for ensuring due consideration of environmental sustainability in plan development. In its decision on issues to be considered in the IPSP hearing, the Ontario Energy Board indicated that in order to meet this requirement the OPA is required to demonstrate that it has "weighed and evaluated" environmental sustainability in a way that is "meaningful" in the development of the IPSP.

In its *IPSP Discussion Paper 6* on sustainability, the OPA embraces sustainability as the basis for "integrated evaluation" in the development of the plan. More specifically, in describing its approach to sustainability-based evaluation, the OPA indicates that it has grounded its decision-making process around the eight core sustainability requirements and six trade-off rules set out in the book, *Sustainability Assessment: Criteria and Processes,* by Robert B. Gibson and colleagues. According to the discussion paper, "The OPA's approach to considering sustainability is to derive context-specific evaluation criteria that encompass Gibson's sustainability requirements."

In this context, the research reported here assessed the adequacy of the OPA's consideration of environmental sustainability in the development of the IPSP in light of three main considerations:

- whether development of the IPSP was underpinned from the outset by explicit adoption of the basic objective to contribute positively to sustainability,
- whether the objective was elaborated for practical application through elaboration of a comprehensive framework of planning and assessment criteria covering core sustainability requirements and trade-off rules, as articulated by Gibson et.al., suitably specified for the case and context; and
- whether the basic objective and criteria were applied consistently as an integrated whole throughout the development of the IPSP and achieved reasonably in the Preliminary and Final Plans, taking into consideration trade-offs between various options and scenarios.

Key planning documents and activities representing the major stages of the development of the IPSP were analysed to determine the degree to which the OPA used, at least implicitly, evaluation and decision criteria that meet the following fundamental expectations:

- cover all generic sustainability requirements articulated by Gibson et. al., including:
    - socio-ecological system integrity;
    - livelihood sufficiency and opportunity;
    - intragenerational and intergenerational equity;
    - cost-effectiveness, efficiency and resource maintenance;
    - prudence, precaution, resilience and adaptive capacity;
    - democratic governance; and
    - immediate and long-term integration issues;
- were specified adequately for the particular case and context;
- were applied consistently as an integrated framework for decision making; and
- were capable of identifying, and guiding decision making with respect to, major trade-offs among core sustainability requirements that might emerge in the course of the development of the IPSP.

An analysis of the key OPA documents and activities related to sustainability matters, based on the foregoing framework, indicates that the requirement for ensuring meaningful consideration of environmental sustainability in the development of the IPSP was not met. The report highlights the following eight core deficiencies in the OPA's "consideration" of environmental sustainability in the development of the IPSP:

1. The OPA did not establish clearly at the outset the basic objective that the planning and the Plan would strive to contribute positively to sustainability and that this would serve as the foundational criterion for evaluations and decisions.
2. The OPA's context-specific planning criteria were not comprehensive enough to cover all of the generic sustainability requirements identified by Gibson et al. The analysis reveals major gaps in the OPA's context-specific planning criteria with respect to all eight generic sustainability requirements. The OPA's treatment of intra and intergenerational equity, and immediate and long-term integration was especially deficient. Major gaps are also identified with respect to socio-ecological integrity,

livelihood sufficiency and opportunity, efficiency and cost-effectiveness, and prudence, precaution and adaptation.

3. The OPA introduced its context-specific planning criteria after it had prepared the *Supply Mix Advice Report*, which provided the foundation for the Minister of Energy's June 2006 Supply Mix directive, which in turn guided the overall direction of the IPSP. Development of the IPSP was already far advanced at the time the OPA began consideration of Gibson et.al's sustainability-based decision-making framework.

4. The OPA did not apply its context-specific planning criteria comprehensively and consistently to the various potential system components or "building blocks" of the IPSP, including the major supply and conservation and demand management options, or transmission system options. Major gaps in discussions of individual supply and demand options contained within the IPSP with respect to generic sustainability requirements have been identified by external governmental and non-governmental stakeholders, and by consultants retained by the OPA itself. Particularly noteworthy is the OPA's failure to apply a comprehensive life-cycle approach to consideration of the environmental performance of CDM and supply options. This left major gaps in the OPA's consideration of implications for socio-ecological integrity, intra and intergenerational equity, efficiency and cost-effectiveness and prudence and precaution.

5. The OPA failed to apply its context-specific planning criteria consistently at the level of the overall plan in such a way to allow for an integrated evaluation of alternatives and trade-offs.

6. Despite recognition of the sustainability-based trade-off rules set out by Gibson et al., the OPA has not provided a comprehensive and explicit identification of the major trade-offs involved in its choices about what options to favour at the component or overall plan levels at any stage in the development of the IPSP. The referenced trade-off rules also require an explicit rationale for each proposed trade-off, but the OPA has also not provided such rationales.

7. The analysis found no evidence of how the OPA's decision making with respect to the IPSP was affected by, or altered as a result of, the consideration of environmental sustainability.

8. The OPA did not provide guidance for further specification and application of sustainability-based criteria in the anticipated more detailed planning and decision making concerning particular sub-plans and projects under the IPSP.

The OPA's selected "context specific" planning and evaluation criteria appear to rest on traditional concerns of power system planning, rather than on a direct effort to specify the recognized generic core sustainability requirements. The result was a compilation of considerations that are not sufficiently comprehensive or well integrated to cover basic sustainability requirements in a systemic way.

To illustrate the basics for ensuring due consideration of sustainability, and to assist the Ontario Energy Board (OEB) in its deliberations, this report outlines the fundamentals of an appropriate approach and provides an illustrative application to clarify the differences between this approach and the approach taken by the OPA.

The first step in the appropriate approach is explicit adoption of the fundamental sustainability objective of achieving multiple, mutually reinforcing and lasting improvements in all the interrelated areas of sustainability concern, while avoiding significant adverse effects. On this foundation, sustainability-based planning builds and then applies a comprehensive set of case-specified sustainability criteria and trade-off rules.

The illustrative application provided in the report includes presentation of a comprehensive set of sustainability criteria and trade-off rules that are based on Gibson et al. and specified for the case and context of integrated power system planning in Ontario. These specified criteria and trade-off rules are then applied in three exercises. The first takes each of the comprehensively specified criteria and trade-off rules and assesses whether it is addressed fully, partially or not at all by the OPA's "context specific evaluation criteria". The second exercise applies the comprehensively specified criteria and trade-off rules in an assessment of the potential CDM, supply and transmission components of a comprehensive integrated power system plan for Ontario. Finally, the comprehensively specified criteria and trade-off rules are used in a comparative overall plan level evaluation of the IPSP as presented by the OPA and an alternative proposal prepared by the World Wildlife Fund (WWF) and the Pembina Institute.

These illustrative applications of a comprehensive sustainability assessment framework suggest that a meaningful approach to sustainability considerations, guided by the fundamental sustainability objective, would point to choices substantially different from those contained in the IPSP proposal. Meaningful consideration of sustainability requirements would support coal phase-out as in the IPSP, but in contrast to the IPSP it would emphasize the following gains and associated plan components:

- Fewer and less significant adverse present and future effects on socio-ecological integrity within and beyond Ontario achieved by pursuing the province’s maximum achievable CDM potential, and increasing reliance on renewable supply resources that avoid the major upstream and downstream biophysical and social effects and the ecological, economic and political risks associated with uranium, coal and natural gas fuel cycles.

- Increased system resilience, reliability and adaptive capacity and reduced cost risks achieved by placing greater emphasis on adding supply resources incrementally and employing technologies that have shorter planning and construction timelines (less than 5 years) and that can be deployed on a modular and distributed basis.
- Greater system efficiency and cost-effectiveness achieved by reducing the role of low-efficiency uses of natural gas (e.g. single cycle gas turbines) though demand response measures and placing greater emphasis on high efficiency uses of natural gas, particularly cogeneration for intermediate and baseload supply.
- Lower path dependency, fewer technological and economic risks, and greater adaptive capacity achieved by reducing the role of large centralized supply resources, particularly nuclear power plants, with long planning and construction timelines and long facility lifetimes. Where nuclear resources are considered, refurbishment projects, with their lower path dependency, technological and economic risks, would be preferred over new build projects.

A plan with these characteristics, many of which are reflected in the WWF-Canada and Pembina Institute’s *Renewable is Doable* proposal, would still comply with the requirements of the Minister of Energy’s June 2006 Supply Mix Directive. As the OEB itself has noted, the directive permits the IPSP to incorporate CDM and renewable components beyond the minimum levels specified in the directive. Similarly, the IPSP may limit the nuclear component to a level below the cap identified in the directive, while emphasizing high efficiency uses of natural gas.

The OEB could adopt and apply the illustrated approach to considering sustainability, including the comprehensive set of case-specified sustainability criteria and trade-off rules, in its examination of the OPA proposal. These criteria and rules would be appropriate in the OEB’s evaluations and decisions with respect to the following matters:

- what portions of the IPSP are and are not worthy of approval as proposed;
- what revisions should be required;
- what terms and conditions of approval would be appropriate;

- what guidance needs to be provided for planning and decision making on subsidiary and subsequent more detailed plans and projects under the IPSP; and
- what must be addressed in future iterations of the IPSP to ensure proper incorporation of sustainability requirements in planning and decision making.

Overall, the analysis reported here indicates that the OPA has not met the requirement for consideration of environmental sustainability in the development of the proposed IPSP and that due attention to sustainability requirements would favour a quite different plan. The clear implication is that the current plan cannot be approved as it stands as it has failed to met the requirement of the IPSP regulation of ensuring due consideration of environmental sustainability in its development.

In light of the need to advance the renewal of Ontario's electricity system, those aspects of the plan that are evidently compatible with sustainability objectives, including the plan's CDM and low-impact renewable energy components and the phase out of coal-fired generation, could be accepted on an enhanced basis. In the areas of significant conflict between the proposed IPSP and the likely conclusions of planning flowing from sustainability-based evaluation, including the plan's nuclear components and low-efficiency applications of natural gas, the OEB would be justified in requiring the OPA to reconsider these options in light of comprehensive, properly specified and carefully applied sustainability criteria and trade-off rules, and to submit a suitably revised IPSP for the next triennial review.

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1. Introduction

The Ontario Power Authority (OPA) has submitted a 20-year Integrated Power System Plan (IPSP) for review by the Ontario Energy Board (OEB). Submission of this plan is intended to meet requirements set out chiefly in three authoritative documents: the Ontario *Electricity Act, 1998,* as amended, the IPSP Regulation (Ontario Regulation 424/04) under that Act, and the Ontario Minister of Energy's "Supply Mix Directive," issued on 13 June 2006. The main requirements relevant to this report are those concerning compliance with the supply mix directions, assurance of economic prudence and cost effectiveness, and consideration of safety, environmental protection and environmental sustainability in the development of the plan.

This report focuses on the OPA's consideration of environmental sustainability in the development of the plan. We examine what the OPA did and contrast that with what should reasonably be expected for the OPA to meet the requirement for ensuring due consideration of environmental sustainability in plan development.

In this examination, we adopt a broad definition of "environment" (as do the IPSP Regulation and the Ontario *Environmental Assessment Act,* which will apply to projects guided by the IPSP). We also recognize (as does the OPA) that sustainability is an overarching concept that incorporates and stresses interactions among the full suite of factors needed for movement towards a desirable and durable future. Consequently, in our work, consideration of environmental sustainability in the development of the IPSP includes attention to matters of prudence and cost effectiveness, as well as conservation, renewability, reliability, flexibility and other factors relevant to the pursuit of sustainability through integrated power system planning.

In its *IPSP Discussion Paper 6* on sustainability, the OPA embraces sustainability as the basis for "integrated evaluation" in the development of the plan.[1] The OPA begins explanation of its approach to sustainability-based evaluation with discussion of broad sustainability principles, referring specifically to the eight sustainability requirements and six trade-off rules set out in the book, *Sustainability Assessment: Criteria and Processes,* by Robert B. Gibson and colleagues. According to the discussion paper, "The OPA's approach to considering sustainability is to derive context-specific evaluation criteria that encompass Gibson's sustainability requirements."[2]

In this report, we begin with the same understanding of the sustainability concept and the same generic set of sustainability requirements and trade-off rules. We also agree that the proper next step is to develop evaluation criteria that encompass the generic requirements but are specified for the particular case and context. Whether the OPA has done a satisfactory job of clarifying the sustainability objective, of specifying the generic requirements, of applying the resulting criteria, and of meeting its obligations to ensure consideration of sustainability in the development of the plan, are questions we will be addressing here.

As a foundation for this analysis, we begin with a discussion of the essentials of sustainability-based assessment, including the generic principles that the OPA presents as its starting point in *Discussion Paper 6,* how they are to be specified for application in particular cases and contexts and how they are to be applied in developing a plan.

2. Sustainability

2.1 The concept and its foundations

2.1.1 The basics

Sustainability is essentially an integrative concept and sustainability-based planning is an essentially integrative approach to the preparation of and decision making on an undertaking or set of undertakings. Together they respond to two big problems, both of which are rooted in narrow motivations, fragmented decision making and a focus on near term effects. The first is our long record of costly surprises and missed opportunities resulting from ill-considered individual undertakings. The second is the increasingly gloomy prospects for human survival and wellbeing evident in key global scale trends.

At the scale of individual undertakings, the need for better planning and decision making is evident in the legacy of agricultural advances that further impoverished the starving, urban renewal projects that destroyed neighbourhoods, development assistance projects that undermined livelihoods, and conservation initiatives that alienated local stewards. All of these undertakings were well intentioned. All of them brought benefits, at least for some people and for some time. But the adverse results have undermined the gains and in retrospect, were often unnecessary. Many if not most could have been avoided if the initial planning had looked further ahead; if a more complete range of issues, interests and options had been taken into account; if local conditions, cultures and capacities had been respected; and if there had been a more determined effort to achieve multiple and durable gains, especially for those most in need.

At the global scale, sustainability-based planning is rooted in fears for our future. It faces the evident need to reverse deeply entrenched patterns of human action that are reducing biodiversity, impairing ecosystem functions, deepening the gap between rich and poor, altering climate chemistry, depleting ground water resources, and fostering greater material consumption among the already comfortable while failing to meet the basic material needs of billions. There is room for disagreement about whether, and if so to what extent, the human load on the planet already exceeds the globe's biophysical carrying capacity. But the trend is clearly towards ever-deeper unsustainability. Despite improved efficiencies and damage reduction on many fronts, our overall material and energy demands and our associated disruptions of biophysical systems are growing implacably. Unless we begin quite quickly to reverse this trend our future prospects will be increasingly grim. At the same time, however, we must for practical as well as moral reasons act to meet the needs of the many people now living in conditions of material deprivation and insecurity. Somehow, sustainability-based decision making must find ways to reconcile the imperatives for growth (at least for the poor) and reduction of burdens on the biosphere. How this may be achieved – through what combinations of efficiency and redistribution, innovation and stewardship, etc. – may be debated. But it is clear that these imperatives must be addressed together.

On this initial basis, sustainability-based planning is best conceived as an approach to planning decision making that respects global imperatives and local context; that recognizes the interdependence of ecological, social and economic objectives; and that seeks comprehensively positive, mutually reinforcing, fairly distributed and lasting gains.

These are considerations central to responsibly well informed, prudent and far-sighted development of all significant initiatives, including integrated power system plans at the provincial scale. They are especially necessary in cases, such as development of the IPSP, where there has been explicit direction to ensure consideration of environmental sustainability.

2.1.2 Eight complementary factors

Over the past decade or so, rising global attention to sustainability needs has been accompanied by several other factors that contribute to the foundations for sustainability-based planning:

- expanded awareness of the interconnections among social, ecological and economic factors, especially in areas of pressing public concern and controversy (e.g., health, security, livelihood maintenance and opportunities, and future quality of life);
- advances in understanding complex systems (multiple interacting factors and dynamic self-organizing processes in multiple interacting systems, at various scales, with pervasive and inevitable uncertainties, and key roles for resilience characteristics such as diversity, flexibility, modularity, etc.);
- recognition that many development failures and other tragedies have been traceable to neglect of factors outside the primary focus of the proponents and/or approving authorities;
- continuing economic globalization combined with concerns about its implications for distributive justice, cultural identity, and ecological stewardship;

- pressures on public authorities and private enterprises to enhance efficiencies, including by getting multiple benefits from individual initiatives;
- growing recognition of the limitations of both governments and markets, and consequent shifts to more broadly-based and open governance regimes;
- repeated lessons from experience that broad rules and general approaches must always be respectful of and specified for the particulars of the context – the cultures, capacities and concerns, assets, stresses and vulnerabilities of different communities and ecosystems; and
- spreading acceptance of the precautionary principle in response to deepening concerns about global scale health and ecological risks, and declining faith in the potential adequacy of scientific knowledge and technical repair.

All of these factors influence efforts to move towards greater sustainability and all of them add both to the richness of our understanding and to the sets of consideration we need to incorporate in sustainability-based planning.

2.2 Sustainability planning best practice

Practical applications of the sustainability concept have ranged widely from green building standards and forest stewardship certification, to blueprints for corporate sectoral reform, urban growth management plans and national sustainability strategies. Many of these include, or are in effect, initiatives in sustainability planning. In addition, more or less formal sustainability planning and assessment processes (sometimes called integrated assessment, sustainability appraisal, triple-bottom-line evaluation, etc.) have been spreading rapidly in planning and assessment at the project and strategic levels.

While "best practice" will always depend to some extent on particular circumstances, the common characteristics of serious sustainability-based planning efforts are evident. They are as follows:

- objectives centred on positive contribution to sustainability as the basic criterion for evaluations and decisions;
    - aiming to identify the best option, achieved in part by comparative consideration of possibly reasonable alternatives;
    - focusing on net gains as well as avoidance of significant (especially, permanent) losses; and

    - seeking to achieve multiple, mutually reinforcing and lasting improvements in all the interrelated areas of sustainability concern, in addition to serving core project purposes;
- evaluation and decision criteria comprehensive of all requirements for progress towards sustainability, and their interrelations (including all factors that may affect prospects for meeting these requirements):
    - covering the full set of general requirements for progress towards sustainability;
    - specified though inclusion of particular sustainability considerations, relevant to the case and context (ecological, cultural, socio-economic, etc.);
    - developed in part through direct engagement of stakeholders in identifying key case-specific concerns and priorities;
    - giving explicit attention to, and open rationales for, trade-offs among the recognized objectives;
    - elaborated as well as applied in an iterative manner; and
- integration of attention to sustainability objectives and criteria throughout the full planning and decision making process (not just at a review stage):
    - applying sustainability objectives and criteria in defining of purposes, identification of alternatives, assessment of potential effects and mitigation/enhancement options, comparative evaluation of options, preparation of detailed designs, review and approval deliberations, implementation and monitoring, and eventual decommissioning or renewal of undertakings; and
    - seeking contributions to sustainability through the assessment process itself as well as through the better decisions that result, achieved in part through incorporating open participative approaches, respecting different interests, and integrating different kinds of knowledge.

All of these characteristics are appropriate for application to integrated power system planning in Ontario and ought to be evident in the record of the OPA's work on the plan as well as in the substance of the plan as submitted. In a manner consistent with the adoption of sustainability as a core concern throughout the planning and decision-making process, the IPSP Regulation requires the OPA to "ensure that safety, environmental protection and environmental sustainability are considered *in developing the plan*" (italics added).[3] In its decision on issues to be considered in the IPSP hearing, the Ontario Energy Board indicated that in order to meet this requirement the OPA is required to demonstrate that it has "weighed and evaluated" environmental sustainability in a way that is "meaningful" in the development of the IPSP.[4]

2.3 The objective of sustainability-based planning

Proper consideration of sustainability begins with adoption of "positive overall contribution to sustainability" as the basic objective. The positive contribution test contrasts with the more modest goal of avoiding or mitigating significant adverse effects that underlies many regulatory and environmental assessment regimes. In Ontario, environmental assessment has since 1975 aimed beyond mitigation, seeking instead "the betterment of people of the whole or any part of Ontario" and requiring (with exceptions) comparative evaluation of alternatives.[5] Implicitly at least, "betterment" rather than mitigation is also the objective underlying the province's electricity system planning regime.

The contribution to sustainability test clarifies what is required for betterment, recognizing three key insights underlying the notion of sustainability:

- the importance of respecting the interests of future as well as present generations,
- the need to reverse trends that are leading us away from a desirable and durable future, and
- the interdependence of social, economic and ecological factors.

Taken together, these clarifications establish the objective of sustainability-based planning: to adopt from among the available options the one (or the package) that offers the most promising set of multiple, mutually reinforcing and lasting improvements in all the interrelated areas of sustainability concern, while avoiding significant adverse effects.

A suitable test of whether the OPA ensured proper consideration of sustainability in developing the IPSP is whether this objective was clearly set at the outset, applied consistently throughout the planning, and achieved reasonably in the submitted plan.

Like most planning undertakings, even in the public sector, the OPA's IPSP has a set of relatively narrow particular purposes as well as a general obligation for betterment and consideration of sustainability effects. The narrower purposes are, however, reasonably treated as a subset of the overarching sustainability agenda. Moreover, sustainability-based planning offers a means both of enhancing service to these purposes and of extending complementary gains in other areas. To ensure attention to the full range of possible benefits, the planning process must identify all of the areas in which gains are needed and adverse effects must be avoided, and it must provide a basis for making judgments about what concerns are most important, what effects are most significant, and what options are most desirable.

2.4 Criteria for evaluations and decision making in sustainability planning

The "contribution to sustainability" objective is crucial for setting the broad agenda and overall expectations, but it is too general to serve as an adequate guide for evaluations and decision making. For practical applications, more specific criteria are needed. These criteria must include and integrate attention to three sets of considerations, recognizing that sustainability is both a global and context-specific objective:

- the basic generic criteria that represent the essential requirements for progress towards sustainability and that apply to all planning initiatives, everywhere, plus details as needed to ensure attention to all the key components and aspects of each requirement;
- the particular problems and possibilities of the particular case and context, which are inevitably important specifying the requirements and identifying the priorities in the planning and implementation of any undertaking meant to contribute to sustainability; and
- the basic rules for dealing with trade-offs where there is conflict between objectives and attaining one desired result seems likely to entail compromising or sacrificing another.

Properly consolidated, these criteria form a comprehensive and integrated foundation for sustainability-based planning and decision making. Further specification may be needed, for subsidiary applications – for instance where planning of more detailed components or individual projects is initiated under the broad strategic guidance of the initial policies, programmes or plan. In the case of the IPSP, sustainability-based criteria for the development of the overall plan will likely need to be specified for the more particular case and context of each major project proposal developed under the plan.

2.4.1 Generic sustainability requirements and assessment criteria

The generic requirements for progress towards sustainability can be set out in many ways and many formulations have been proposed and applied. The basic framework of core generic criteria favoured by the OPA in *Discussion Paper 6*, and used in this report, is taken from Robert B. Gibson et al, *Sustainability Assessment: Criteria and Processes.* It has the advantage of being based on a synthesis of insights from the sustainability literature and applied sustainability experience as well as from a review of many other sets of sustainability assessment criteria developed for a wide range of particular applications. Moreover, it is accompanied by a set of associated trade-off rules. The generic criteria categories are reproduced in *Discussion Paper 6,* appendix 1, but for convenience are also included here in the following box.

Box 1: Core Generic Criteria for Sustainability Assessments

Socio-ecological system integrity
Build human-ecological relations to establish and maintain the long term integrity of socio-biophysical systems and protect the irreplaceable life support functions upon which human as well as ecological well-being depends.

Livelihood sufficiency and opportunity
Ensure that everyone and every community has enough for a decent life and that everyone has opportunities to seek improvements in ways that do not compromise future generations' possibilities for sufficiency and opportunity.

Intragenerational equity
Ensure that sufficiency and effective choices for all are pursued in ways that reduce dangerous gaps in sufficiency and opportunity (and health, security, social recognition, political influence, etc) between the rich and the poor.

Intergenerational equity
Favour present options and actions that are most likely to preserve or enhance the opportunities and capabilities of future generations to live sustainably.

Resource maintenance and efficiency
Provide a larger base for ensuring sustainable livelihoods for all while reducing threats to the long term integrity of socio-ecological systems by reducing extractive damage, avoiding waste and cutting overall material and energy use per unit of benefit.

Socio-ecological civility and democratic governance
Build the capacity, motivation and habitual inclination of individuals, communities and other collective decision-making bodies to apply sustainability requirements through more open and better informed deliberations, greater attention to fostering reciprocal awareness and collective responsibility, and more integrated use of administrative, market, customary and personal decision-making practices.

Precaution and adaptation
Respect uncertainty, avoid even poorly understood risks of serious or irreversible damage to the foundations for sustainability, plan to learn, design for surprise, and manage for adaptation.

Immediate and long term integration
Apply all principles of sustainability at once, seeking mutually supportive benefits and multiple gains.

It is important to recognize that this box only sets out the broad requirements and summarizes very briefly the substantive obligations. Each criterion is effectively a category involving many interactive considerations. In practical applications these considerations need to be set out in some detail (and, as discussed below, they need to be specified for the case and context).

The eight generic criteria are designed to incorporate all of the key requirements for progress towards sustainability and to apply to all cases. They are a package – all of the requirements are necessary for sustainability; positive gains in all areas must be achieved, and what happens in any one area affects what happens in all of the others. Each component is necessary and, as the final criterion emphasizes, all the components are interconnected.

The objective of multiple, mutually reinforcing and durable gains depends on and exploits this interconnection. The idea is that, especially over the long term, efforts to meet the various requirements for sustainability – to strengthen ecological stewardship and sustainable livelihoods and informed citizen engagement and energy/material efficiencies and equitable distribution of benefits and risks, etc. – can each support and enhance the others. Consequently the aim of sustainability-based planning and decision making is not to balance these requirements as competing ends but rather to integrate and pursue them jointly.

2.4.2 Specification of sustainability assessment criteria for particular cases and contexts

The generic criteria and trade-off rules are fundamental but not sufficient guides for sustainability-based planning and decision making. For practical applications, it is necessary also to recognize the particular concerns and possibilities raised by case- and context-specific factors.

While the generic criteria are designed to ensure attention to all of the major requirements for progress towards sustainability, specification for the case and context is required to ensure proper sensitivity to the factors that may affect how the generic requirements can be most successfully pursued in particular circumstances. The factors include particular conditions and trends, resources, capacities and other assets, opportunities and barriers, concerns and aspirations, stresses and vulnerabilities. All of these vary more or less significantly among different cultures, ecosystems, jurisdictions and sectors, etc. And all of them involve a particular mix of considerations at various interrelated scales from the global (global climate change and the availability and prices of internationally traded commodities) to the local (employment needs of particular communities and the assimilative capacity of individual bodies of water).

Sometimes the main peculiarities of a case and context will be evident. This is particularly true in cases such as electrical power system planning Ontario where there has been a long history of open public deliberation on overall system issues and on many of the component technologies, as well as a rich public policy context including law and other guidance, and access to extensive public and professional discussion of relevant matters from other jurisdictions. It is clear, for example, that deep dependence on the power system makes reliability a priority, that a history of fallibility and surprise leads to a sensible focus on system resilience, and that experience with costly miscalculations encourages attention to prudence and cost effectiveness.

To extend, update and confirm the initially evident considerations, there are plenty of established methodologies for additional research and discussion (baseline studies of relevant social and ecological systems, reviews of case experience elsewhere, public and other stakeholder consultations about present concerns and desired futures, etc.).

No list of case and context concerns, no matter how detailed, is sure to qualify as an adequate specification of the generic criteria, however. Each of the particular issues and priorities will be in some way relevant to one or more of the generic criteria. All of them together may cover much of the relevant ground. But the generic criteria represent the comprehensive foundation and it is necessary to integrate the case and context particulars with the generic requirements in a way that ensures that the comprehensiveness is maintained while the specifics are added.

2.4.3 Integration of the generic criteria and case/context specific concerns

Once the generic sustainability requirements are recognized and the case- and context-specific concerns have been identified, the next step is to consolidate them into one coherent and comprehensive set of criteria. Appropriate consolidations can take many different forms. But they must always retain attention to the full suite of generic requirements and their interconnections, recognizing that each of the eight requirements summarized in box 1, above, is in effect a large category with many subsidiary aspects and components to be specified in light of the case and context.

It is often best to begin with the generic criteria as the basic framework and incorporate the case and context concerns as matters deserving particular emphasis under each of the generic criteria titles. This approach is most likely to preserve the generic comprehensiveness of the criteria set and can facilitate more consistency in multiple related assessments.

In contrast, it is possible to establish an appropriate criteria framework organized largely or even entirely into categories that are drawn from the major concerns of the case and context and that use the particular language and categorization of issues that have been established during the history of deliberations on the undertaking involved. This approach has the advantage of using familiar concepts and language that can facilitate public discussion. A potential disadvantage is the risk of favouring conventional concepts and objectives in a world where what is conventional is generally unsustainable. Moreover, this approach can work only if the organizing framework of major criteria and more detailed specifics are actually comprehensive of all the basic requirements for progress towards sustainability and are amenable to integrated consideration that recognizes interactive effects.

A hybrid approach may often be most suitable. It involves integrating the generic and specific criteria into a framework that clearly retains attention to all aspects of the generic requirements but also uses incorporates major case and context specific considerations. This approach is illustrated in the report for the Joint Review Panel for the Mackenzie Gas Project, which is noted favourably in *Discussion Paper 6.*[6]

Whatever approach is adopted, the key test is whether all of the fundamental requirements are incorporated and whether all the main case and context specific concerns are recognized.

2.4.4 Trade-off rules

In addition to the set of core generic criteria discussed above, OPA Discussion Paper 6 presents favourably a set of associated trade-off rules, also taken from Robert B. Gibson et al, *Sustainability Assessment: Criteria and Processes.* They are reproduced in the box below.

Like the generic sustainability criteria, these trade-off rules are broadly applicable and can be specified for the case and context. The underlying idea is that trade-offs are undesirable but likely to be unavoidable in many practical circumstances. Consequently, the rules are designed to make trade-offs an option of last resort – requiring explicit justification and discouraging those that would displace significant adverse effects to future generations, which cannot be present now to defend their interests.

Box 2: Basic Sustainability Assessment Trade-off Rules

Maximum net gains
Any acceptable trade-off or set of trade-offs must deliver net progress towards meeting the requirements for sustainability; it must seek mutually reinforcing, cumulative and lasting contributions and must favour achievement of the most positive feasible overall result, while avoiding significant adverse effects.

Burden of argument on trade-off proponent
Trade-off compromises that involve acceptance of adverse effects in sustainability-related areas are undesirable unless proven (or reasonably established) otherwise; the burden of justification falls on the proponent of the trade-off.

Avoidance of significant adverse effects
No trade-off that involves a significant adverse effect on any sustainability requirement area (for example, any effect that might undermine the integrity of a viable socio-ecological system) can be justified unless the alternative is acceptance of an even more significant adverse effect.

- Generally, then, no compromise or trade-off is acceptable if it entails further decline or risk of decline in a major area of existing concern (for example, as set out in official international, national or other sustainability strategies or accords or as identified in open public processes at the local level), or if it endangers prospects for resolving problems properly identified as global, national and/or local priorities.
- Similarly, no trade-off is acceptable if it deepens problems in any requirement area (integrity, equity, etc.) where further decline in the existing situation may imperil the long term viability of the whole, even if compensations of other kinds, or in other places are offered (for example, if inequities are already deep, there may be no ecological rehabilitation or efficiency compensation for introduction of significantly greater inequities).
- No enhancement can be permitted as an acceptable trade-off against incomplete mitigation of significant adverse effects if stronger mitigation efforts are feasible.

Protection of the future
No displacement of a significant adverse effect from the present to the future can be justified unless the alternative is displacement of an even more significant negative effect from the present to the future.

Explicit justification
All trade-offs must be accompanied by an explicit justification based on openly identified, context specific priorities as well as the sustainability decision criteria and the general trade-off rules.

- Justifications will be assisted by the presence of clarifying guides (sustainability policies, priority statements, plans based on analyses of existing stresses and desirable futures, guides to the evaluation of "significance", etc.) that have been developed in processes as open and participative as those expected for sustainability assessments.

Open process
Proposed compromises and trade-offs must be addressed and justified through processes that include open and effective involvement of all stakeholders.

- Relevant stakeholders include those representing sustainability-relevant positions (for example, community elders speaking for future generations) as well as those directly affected.
- While application of specialized expertise and technical tools can be very helpful, the decisions to be made are essentially and unavoidably value-laden and a public role is crucial.

The trade-off rules have more limited application than the larger set of criteria for evaluation and decision making. Trade-offs are likely to be important considerations only after alternatives have been considered in some detail in light of the sustainability criteria and the major unresolved conflicts have been identified.

Like the evaluation and decision making criteria, the trade-off rules need to be adopted explicitly, specified and applied consistently.

2.5 Attention to the basic sustainability objective and the elaborated criteria throughout the planning and decision making process

The sustainability objective and criteria should inform the entire planning process from the outset. As noted above, power system planning, like many other undertakings, begins with particular goals but also a broad obligation to contribute to overall betterment. In the present context, betterment requires acceptance of the broad "contribution to sustainability" purpose as the frame in which to pursue the more particular goals set out in the IPSP Regulation and the Supply Mix Directive, etc. For power system planning this means beginning with the intent to develop an IPSP that offers the most promising set of multiple, mutually reinforcing and lasting improvements in all the interrelated areas of sustainability concern, while avoiding significant adverse effects. And it entails explicit early adoption and elaboration of a comprehensive and specified set of sustainability-based criteria for evaluations and decision making.

The objective and criteria are needed to inform all steps and deliberations in the planning process, including

- how the particular purposes of the plan should be understood from the perspective of public interest in progress towards sustainability;
- how interested citizens, organizations and other stakeholders are to be engaged in the planning process and how different perspectives and different kinds of knowledge can be accommodated;
- what planning options and components (technologies, programmes, linkages, responsibilities, etc.) ought to be examined;
- what possible effects (including direct, indirect, induced and cumulative effects) deserve more detailed attention;
- which effects are likely to be (or might be) most significant, given sustainability objectives;
- what important opportunities or perils need attention;

- how anticipated positive effects could be enhanced and how adverse effects could be mitigated;
- which trade-offs may be unavoidable and, of these, which ones might be acceptable (or least unacceptable);
- what are the strengths and limitations of each possible system component, including interconnections;
- what are the strengths and limitations of each overall plan option;
- which components (technologies, programmes, etc.) and what plan option(s) best meet the criteria and overall purpose of the undertaking, in comparison with other potentially reasonable alternatives;
- what specifics are needed in the plan, and/or what arrangements are needed for subsidiary and subsequent deliberations and decisions (e.g. on particular projects under the plan) to ensure proper consideration of purposes, alternatives, effects, mitigation and enhancement options, trade-offs, etc. in light of the sustainability objective and criteria;
- whether and under what terms and conditions the proposed plan should be approved;
- what monitoring and adaptive response requirements are imposed; and
- what preparations by various parties are necessary and desirable to ensure that negative effects are avoided or mitigated, that unanticipated effects are identified and addressed quickly, that subsidiary planning and project development proceeds appropriately, that the plan is reviewed and revised regularly, that maximum mutually reinforcing gains are achieved and that significant adverse effects are avoided.

3. The adequacy of what the OPA did

3.1 Investigating the OPA's consideration of environmental sustainability throughout the development of the IPSP

This report investigates whether the OPA fulfilled the requirement set out by the Minister of Energy in the June 2006 Directive to consider environmental sustainability in the development of the IPSP. For this purpose, a critical review was undertaken of supply mix and integrated power system planning documents accessible to the public through the OPA's website. First, the report asks what the OPA did to consider environmental sustainability in developing the IPSP. Second, it analyses the OPA's approach for strengths and deficiencies in light of the fundamentals of the concept of sustainability and the practice of sustainability assessment. Third, it provides an example of what the OPA ought to have done to consider adequately environmental sustainability in developing the IPSP.

The critical review involved selecting from the supply mix and IPSP documents specific planning elements for analysis. A planning element was selected if it (i) was developed or initiated explicitly by the OPA; and (ii) worked towards fulfilling the requirement to consider environmental sustainability; and (iii) had significant potential to affect decision-making outcomes. Specific regulations and policies that underpin IPSP planning (e.g. *The Electricity Restructuring Act, 2004*), and descriptions of the origins of sustainability principles and integrated resource planning, for example, were not included in the analysis.

Overall, the OPA's consideration of environmental sustainability was analysed according to whether IPSP planning was underpinned at the outset by the basic objective to contribute positively to sustainability, whether the objective was elaborated for practical application through comprehensive sustainability-based evaluation and decision criteria; and whether the basic objective and criteria were applied consistently throughout the planning process and achieved reasonably in the Preliminary Plan. The key planning documents and activities representing the major stages of the development of the IPSP were analysed according to whether they used, at least implicitly, evaluation and decision criteria that were comprehensive of all generic sustainability requirements, including cost-effectiveness, prudence, and resilience issues; were specified adequately for the particular case and context; were applied consistently as an integrated framework for decision making; and were capable of handling trade-offs.

The OEB review and approval process is, by legislated mandate, focused on the IPSP and its compliance with the Directive.[7] The investigation reported here includes the supply mix phase in the analysis in accord with the OPA's assertion that "…the development of the IPSP started with the Minister's May 2, 2005 letter to the OPA to 'begin the process of developing a proposed integrated Power System Plan' by providing the Minister with advice on the appropriate supply mix".[8] Legislated requirements to address sustainability considerations in the IPSP were established even before the Minister's May 2005 letter. The plan flows from the provisions of the *Electricity Restructuring Act, 2004,* amending the *Electricity Act, 1998.* In addition to establishing the OPA and mandating it to develop a 20-year "Integrated Power System Plan" for Ontario, the amendments added to the purposes of the *Electricity Act* the promotion of "economic efficiency and *sustainability* in the generation, transmission, distribution and sale of electricity."[9] Considerations of environmental sustainability, then, should have been present and applied consistently in preparation of the *Supply Mix Advice Report* and through the rest of the process to the final stages in the development of the proposed plan.

It is important to note too that although May 2, 2005 flags the formal beginning of development of the current IPSP, electricity system planning in Ontario has a rich history dating back to the early 20th century.[10],[11] This history forms part of the context that underpins IPSP development. The details of this history do not fall within the scope of this report. Instead, we will begin with a chronological account of what the OPA did to consider environmental sustainability – from the supply mix advice to the preliminary plan. The planning documents and activities that were selected for analysis are included in the chronological descriptions below.

3.2 OPA documents and activities related to consideration of environmental sustainability in developing the IPSP

3.2.1 The Supply Mix Advice Report (June-December 2005)

Acting on the Minister of Energy's May 2, 2005 letter to the OPA requesting advice on an appropriate mix of supply options for Ontario's future electricity system, the OPA prepared its advice on an appropriate supply mix to meet Ontario's projected electricity requirements to 2025. In December 2005, the OPA delivered to the Minister of Energy its *Supply Mix Advice Report*. The OPA's recommended supply portfolio formed the basis of the Minister's June 2006 Supply Mix Directive.

The many steps that were taken by the OPA in the development of a recommended supply portfolio are described in Volumes 1 to 4 of the *Supply Mix Advice Report*. Key activities at this stage included consultations with the public to determine their perspectives and values about electricity system planning; assessing the environmental (biophysical), economic and reliability performance of various supply resources and supply mixes; estimating the potential for conservation and demand management; estimating the potential for renewables; and assessing various supply mix options for potential risks, costs and benefits.

As well, the OPA prepared and released a background report, *Sustainability Principles and Integrated Planning,* which recognizes the comprehensive character of the sustainability concept, though it focuses on a relatively limited set of concerns related to the biophysical environment.[12]

In our research, we reviewed Volumes 1 to 4 of the *Supply Mix Advice Report* and selected the following elements of the OPA's planning for analysis:

- the OPA's guiding principles for the development of the supply mix advice;
- the OPA's life-cycle approach to evaluating the environmental impacts of various supply sources and potential supply mixes;
- the OPA's Levelized Unit Energy Cost (LUEC) analysis of various supply resources; and
- the OPA's key measure of social impact.

3.2.2. The Supply Mix Directive, Environmental Assessment Act exemption and IPSP Regulation (June 2006)

The December 2005 Supply Mix Advice provided the basis for the Supply Mix Directive issued to the OPA by the Minister of Energy on June 13, 2006. The directive specified minimum targets for incorporation of conservation and demand management (CDM) activities and renewable energy supply in the IPSP, along with a maximum level of nuclear supply. The directive also required that the plan provide for the phase-out of coal-fired generation and focus on high value and high efficiency uses of natural gas.

The directive was accompanied by two regulations, which were central to considerations of the environment and sustainability in the development and approval of the plan. Breaking with the precedent of Ontario Hydro's 1989 Demand Supply Plan, which was subject to review under the Ontario *Environmental Assessment Act*, Regulation 276/06 had the effect of exempting the IPSP from review under that act. Instead, the IPSP regulation directed the OPA to "ensure that safety, environmental protection and environmental sustainability are considered in developing the plan."[13]

3.2.3 The Seven Discussion Papers (June – November 2006)

As noted above, the June 2006 Supply Mix Directive set out rules including minimum targets and caps for conservation, renewable energy, nuclear, natural gas, and coal-fired generation contributions, and transmission system planning. It also stipulated that the plan should comply with Ontario Regulation 424/04. From that point forward, the OPA began to develop the IPSP around the specific regulations, goals, and areas of discretion left open by the Directive.[14]

From June to November 2006, the OPA prepared the seven discussion papers that underpin the draft IPSP (Discussion Paper 8: Procurement Options was released in January 2007, after the IPSP was completed). The discussion papers describe the "building blocks" of the preliminary plan (load forecasts, conservation potential, supply resources, transmission needs and solutions, etc.) and a central element of their purpose was to generate feedback from stakeholders. There is significant overlap between the supply mix stage and the discussion papers stage in that many of the studies undertaken for the supply mix advice were carried over to the discussion papers stage.

We reviewed seven discussion papers and selected the following elements of the OPA's planning for analysis:

- the OPA's context-specific planning criteria and trade-off criteria;
- the OPA's stakeholder participation process; and
- the OPA's integration of the building blocks of the preliminary plan.

3.2.4 The preliminary plan (June 2006 – August 29, 2007)

Meanwhile, the OPA prepared the preliminary plan. The OPA states that the specific goals set out in the Directive and the areas of discretion left open by the Directive were integrated in light of context-specific planning criteria:

> This resulted in an IPSP that prioritizes how Conservation and supply resources should be acquired through (i) meeting the requirements of the Directive in light of the OPA's planning criteria (the "Directive Priority"); and (ii) sequencing the installation of resources, in light of lead times and necessary transmission enhancements (the "Implementation Priority").[15]

Again, there is considerable overlap between the supply mix, discussion papers, and the parts of the IPSP. Many of the studies undertaken during the supply mix stage are carried over to the parts of the IPSP, and most of the information provided in the discussion papers is repeated in the IPSP documents.

We reviewed the IPSP documents and selected one final element in the OPA's planning process for analysis:

- the OPA's meetings with the Sustainability Advisory Group (October 27, 2006 and December 20, 2006).

3.3 Analysis of selected supply mix and IPSP planning elements

3.3.1 The OPA's guiding principles for the development of the supply mix advice

The OPA identified six principles that guided its planning during the supply mix advice stage in the development of the IPSP: listening, sustainability, flexibility, embracing the future, managing risks, and prudence.[16] According to the OPA, these principles:

> …created a broad and well-defined set of criteria for solutions within the policy framework. These criteria took into account, on a full life-cycle basis, the overall costs of each supply option, the degree of financial risk it carried, and its general environmental impact. As combinations of options were developed, these were checked for reliability, feasibility, and long-term flexibility.[17]

As noted above, the OPA prepared and released a background report, *Sustainability Principles and Integrated Planning,* recognizing the comprehensiveness of the sustainability concept, but even though the report's focus is on a relatively limited set of biophysical concerns.[18]

The OPA should be credited for its initiative to underpin the supply mix advice with a set of criteria to guide decision making. This is an important initial step in any planning exercise. In light of sustainability planning best practice, however, the guiding principles and their application fall short of meeting basic requirements for ensuring due consideration of sustainability.

The initial shortcoming is that the OPA did not at this early stage establish as an overarching evaluative criterion the basic sustainability objective: that the supply mix and power system planning would contribute positively to sustainability by ensuring that the recommended supply mix would be, of all the available planning options, the one (or package) offering the most promising set of multiple, mutually reinforcing and lasting improvements in all the interrelated areas of sustainability concern, while avoiding significant adverse effects. While the OPA defined "sustainability" broadly enough to include economic and social as well as biophysical and ecological aspects, it treated sustainability mostly as the entry point for attention to biophysical effects.[19] Sustainability was also only one of several priority considerations, which were addressed "in parallel" rather than in a fully integrated way. In the absence of an initial commitment to the basic sustainability objective, the OPA did not have from the outset a foundation linking its priorities and recognizing their interrelations. This precluded an effective sustainability-based approach that would guide identification of all of the areas in which gains are needed and adverse effects must be avoided, and provide a foundation for making judgments about what concerns are most important, what effects are most significant, and what options are most desirable.

A second important deficiency is that the OPA's guiding principles were not comprehensive of the full suite of generic sustainability requirements. The OPA's "listening" principle, for example, addresses only some aspects of the "socio-ecological civility and democratic governance" criterion. It does aim to incorporate the values and concerns of Ontarians in electricity system planning. This, in turn, may minimize threats to valued community qualities. Unfortunately, the "listening" principle does not cover important issues related to governance capacity, social capital, and social learning. Nor was it likely to ensure attention to issues related to inter- and intra-generational equity in electricity system planning. Similarly, the OPA's "sustainability" principle reflects some generic sustainability requirements in that it was used by the OPA as the category for addressing effects on the biophysical environment, including matters with significant economic and social implications. But the OPA's use of the "sustainability" principle is not comprehensive even of the full suite of sustainability concerns (socio-ecological system integrity, livelihood sufficiency and opportunity, inter- and intra-generational equity, etc.) related to the biophysical environment. Similar comments can be made for the OPA's principles of "flexibility", "embracing the future", "managing risks" and "prudence".

Finally, the guiding principles were not used explicitly by the OPA as a consolidated evaluative framework against with the various planning elements (CDM, renewables, conventional generation, etc.), supply mix scenarios, and trade-offs could be compared and assessed. At this stage, independent studies were undertaken on behalf of the OPA to consider some environmental (SENES), economic (CERI), and social (Decision Partners) dimensions of supply combinations. The results of these analyses are discussed and illustrated individually and as combined impacts in charts, and the OPA shares the results of its studies of environmental effects, costs, risks, and sensitivities studies for each supply mix scenario.[20] In this process, however, the guiding principles are fragmented. They function individually as opposed to being incorporated in a unified framework for comparative evaluation of the various supply mix alternatives and the trade-offs involved. Consequently, certain technologies and/or supply resources may have been discounted for certain purposes based on only a partial analysis. This is in sharp contrast to proper practice in sustainability assessments, where planning options and trade-offs are evaluated against a comprehensive and integrated set of sustainability criteria.

The above weaknesses in the OPA's consideration of environmental sustainability at this early stage have far-reaching implications for later stages in IPSP development. Many decisions on fundamental aspects of electricity system planning (appropriate uses for particular supply resources, appropriate incorporation of particular supply resources, etc.) were made at this time and were carried forward without the greater enlightenment that would have come with attention to the basic sustainability requirements.

3.3.2 The OPA's approach to evaluating the environmental impacts of various supply sources and potential supply mixes

The OPA's approach to evaluating the environmental impacts of various supply sources and potential supply mixes is relevant to many sustainability requirements, notably socio-ecological system integrity, as well intragenerational and intergenerational equity, efficiency, cost-effectiveness and resource maintenance, and prudence, precaution and adaptive capacity.

Several governmental and non-governmental stakeholders, including the Pembina Institute, the GEC and the City of Toronto's Medical Officer of Health identified major gaps in the OPA's approach to evaluating the environmental performance of different supply resources. In particular they noted that the analysis by SENES consultants, which provides the foundation for the OPA's assessment of the environmental performance supply resources, failed to take a comprehensive, life-cycle approach to these resources. The consequence is a tendency to downplay or ignore important adverse biophysical and socio-economic effects including fuel-cycle related upstream and downstream effects, effects on water quality, waste impacts and radiological hazards. [21]

The OPA itself concedes that it did not take a comprehensive life-cycle approach to the assessment of the environmental performance of supply options, focusing instead on operating stage emissions.[22] This constitutes a serious gap from the perspective of the consideration of environmental sustainability, as all of the fuel cycles associated with the non-renewable supply technologies considered in the IPSP (i.e. nuclear, coal and gas) have major direct and long-term upstream impacts and risks. In some cases, their fuel cycles are also associated with major downstream impacts and risks as well.

In addition, SENES' methodology was never part of a consolidated evaluative framework that could integrate environmental concerns with the other planning criteria and could then be applied consistently throughout the development of the IPSP. The OPA does compare the combined cost, risk, and environmental loading scores for each supply mix portfolio component but it does not provide an explicit and transparent evaluation of the trade-offs between the various technologies and supply mix options in such a way that environmental impacts are examined within an integrated set of electricity system planning criteria. Again, this is in sharp contrast to proper sustainability assessment practice, where planning options and trade-offs are evaluated against a comprehensive and integrated set of sustainability requirements.

3.3.3 The OPA's Levelized Unit Energy Cost (LUEC) analysis of various supply resources

The costs associated with particular supply technologies and supply resources span a range of integrated concerns (biophysical and social) with a complex set of implications for the full suite of sustainability criteria.

During the supply mix advice phase, the OPA commissioned the Canadian Energy Research Institute (CERI) to quantify the relative differences between technologies on the dimensions of performance and cost. The results of CERI's analysis were carried over to the IPSP development stage. Costs were represented as levelized unit energy costs (LUECs): "…the price of electricity output required by a plant to recover exactly the net present value of all capital, operation and maintenance, fuel, and decommissioning costs expected to be incurred over its economic life".[23] The LUECs were used to evaluate the cost effectiveness of various supply options prior to the development of the portfolios and scenarios.

The Pembina Institute, GEC, and the Ontario Clean Air Alliance (OCAA) have identified several deficiencies in CERI's LUEC analysis. Pembina notes that the LUECs may not fully incorporate future costs:

> In practice, with certain technologies large costs are transferred into the future, with high uncertainty about what these costs will ultimately turn out to be. In the result these costs may not be fully captured in the LUEC.[24]

While the LUEC for nuclear energy may reflect estimated costs for facility decommissioning and waste fuel management, these activities will involve very large expenditures extended over extremely long time frames (an estimated $24 billion over approximately 300 years in the case of waste nuclear fuel under the Nuclear Waste Management Organization's "adaptive phased management" strategy). There are significant possibilities that implementation of these strategies may turn out to be much more complex and costly in practice than current estimates and proposals indicate. These risks and costs cannot be fully captured in the estimates that form the basis of the current LUEC.

In light of sustainability requirements, a second important deficiency in the OPA's LUEC analyses is that they consider only the capital and operating costs of various supply technologies. There are two key issues here. First, the biophysical, social and economic externalities associated with different supply mix options are not incorporated and therefore key sustainability concerns are ignored. These include externalized health, social and ecological costs. As GEC points out, studies by the Ontario Medical Association reveal that the health impacts of smog cost Ontarians over a billion dollars each year.[25] Pembina's life cycle analysis of nuclear power generation in Canada identifies a range of socio-ecological impacts (atmospheric, water, waste, landscape and ecosystem, and occupational and community health) of nuclear generation, and the challenges that these impacts pose for sustainability.[26]

Second, the OPA's capital and operating cost estimates appear to be unreasonably low. OCAA notes that the OPA's analysis of the capital cost of a new CANDU 6 nuclear reactor ($2,845/kW) is 30% less than the actual historic capital cost ($4,085/kW in 1993) of the Darlington nuclear station – the most recent nuclear power plant built in Ontario. Moreover, the actual capital cost of building nuclear reactors has historically been much higher than forecast. For example, the OPG's 1999 estimate of the total cost of returning Pickering A Unit 1 to service ($213 million) was far less than the final cost ($1.016 billion). Similarly, the final cost ($750 million) of returning Bruce A Units 3 and 4 to service was twice Bruce Power's estimate ($375 million).[27] Significant delays and cost overruns have also hit new reactor construction, for example Areva's third generation Olkiluoto project in Finland.

3.3.4 The OPA's key measure of social impact

According to the OPA,

> The social impact of choices for the electrical system depends on the values of society. Public opinion research conducted for the supply mix advice showed that in Ontario, as elsewhere, reliability of supply is the most important concern. The key measure of social impact at this stage of planning, therefore, is whether electricity supply provided by the recommended mix will be reliable. Other broad concerns, including price and acceptability, also come into play.[28]

Reliability (adequacy and security) of supply and the costs of electricity for consumers are important sustainability concerns because they may have implications for present and future generations. But the social impacts of electricity planning span a much broader spectrum of integrated considerations. The sustainability criteria, for example, incorporate concerns related to the distribution of costs and benefits in relation to supply mix choices, particularly for disadvantaged communities; the boom and bust effects of supply mix choices; and economic development opportunities and risks associated with supply mix choices – to name a few that are not captured by reliability and cost considerations.

The public opinion research undertaken by Decision Partners Incorporated on behalf of the OPA focused narrowly on issues related to Ontario's need for electricity and the supply mix question: "The purpose of the interviews was to discover the primary influences on stakeholder judgment of Ontario's need for electricity and their idea of an appropriate balance of supply mix elements – namely, conservation and demand management (CDM), renewable resources, and advanced conventional sources".[29] The reliability criterion therefore captures only a narrow set of social concerns reflected in the scope of the OPA's public opinion research.

3.3.5 The OPA's context-specific planning criteria, and trade-off criteria

During the Discussion Paper and Preliminary Plan development stages, the OPA introduced six context-specific evaluation criteria (feasibility, reliability, flexibility, cost, environmental performance, and societal acceptance). This list is somewhat different from the one set out for the supply mix advice work (see section 3.3.1, above). According to the OPA, these new criteria are context-specific expressions of the generic sustainability requirements and trade-off rules laid out in Robert B. Gibson's *Sustainability Assessment: Criteria and Processes*.[30]

The OPA's recognition of Gibson's generic sustainability assessment principles and trade-off rules is a good starting point. Gibson's principles rules are based on a synthesis of the literature on sustainability, and insights from decades of practice in the field of environmental assessment. As noted above in section 2.4, the generic principles are based on the fundamental requirements for progress towards sustainability and are applicable to any case and context, though they must be properly specified to respect the particular circumstances of the application. The OPA states that it has embraced Gibson's principles and the need for specification:

> The OPA's approach to considering sustainability is to derive context-specific evaluation criteria that encompass Gibson's sustainability requirements.[31]

There is, however, a large gap between the sustainability requirements and the OPA's specific criteria.

The OPA's summaries of Gibson's sustainability principles and trade-off rules depart somewhat from the language, intent and substance of the criteria and their implications as set out in the *Sustainability Assessment* book. The effect of these departures is generally to make the principles and rules narrower and less demanding.[32] However, even the weakened versions are considerably more comprehensive than the criteria that the OPA presents as its "context specific evaluation criteria" despite the claim that these criteria "encompass Gibson's sustainability requirements". As will be discussed below, the OPA's six context-specific evaluation criteria are not comprehensive of the basic sustainability requirements identified in Gibson's work. Moreover, other components of sustainability-based planning are missing from the OPA's practice in developing and using sustainability-based criteria in its preparation of the Preliminary Plan.

To ensure due attention to sustainability in developing the IPSP, the OPA's key initial step would have been explicit commitment to ensuring that the IPSP would be designed to make a positive contribution to sustainability. No such commitment appears to have been made in the development of the Preliminary Plan. In *Discussion Paper 6: Sustainability,* the OPA notes that development of the IPSP is an "opportunity to set the province's electricity system on a path towards sustainability" and that a "focus on sustainability has been a common theme in electricity sector development for a number of years in Ontario."[33] The OPA also asserts that "the OPA was established, in essence, to put the electric industry on a path towards sustainability."[34] These statements, however, fall short of an explicit commitment to ensure that the Preliminary Plan's objective would be contribute positively to sustainability and this would be the fundamental criterion for evaluations and decisions.

Moreover, the OPA's selected context-specific criteria are not comprehensive enough to serve as a means to ensure that decision making on IPSP matters would deliver multiple, mutually reinforcing and lasting improvements in all the interrelated areas of sustainability concern. This has been pointed out in earlier comments. GEC has noted that much of the substance of Gibson's sustainability criteria was lost in the OPA's translation process from Gibson's criteria to the context-specific evaluation criteria in *Discussion Paper 6: Sustainability*.[35] Similarly, the Pembina Institute has stated that "the OPA's proposed context-specific evaluative criteria for the IPSP fail to effectively integrate key sustainability requirements as identified in the OPA paper".[36] Both GEC and Pembina point out that the context-specific planning criteria are particularly weak in their incorporation of inter- and intra-generational equity requirements:

> There appear to be no OPA criteria that consider how community impacts are distributed or how particular groups of individuals might be disproportionately impacted by particular generation or transmission options.[37]

In our review, we have found no evidence that the OPA attempted to apply Gibson's sustainability assessment principles and trade-off rules or the OPA's softened interpretation of them presented in *Discussion Paper 6*. The OPA does not describe any process it may have used to specify these principles and rules for the case, or to integrate the generic criteria and case specific concerns into a comprehensive overall evaluation framework for the purpose of electricity system planning. Instead the OPA set out its "context specific evaluation criteria" in *Discussion Paper 6*, asserted that they are "consistent with" the sustainability requirements underlying Gibson's criteria, and identified points of overlap. The discussion of how the planning criteria relate to the core sustainability requirements is vague and incomplete. The OPA does not attempt to demonstrate that the context specific evaluation criteria cover all of the requirements.

Certainly the case specific criteria that the OPA describes in *Discussion Paper 6* fail to include many of the key considerations under the eight main principles categories from Gibson's set of generic sustainability criteria. Appendix 2, below, reveals the general extent of the gap between the OPA's set of evaluation criteria and a reasonably comprehensive set of sustainability criteria based on Gibson's principles but elaborated for the case and context (initially presented in Appendix 1). The analysis takes each criterion in the comprehensive set and identifies whether it is addressed fully, partially or not at all by any of the six criteria adopted by the OPA. As the table in Appendix 2 shows, none of the directly specified criteria is fully covered and while many are partially covered, almost equal numbers are neglected entirely.

The OPA has therefore not recognized in its consideration of environmental sustainability that sustainability requires explicit attention to adopting from among available planning options the one option or package of options that offers the most promising set of multiple, mutually reinforcing and lasting improvements in all the interrelated areas of sustainability concern, while avoiding significant adverse effects. Consequently, the OPA did not at any stage identify all of the areas in which gains are needed and adverse effects must be avoided, and it did not provide a basis for making judgments about what concerns are most important, what effects are most significant, and what options are most desirable.

In the absence of an adequately comprehensive set of sustainability-based criteria, the OPA was not in a position to identify the areas in which gains are needed and adverse effects must be avoided, and did not have a basis for making judgments about what concerns were most important, what effects were most significant, and what options were most desirable. It did not have a suitable set of evaluation criteria that it could apply in a clearly defined process for identifying among available planning options the one option or package of options that offered the most promising set of multiple, mutually reinforcing and lasting improvements in all the interrelated areas of sustainability concern, while avoiding significant adverse effects.

3.3.6 The OPA application of its context-specific planning criteria, and trade-off criteria

In addition to the serious substantive weaknesses of the OPA's criteria, there are problems with the OPA's application of its selected criteria as a framework for decision making. MK Jaccard and Associates Incorporated have observed:

> The first major problem is that the sustainability framework is not used to evaluate and make decisions about the large proportion of the IPSP that is pre-determined by the Minister's Directive on the supply mix. The other concern is that the sustainability plan does not include an explicit process for scoring each electricity system scenario against each criterion, or any discussion of how to weight the criteria or otherwise enable tradeoffs and decisions to be made.[38]

The context-specific planning criteria were not applied consistently by the OPA as an integrated evaluative framework against which electricity system alternatives, options associated with each element of the IPSP (CDM, supply resources, transmission, etc.), and trade-offs could be compared and assessed. The OPA did not adopt or apply Gibson's trade-off rules in decision making. Nor did the OPA establish clear tests and/or measures to assess whether their own criteria were addressed. The context-specific planning criteria were therefore not explicitly and transparently used to guide decision making. Rather, the OPA's criteria seem to have been used to justify decisions after they were made, and the justification was not based on an explicitly rigorous analysis so much as on identification of how IPSP decisions reflected the context-specific planning criteria.

One instance of the above deficiency is the OPA's description of how reliability was taken into account in developing the IPSP.[39] First, the OPA defines reliability as centred on adequacy of supply and security of the overall system. The OPA then states that reliability was taken into account in their determination of future demand and planning reserve requirements, in their projection of how current and planned resources will perform over the long term, and in their recommendation of projects to ensure reliability. There is, however, no indication that the OPA made an effort to carry out an integrated evaluation whereby supply options and demand management, planning elements, and trade-offs could be compared and evaluated against a comprehensive set of sustainability criteria. The links and interdependencies between various aspects of the plan were apparently not addressed.

One consequence of the above weakness is that the OPA's evaluative framework could not recognize the interdependence of social, economic and ecological factors in such a way that they were considered in overall analyses and evaluations of alternatives and trade-offs.

Also important for sustainability assessment is further specification of the generic criteria for the context of particular planning elements. In order to address adequately the implications of various supply technologies and portfolios for sustainability, the OPA's criteria need to be further specified for the particulars of each technology, scenario, and system element (e.g. transmission). The OPA failed to take this extra step. The planning criteria, for example, were never explicitly specified for the purpose of evaluating alternatives in order to determine appropriate transmission projects for renewables. In such an evaluation, specification would require expanding each criterion to incorporate the particular issues related to transmission projects.

The timing of the OPA's development of the criteria is also significant in that they were developed and applied after the supply mix advice was delivered to the Minister; in other words, after many of the most important decisions in electricity system planning were made. At no time were the context-specific planning criteria applied in evaluating various supply mix scenarios that underpin the Preliminary Plan.

3.3.7 The OPA's stakeholder participation process

Electricity system planning involves a diverse range of stakeholders with a variety of perspectives on issues of common concern. Public participation is therefore a central component of sustainability-based planning for electricity systems. It is a means by which the concerns and interests of a project's stakeholders are identified and taken into account. Included in Gibson's *Socio-ecological Civility and Democratic Governance* criterion is recognition that community capacity to apply sustainability requirements is fostered by open and informed deliberations, a sense of reciprocal awareness and collective responsibility, and an integrated use of administrative, market, customary and personal decision making practices.

The OPA's engagement of stakeholders in decision making during the supply mix advice stage included presentations and submissions from individuals, associations, organizations, business, and industry. Through these submissions and presentations, the OPA received advice on CDM, renewables, conventional resources, education and training, connection and siting issues, municipal issues, generation development, the standard offer program, and more.[40]

Stakeholder involvement during IPSP development was linked to the "societal acceptance" planning criterion and regulatory requirements for stakeholder engagement.[41] The OPA asserts that the criterion of societal acceptance was met, in part, by their open and transparent planning process:

> All interested parties were invited to share their views on all aspects of the Plan and were provided with the details of the components and key assumptions…The OPA's discussion papers and workshops have allowed diverse views to be heard, and some incorporated into the planning process…The progress of OPA's planning process, which included the Supply Mix Advice Report and the eight IPSP discussion papers and stakeholder presentation enabled public input to be integrated over the entire time period of the Plan development (i.e., since 2005)…[42]

The OPA documented the input they received from stakeholders and published a description of how they addressed stakeholder issues in the development of the IPSP:

> Although the fundamental aspects of the Preliminary Plan published in November 2006 remained the same for the IPSP, a number of areas of the Plan have undergone increased scrutiny and have been modified and updated to reflect stakeholder input.[43]

Deficiencies in the OPA's approach to stakeholder involvement have been identified by the Pembina Institute and the Provincial Council of Women of Ontario (PCWO). PCWO, for example, asserts that the IPSP consultation process was flawed in several ways: important discussions were held in the late summer, just after Labour Day, when many people could not attend; the notice given for meetings was too short; the OPA over-relied on gaining input from web discussions, which was not a reliable method for two-way communications; teleconferences were not inclusive of all participants; the OPA's Supply Mix Advice summer meetings with stakeholders did not allow for adequate discussion among participants; the time allotted for responses to the background papers was inadequate; and delays in the release of pertinent materials hindered public interest research efforts.[44]

Similar issues were raised by Pembina:

> The OPA's policy development process leading up to the Supply Mix Advice Report was simply inadequate to generate good advice on such complex and contested issues. The process for developing the supply mix advice was essentially closed. The OPA received submissions from external stakeholders, but provided virtually no opportunity for discussion of contested issues among experts or stakeholders and made no serious effect to assess public views on the potential trade-offs and risk associated with the choices embedded in the supply mix advice.[45]

The key point here rests on the difference between participatory processes that allow for input by stakeholders (e.g. through online submissions, presentations, and workshops) and participatory processes that stimulate deliberation among stakeholders on contested project elements. The latter are likely to be more meaningful means of clarifying stakeholder views, fostering a sense of reciprocal awareness and collective responsibility, encouraging consensus where possible on various contested planning elements and building participative skills and capacity for future applications. In the case of IPSP development, the topics for deliberation necessarily involved complex and contested electricity system planning elements (e.g. CDM targets, electricity demand forecasts, renewable energy targets, life-cycle environmental impact methodology, etc.). The OPA's consultation process, however, was inadequate in that it was mostly oriented towards hearing presentations and receiving comments on various parts of the IPSP, rather than open and inclusive deliberation on contested IPSP elements.

Moreover, in light of sustainability planning requirements, the OPA's stakeholder consultations should have involved incorporating their concerns into the specification of the context-specific planning criteria—to ensure attention to the particulars of various planning contexts. The OPA has provided a discussion of many of the comments it received from stakeholders on many aspects of planning, but it did not incorporate the comments in an elaboration of the context-specific planning criteria. Again, this reveals a lack of attention to the basic sustainability planning requirements described in section 2, above.

3.3.8 The OPA's integration of the building blocks of the preliminary plan

The OPA reports that it applied the context-specific planning criteria to establish the Preliminary Plan and that the system components that were incorporated were chosen because they satisfied all of the criteria simultaneously to the greatest possible extent. The OPA also noted that trade-offs among the criteria are inevitable and therefore a clear and consistent method for addressing trade-offs is required.

According to the OPA, integration occurred in a number of steps. First, an initial plan was developed that met the basic system needs for feasibility and reliability. This plan was then assessed for its ability to meet cost, flexibility, environmental performance and societal acceptance criteria. A second iteration of the plan was undertaken based on this assessment, leading to a refined plan. The OPA's *Discussion Paper 7* provides a discussion of the evaluation of the Preliminary Plan with attention to use of the context-specific planning criteria.

The OPA's integration of the planning elements nonetheless fell short of meeting basic sustainability planning best practice requirements. First, the OPA did not carry over to this stage the basic objective that the Preliminary Plan would strive to make a positive overall contribution to sustainability, delivering multiple, mutually reinforcing and lasting improvements in all the interrelated areas of sustainability concern. As well the OPA failed to undertake any explicit comparison of alternatives and evaluation of trade-offs in light of positive and negative effects on sustainability.

Second, the OPA's integration process could not adequately consider the full suite of sustainability concerns because the OPA's context-specific planning criteria are not comprehensive of all sustainability requirements. This is especially true for inter- and intragenerational equity matters.

Third, the context-specific planning criteria were not applied explicitly and consistently as an integrated evaluative framework. Rather, the OPA initiated independent studies that served as "screens" for decision making on supply mix and integration. Later, in *Discussion Paper 7*, the OPA identifies ways in which the Preliminary Plan meets the context-specific planning criteria, but this is a poor substitute for an explicit and integrated evaluation of Preliminary Plan alternatives and trade-offs.

Pembina's assessment of the OPA's evaluation of the draft plan in light of the context-specific planning criteria raises similar concerns:

> The overall sustainability framework employed to assess the plan (Part 3) is incomplete, and fails to reflect key sustainability principles articulated in discussion paper 6, particularly intergenerational and intragenerational equity. Externalized environmental, social and some economic costs, and the avoided externalized costs associated with CDM initiatives, are generally not considered in the plan.[46]

3.3.9 The OPA's meetings with the Sustainability Advisory Group (October 27, 2006 and December 20, 2006)

In *Development of the IPSP* (Exhibit B-3-1), the OPA reports that it sought input from a Sustainability Advisory Group in developing its approach to considering sustainability in the IPSP. The Group advised the OPA on the development of the sustainability framework, the application of basic sustainability process principles, the appropriateness of the context-specific criteria, the assessment of environmental performance of the Preliminary Plan, advice on the Preliminary Plan, and comments on the stakeholder consultation process. Exhibit B-3-1 provides a list of specific advice the OPA received from the Advisory Group.[47]

The OPA's meetings with the Sustainability Advisory Group, however, came too late in IPSP development to have a significant impact of the planning process, including the development and application of the context-specific planning criteria. The OPA's meetings with the Group occurred on October 27, 2006, and December 20, 2006, well after the supply mix advice had been submitted to the Minister and after many of the Discussion Papers had been published.

3.4 Overall strengths and deficiencies in the OPA's consideration of environmental sustainability throughout the development of the IPSP

The OPA clearly did pay attention to some important sustainability-related considerations. The planning elements selected for analysis above are relevant to sustainability requirements. As well the OPA should be commended for its recognition of a broad sustainability obligation in power system planning (most evident in *Discussion Paper 6*) and for its recognition of a comprehensive and integrated set of core sustainability requirements and trade-off rules as a starting point for considering environmental sustainability in the development of the IPSP.[48] Unfortunately, the OPA's approach to sustainability was neither reasonably comprehensive nor suitably integrated, and its recognition of core sustainability requirements seems to have come too late to be incorporated into the specification of planning and evaluation criteria for IPSP development.

The above analysis reveals the following core deficiencies in the OPA's consideration of environmental sustainability throughout the development of the IPSP:

- The OPA did not establish clearly at the outset the basic objective that the planning and the Plan would strive to contribute positively to sustainability and that this would form as the fundational criterion for evaluations and decisions.
- The OPA's context-specific planning criteria were not comprehensive enough to cover all of the generic sustainability requirements identified by Gibson et al. The analysis reveals major gaps in the OPA's context-specific planning criteria with respect to all eight generic sustainability requirements. The OPA's treatment of intra and intergenerational equity, and immediate and long-term integration was especially deficient. Major gaps are also identified with respect to socio-ecological integrity, livelihood sufficiency and opportunity, efficiency and cost-effectiveness, and prudence, precaution and adaptation.
- The OPA introduced its context-specific planning criteria after it had prepared the *Supply Mix Advice Report*, which provided the foundation for the Minister of Energy's June 2006 Supply Mix directive, which in turn guided the overall direction of the IPSP. Development of the IPSP was already far advanced at the time the OPA began consideration of Gibson et.al's sustainability-based decision-making framework.

- The OPA did not apply its context-specific planning criteria comprehensively and consistently to the various potential system components or "building blocks" of the IPSP, including the major supply and conservation and demand management options, or transmission system options. Major gaps in discussions of individual supply and demand options contained within the IPSP with respect to generic sustainability requirements have been identified by external governmental and non-governmental stakeholders, and by consultants retained by the OPA itself. Particularly noteworthy is the OPA's failure to apply a comprehensive life-cycle approach to consideration of the environmental performance of CDM and supply options. This left major gaps in the OPA's consideration of implications for socio-ecological integrity, intra and intergenerational equity, efficiency and cost-effectiveness and prudence and precaution.
- The OPA also failed to apply its context-specific planning criteria consistently at the level of the overall plan in such a way to allow for an integrated evaluation of alternatives and trade-offs.
- Despite recognition of the sustainability-based trade-off rules set out by Gibson et al., the OPA has not provided a comprehensive and explicit identification of the major trade-offs involved in its choices about what options to favour at the component or overall plan levels at any stage in the development of the IPSP. The referenced trade-off rules also require an explicit rationale for each proposed trade-off, but the OPA has also not provided such rationales.
- The analysis found no evidence of how the OPA's decision making with respect to the IPSP was affected by, or altered as a result of, the consideration of environmental sustainability.
- The OPA did not provide guidance for further specification and application of sustainability-based criteria in the anticipated more detailed planning and decision making concerning particular sub-plans and projects under the IPSP.

In section 2.6, above, we identified the basic tests of sustainability-based planning in the form of three questions for the OPA IPSP case:

1. Did the OPA adopt the fundamental objective of sustainability-based planning explicitly, at the outset of the planning for the IPSP?
2. Also at the outset of IPSP planning, did the OPA specify a framework and elaborated set of sustainability based criteria for evaluations and decisions that covered all the generic requirements for progress towards sustainability as well as the major case and context-specific considerations?

3. Did the OPA pursue the fundamental sustainability objective and the elaborated sustainability criteria consistently through the planning process?

Analysis of the key OPA documents and activities related to sustainability matters indicates that the OPA has not passed any of these three tests. As a result, the requirement to demonstrate meaningful consideration of environmental sustainability in the development of the IPSP has not been met.

4. What the OPA should have done

4.1 Appropriate steps for the OPA to have taken to consider environmental sustainability adequately in developing the IPSP

To consider environmental sustainability adequately in electricity system planning, the OPA needed to shift its analytical approach from a fragmented analysis that involves a compilation of generic considerations that are more or less relevant to sustainability to a context-specific evaluation that is comprehensive of the full suite of sustainability criteria, and applied consistently as a whole.

4.1.1 Adopting the "contribution to sustainability" objective

The OPA should have first adopted the fundamental objective of sustainability-based planning explicitly, at the outset of the planning for the IPSP. As noted above, for power system planning this means beginning with the intent to develop an overall IPSP that offers the most promising set of multiple, mutually reinforcing and lasting improvements in all the interrelated areas of sustainability concern, while avoiding significant adverse effects. This in turn would have entailed explicit early adoption and elaboration of a comprehensive and specified set of sustainability-based criteria for evaluations and decision making. Just when the initial commitment should have been made is open to discussion. Power system planning has been practiced in Ontario for decades, in various forms and stages. The current initiative began with the formation of the OPA and the beginning of work on supply mix advice. An explicit commitment to the "contribution to sustainability" objective then would have been appropriate and timely.

4.1.2 Specifying the sustainability criteria for the case and context

The second step would have been adoption and elaboration of a comprehensive framework of planning and assessment criteria covering core sustainability requirements and trade-off rules suitably specified for the case and context. This framework for evaluation and analysis would have then guided development of the system plan including the supply mix advice phase and preparation of the Preliminary Plan.

The essential considerations for specifying the basic criteria for a particular case and context are discussed above in sections 2.4.2 and 2.4.3. For integrated power system planning, specification of the criteria would centre on elaboration of the generic set of criteria based on the basic requirements for progress towards sustainability (see Box 1, above) and the generic trade-off rules (see Box 2, above) taking care to ensure particular attention to the main concerns that have emerged in the years of deliberations on power system planning in Ontario, as well as current, emerging and reasonably anticipated considerations. This would include attention to the considerations that the OPA identifies in *Discussion Paper 7* as its "context specific evaluation criteria" (feasibility, reliability, cost, flexibility, environmental performance, and social acceptance).[49] In contrast to the OPA's approach, however, these considerations would be integrated into the comprehensive framework rather than presented as a sufficient set of considerations by themselves.

Appendix 1, below, provides an illustrative set of criteria that begins with the generic requirements for the IPSP case and context and provides some more specific elaboration. Considerations addressing the OPA's more limited set of criteria are included along with many other relevant factors. Some of the generic requirement categories are renamed to draw attention to some of the OPA's considerations. For example, the "Precaution and Adaptation" category in Box 1 is renamed "Prudence, Precaution and Adaptation" in the specified criteria list in Appendix 1. Notes at the beginning of the appendix outline the scope of the criteria set and intended approach to application.

Appendix 2, below, assesses the extent to which the comprehensive sustainability-based criteria are covered by the OPA's "context specific evaluation criteria". The table reveals that many areas are wholly neglected and the OPA criteria do not cover any of the core sustainability concerns adequately.

4.1.3 Applying the criteria in developing the plan

The OPA should have then applied the context specific evaluative criteria explicitly and consistently as an integrated whole throughout the development of the IPSP, taking into consideration the trade-offs between various supply technologies and supply scenarios. Section 2.5, above, provides a list of the main categories of analyses and decisions through the planning process that should have been informed by application of the criteria. That list is reproduced here in box 3.

Box 3: Major Issues Requiring Application of Sustainability-based Evaluation and Decision Criteria during Development of an Integrated Power System Plan

1. how the particular purposes of the plan should be understood from the perspective of public interest in progress towards sustainability
2. how interested citizens, organizations and other stakeholders are to be engaged in the planning process and how different perspectives and different kinds of knowledge can be accommodated
3. what planning options and components (technologies, programmes, linkages, responsibilities, etc.) ought to be examined
4. what possible effects (including direct, indirect, induced and cumulative effects) deserve more detailed attention
5. which effects are likely to be (or might be) most significant, given sustainability objectives;
6. what important opportunities or perils need attention
7. how anticipated positive effects could be enhanced and how adverse effects could be mitigated
8. which trade-offs may be unavoidable and, of these, which ones might be acceptable (or least unacceptable)
9. what are the strengths and limitations of each possible system component, including interconnections
10. what are the strengths and limitations of each overall plan option
11. which components (technologies, programmes, etc.) and what plan option(s) best meet the criteria and overall purpose of the undertaking, in comparison with other potentially reasonable alternatives
12. what specifics are needed in the plan, and/or what arrangements are needed for subsidiary and subsequent deliberations and decisions (e.g. on particular projects under the plan) to ensure proper consideration of purposes, alternatives, effects, mitigation and enhancement options, trade-offs, etc. in light of the sustainability objective and criteria
13. whether and under what terms and conditions the proposed plan should be approved
14. what monitoring and adaptive response requirements are imposed
15. what preparations by various parties are necessary and desirable to ensure that negative effects are avoided or mitigated, that unanticipated effects are identified and addressed quickly, that subsidiary planning and project development proceeds appropriately, that the plan is reviewed and revised regularly, that maximum mutually reinforcing gains are achieved and that significant adverse effects are avoided

As this list makes clear, consistent application of the criteria would proceed throughout the process in multiple, interrelated analyses and choices. The result would be a product of iterative planning that would consistently inform and favour options that served the "contribution to sustainability" objective.

Items 12 to 15 indicate that the criteria also apply to matters of implementation, though most of the implementation issues noted are ones that ought to be included in the plan as reviewed. A particularly important item in this case is #12, Like many strategic level undertakings, the IPSP is designed to guide subsidiary and subsequent undertakings, including more specific planning and the selection among and development of particular project proposals. Such strategic level plans typically need to present clear directions for how planning for these subsidiary and subsequent undertakings should be designed and carried out. It should also be careful to ensure that all key issues not resolved at the strategic level are addressed openly and rigorously at the more specific planning or project level. In this more specific work too, the sustainability-based evaluation and decision criteria apply, though they may well need further, more detailed elaboration.

5. Reviewing the Proposed IPSP

5.1 The continuing value of properly elaborated sustainability-based criteria

An elaborated set of sustainability-based criteria is still useful now, after a proposed plan has been developed and submitted for review. In the evaluation of the submitted IPSP, application of the more comprehensive criteria can guide evaluation, including comparative evaluation, of the following:

- each power system component/technology (including transmission conservation/demand reduction) in the IPSP or worthy of consideration as an alternative;
- each major (set of) alternatives(s) within each component, recognizing differences of particular technology, siting, timing, scale, ownership/ management; and
- the proposed overall system configuration (the particular combination of technologies and the roles of each) and alternatives to it.

Appendices 3 and 4, below, summarize two exercises in applying the specified criteria from Appendix 1. Appendix 3 outlines an evaluation of the main technologies and other components of the system plan. Appendix 4 provides an overall comparison of the IPSP and an alternative proposal presented in the *Renewable is Doable* document prepared by the World Wildlife Fund Canada and Pembina Institute.

Like appendix 1, appendices 2, 3 and 4 are provided here for illustrative purposes. The appendices consider power system planning components and plan options at a broad level. Nonetheless, appendices 2, 3 and 4 provide useful indications of

- the difference between a comprehensive set of elaborated sustainability criteria and trade-off rules and the set of "context specific evaluation criteria" presented by the OPA as the basis for IPSP decisions; and
- the likelihood that application of a comprehensive set of sustainability criteria specified for the case would lead to conclusions different in substantively important ways from those reached by the OPA in the development of the IPSP.

5.2 Conclusions

In *Discussion Paper 6,* the OPA clearly recognizes the importance of a sustainability-based framework for integrated power system planning. It is not evident whether this recognition was inspired largely by awareness of legal obligations, or acceptance of a moral imperative, or appreciation of sustainability's practical value as an integrative and overarching concept, or, some combination of the two, perhaps with additional considerations. But the OPA deserves credit for embracing the idea.

Unfortunately, the understanding revealed in *Discussion Paper 6* was late and incomplete. The OPA identified a full set of evaluation and decision criteria based on the core requirements for progress towards sustainability. It also identified the accompanying general rules for dealing with trade-offs. But by then the OPA had already done its supply mix planning and was well advanced in preparing the IPSP using a fragmentary set of established considerations as a base for its evaluations and decisions. Instead of taking the generic sustainability-based criteria and trade-off rules and elaborating them for the particular circumstances of power system planning in Ontario as a comprehensive and integrated foundation for planning, the OPA chose to present the factors that it had considered and argue that they were "consistent with" application of the comprehensive criteria.

As we have seen, the approach was unsuccessful. The OPA's planning had not begun with a clear commitment to making a positive and well-integrated contribution to sustainability. The considerations that apparently did guide the OPA's planning (the "context specific evaluation criteria") did not cover the full set of basic sustainability criteria. They addressed some aspects only and it is at best misleading to claim that they were "consistent with" application of the full set of basic criteria presented in *Discussion Paper 6.* Moreover the "context specific evaluation criteria" that were used were not applied consistently in an integrated way for allow properly illuminated evaluation of alternatives and trade-offs.

This is in part a compliance problem. The IPSP Regulation requires the OPA to "ensure that safety, environmental protection and environmental sustainability are considered in developing the plan."[50] The analysis here indicates that the requirement for ensuring consideration of environmental sustainability was not met. Only some relevant aspects were considered.

More importantly this is a substantive problem. As a general rule, different criteria point to different choices. In this case, the OPA using its criteria chose the components and overall features proposed in the current IPSP. The exercise documented in Appendix 4, below, suggests that a more complete set of sustainability-based criteria, specified directly for the case and context, would lead to some significantly different evaluations of the various possible technologies and other system components, and to some significantly different choices in the elaboration of an overall system plan. Thus the inadequacies of the OPA's consideration of sustainability undermine the rationale for the proposed plan in important areas.

The appendices below indicate that the OPA's decisions on an appropriate supply mix would have been significantly different had the OPA applied the full suite of sustainability requirements and trade-off rules. In particular, it seems likely that application of a comprehensive set of specified sustainability criteria at the supply mix stage would not have identified nuclear energy as the preferred supply option for meeting virtually all baseload requirements. During the IPSP stages, application of proper sustainability criteria would, for example, likely have led the OPA to give greater consideration to full lifecycle effects, climate change implications, and the risks of path dependency. It would likely also have favoured decisions to pursue maximum conservation and demand management potential, to keep the nuclear component well below the maximum allowed by the Supply Mix Directive, and to improve transmission capacity chiefly in ways and areas that do not reinforce a centralized grid design. And it would have encouraged clear direction on how to ensure due application of sustainability criteria to more specific decisions on issues that require attention in the power system (e.g. choices between nuclear new build and refurbishment options) but were not resolved in the IPSP.

One notable difference between the OPA's Preliminary Plan and an alternative that gives due consideration to environmental sustainability is that in the latter case the benefits that would result from decision making on various planning elements (appropriate supply mix, transmission, etc.) would be distributed across a more diverse range of stakeholders, and integrated across a more diverse range of social and ecological concerns.

If the Ontario Energy Board adopts and applies a properly comprehensive set of sustainability criteria and trade-off rules, such as those we have elaborated, these would be expected to affect its evaluations and decisions about several matters:

- what portions of the IPSP are and are not worthy of approval as proposed;
- what revisions should be required;
- what terms and conditions of approval would be appropriate;
- what guidance needs to be provided for planning and decision making on subsidiary and subsequent more detailed plans and projects under the IPSP; and

- what must be addressed in future iterations of the IPSP to ensure proper incorporation of sustainability requirements in planning and decision making.

Overall, the analysis reported here indicates that the OPA has not met the requirement for consideration of environmental sustainability in the development of the proposed IPSP and that due attention to sustainability requirements would favour a quite different plan. The clear implication is that the current plan cannot be approved as it stands as it has failed to met the requirement of the IPSP regulation of ensuring due consideration of environmental sustainability in its development.

In light of the need to advance the renewal of Ontario's electricity system, those aspects of the plan that are evidently compatible with sustainability objectives, including the plan's CDM and low-impact renewable energy components and the phase out of coal-fired generation could be accepted on an enhanced basis. In the areas of significant conflict between the proposed IPSP and the likely conclusions of planning flowing by sustainability-based evaluation, including the plan's nuclear components and low-efficiency applications of natural gas, the OEB would be justified in requiring the OPA to reconsider these options in light of comprehensive, properly specified and carefully applied sustainability criteria and trade-off rules, and to submit a suitably revised IPSP for the next triennial review.

Appendix 1

Comprehensive and specified criteria for sustainability-based evaluations and decisions related to Ontario Integrated Power System Planning (including assessment of technologies/components and full system proposals)

A1.1 A comprehensive set of planning criteria based on generic requirements for progress towards sustainability, specified for the case and context of the IPSP

The table below presents a basic matrix for applying sustainability-based criteria for evaluation of integrated power system plan technologies (e.g. supply from new or refurbished nuclear plants, wind farms, hydro electric installations; transmission facilities and conservation/demand management initiatives) and alternative system scenarios or plans. The key substance is the set of criteria, which are presented in illustrative contrast to the "context specific evaluation criteria" set out by the OPA in *Discussion Paper 6, Sustainability.*

The criteria were developed in a process that began with criteria categories based on the generic requirements for progress towards sustainability as set out in Gibson et al, *Sustainability Assessment: Criteria and Processes.* These criteria were then elaborated with particular attention to how the relevant concerns emerge or are expressed in power system planning applications generally and in Ontario. This included recognition of the considerations underlying the OPA's "context specific evaluation criteria".

The result is rough and meant only to be illustrative. Proper development would have involved much broader consultation and public deliberation than was possible in the circumstances.

The criteria below were used in the analyses reported in the following appendices.

A1.2 Criteria design and application notes

1. The criteria set out below in section A1.3 are designed to be applied to evaluation, including comparative evaluation, of the following:

- proposed or potential power system components/technologies (including transmission and conservation/demand reduction), including each major (set of) alternatives(s) within each component, recognizing differences of particular technology, siting, timing, scale, ownership/management (e.g. public, private, co-op);
- each proposed or potential overall system configuration (the particular combination of components/technologies and the roles of each) as a whole, including alternatives in timing, flexibility, policy and regulatory support, implementation monitoring, etc.

2. The set of criteria include, and elaborate and specify for the case/context, all of the generic sustainability criteria that apply to all applications. They begin with the generic sustainability assessment requirements/criteria, supplemented by more emphasis on resilience issues because of the evident importance of resilience in this case. They are then specified by giving particular attention to issues of clear significance to the case and context. To ensure comprehensive attention to all the major generic matters the framework structure mostly follows the main category names of the generic sustainability assessment criteria. But in the interests of ensuring due attention to the key issues of the case and context (esp. prudence and cost-effectiveness), the names of some criteria categories have been expanded or adjusted to use language or emphasize concerns particular to the application.

3. Application of each criterion includes consideration of the following:

- direct effects (e.g. a new dam disrupting navigation and fish movement)
- indirect effects (e.g. new transmission corridors through previous inaccessible forest areas leading to more access, leading to more forest harvesting, hunting and/or other opportunities and pressures in the area)
- induced effects (e.g. significant expansion of intermittent supply components and stronger market for effective storage options inducing an increase in storage technology research and development)
- cumulative effects (e.g. the combined effects of multiple concurrent projects in one area – such as nuclear plant refurbishment, low/medial level radioactive waste repository construction, transmission capacity expansion, major wind farms and new build nuclear project, plus other induced economic activities in other sectors all in Bruce County)

4. In all cases attention to issues and effects covers

- the full life cycle, including upstream (e.g. fuel cycle and construction inputs) and downstream (e.g. decommissioning, long-term waste management) components
- opportunities opened and foregone (opportunity costs)
- local/regional, provincial/national and global effects

5. In all cases, effects may be positive and/or negative and affected by mitigation and/or enhancement efforts. Likelihood of mitigation and/or enhancement success is considered.

6. In all cases, attention is paid to include increased likelihood or severity of, or exposure to, undesirable risks and positive openings as well as more or less firmly predictable effects. Undesirable risks include potential for and vulnerability to

- human error
- technological failure and accidents
- geo-political activities and changes (e.g. malfeasance and terrorism, climate change, global economic functioning, key supply pricing and availability)
- technological advances that are disruptive or that are attractive but cannot be incorporated in the systems as designed.

7. In every category, attention should be focused on areas of particular opportunity or concern (including approaching thresholds, windows of opportunity, vulnerable sectors).

8. In all cases, the potential significance of effects is influenced by

- impact characteristics such as magnitude (intensity, spatial distribution, etc.) and severity (including threshold crossing potential), likelihood, frequency, duration, reversibility, equity of distribution
- receiving environment characteristics (public value, known/suspected system importance, sensitivity/resilience including the extent/severity of existing stresses, scarcity, replaceability, managerial and other response capacity, and system objectives, especially nature of desired futures)
- potential for cumulative contributions (with effects that may be additive, multiplicative and/or synergistic) and are unlikely to be simply linear because of time lags (e.g. carcinogens), spatial movement (e.g. acid rain), triggers, biomagnification (e.g. persistent toxics), fragmentation (e.g. forest ecosystems), thresholds (e.g. cod overfishing)

9. In all applications of the criteria, uncertainties about effects predictions should be stated, possible range identified and implications of the uncertainties assessed.

A1.3 Sustainability-based planning and assessment criteria specified for the case and context of integrated electrical power system planning in Ontario

Criteria

For application to development of an IPSP for Ontario or, now that the OPA's IPSP has been completed and proposed, for evaluation of

- the anticipated and possible effects of the OPA's proposed IPSP, including each technology/component, the full system and alternative configurations;
- other options for technologies/components and other full system configurations (e.g. the Renewable is Doable option); and
- their comparative merits and deficiencies and overall desirability.

Socio-Ecological System Integrity

What is the nature and significance of

- overall effects on rate of growth of electricity demand and consumption and associated activities likely to add to local to global scale system stresses
    - effects on biophysical and socio-biophysical systems and the provision of ecosystem goods and services
    - atmospheric (GHGs, smog and acid rain precursors, heavy metals, hazardous air pollutants incl. POPS and heavy metals);
    - water quality (releases of radioactive, conventional and hazardous contaminants to surface and groundwater, thermal change, flow change);
    - water quantity (consumption, impacts on surface and groundwater storage, flows and cycling);
    - waste generation (radioactive, hazardous, high volume);
    - habitats, ecosystems and landscapes (new access/stresses, connectivity/fragmentation)
- effects on livelihood system resources
    - foodlands (soil quality, access, fragmentation)
    - fisheries (sport, commercial)
    - forests (recreation, hunting and trapping)
- effects on human health
    - occupational (construction, fuel cycle, operation, post-closure)
    - individual and community (construction, operational, fuel cycle, post closure, extreme events; consider impacts on vulnerable populations)
- effects on important/valued ecological, social and socio-ecological systems and system components, characteristics and capacities, including
    - human appropriation of primary productivity
    - communities' social and economic resilience including social capital, cultural and economic diversity, innovative and adaptive capacity, etc.)
    - culture of conservation

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- effects on qualities maintaining socio-ecological system integrity
  - biodiversity,
  - social capital, cultural and economic diversity, cooperative governance linkages, innovative capacity
  - monitoring/feedback/response systems,

- effects on areas of particular opportunity or concern (approaching thresholds, windows of opportunity, vulnerable sectors)

- local/regional effects on
  - capacity of biophysical systems to deliver valued goods and services reliably into the future
  - social capital and livelihood resilience
  - infrastructure capacity
  - governance requirements/capacities
  - landscape aesthetics

- provincial/national effects on
  - contribution to resilience/reliability of the power system and the Ontario socio-economy (including valuable ecosystem goods and services, durable employment, distribution of direct and induced opportunities and stresses, etc.)
  - air quality: smog, acid rain, air toxics, including transboundary pollutants, etc.
  - water quality, including contaminants/bioaccumulants, temperature, etc.
  - population and job distribution
  - economic development path/options
  - governance requirements/capacities

- global effects on
  - climate change (GHG emissions, adaptive capacity, etc.)
  - security and risks (weapons proliferation, terrorist targets, risk of accidents, risks of systems failures, etc.)
  - Ontario's appropriation of global biocapacity

Livelihood Sufficiency and Opportunity

What is the nature and significance of

- effects on reliable provision of energy services through system including consideration of CDM as well as supply

- effects on affordable provision of energy services, especially for crucial needs, disadvantaged interests

- employment/livelihood opportunities
  - number, durability, security, diversity, quality, accessibility/proximity to needs, equity/appropriateness of distribution, safety, flexibility, spin-off potential
  - direct and induced
  - fit with anticipated needs
  - potential for capacity building (learning, social capital)
  - potential for innovation for sustainable livelihoods in CDM and renewables (solar and wind performance gains, storage, etc.)
  - market access for small producers

- avoidance of boom and bust effects
  - plan/project design and scheduling

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- bridging provisions (capacity building, heritage funds)
- diversification

• associated economic development opportunities/risks (directly linked and induced)
  - quality
  - location (where opportunities are needed vs where growth is already a problem)
  - permanence vs boom/bust
  - spin-off opportunities, multipliers

• local/regional effects
  - community solidarity and governance capacity
  - adequacy and demands on local and regional services
  - growth management in GGH
  - job/development needs of rural and remote communities, First Nations
  - contribution to rural renaissance

• provincial/national effects on
  - livelihoods beyond Ontario (life-cycle effects, trade opportunities, etc.)

• global effects on
  - transfer of beneficial technologies
  - opportunity for technology/trade advancement

Intragenerational Equity
(distribution of costs and risks in the present)

What is the nature and significance of

• overall effects on consumption, wealth and resource access gaps between the first and fifth quintile of the population

• equity effects of (re)distribution of risks, costs, benefits and opportunities among income groups, genders, age groups, regions, indigenous/non-indigenous people, areas of growth and decline, including
- positive openings (e.g. durable economic development opportunities)
- opportunities foregone (e.g. allocation of transmission capacity to one generation source)

• distribution of effects on key quality of life considerations (health, valued employment, respected knowledge, community security, access to opportunity, influence in decision making, durable economic development opportunities, etc.)

• allocations of costs/risks to those who benefit little or not at all from the system

• effects on externalization or internalization of risks, costs and benefits on distribution of risks, costs and benefits among investors, suppliers, consumers and governments (i.e. taxpayers)

• social and economic effects of electricity costs and pricing among suppliers, consumer groups (who wins, who loses)

• local/regional effects on
  - employment for local or transient or outside people
  - opportunities for small producers

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- new governance burdens for local authorities and residents

- provincial/national effects on
  - special needs of rural areas, First Nations, declining communities
  - concentration or dispersion of influence on energy policy and practice

- global effects on
  - wealthy nations' responsibility for major GHG cuts and other reduction of energy, material and ecological system demand
  - ood vs fuel

Intergenerational Equity

What is the nature and significance of

- long term enhancements of opportunities (technological advantages, developed social capital, stimulation of innovation, resilient systems, etc.)

- long term costs, risks and other burdens (costs, risks, debts, wastes requiring long-term/permanent management, decommissioning/rehabilitation needs, permanent damages (health, landscape, ecosystem productive capacity), security and safety risks, etc.) transferred to future generations

- shrinking or foreclosure of options for future generations (e.g. depletion of non-renewable resources or renewable resource capital base).

- distribution of long term positives and negatives (e.g. overall effects on future consumption, wealth and resource access gaps between the first and fifth quintile of the population)

- capacity and provisions for use of near term benefits as bridge to more long term sustainable options (e.g. from non-renewable to renewable supply sources)

- intergenerational distribution aspects of
  - residual gains and losses, openings and risks
  - long term effects on expanding or closing the gap between rich and poor

- local/regional effects on
  - permanent changes (e.g. in landscapes, ecological system impairment)
  - long term management responsibilities, risks, costs (e.g. wastes)

- provincial/national effects on
  - decommissioning and rehabilitation costs
  - residual wastes/risks and associated management burdens
  - potential for residual debt

- global effects on
  - overall and distributional results of long term climate effects, and effects on overall energy, material and ecological system demand
  - depletion of non-renewable resources, - impairment of biophysical and/or social system resilience

- global (in)equities
- global security (vs armed conflict, scarcity/deprivation, vulnerability to economic and biophysical hazards,...)

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Efficiency, Cost-Effectiveness and Resource Maintenance

What is the nature and significance of

- contribution to overall reduction of material, energy and ecological system demand
  - particular focus on maximum reduction of electricity demand and associated footprint
- sustainability of primary energy sources
- maintenance/enhancement of
  - ecological base for delivery of ecological goods and services
  - renewable resource base
  - non-renewable resources (including through effective bridging)
  - social capital and other community goods
- minimization of costs (lifecycle, full costs basis including legacy, environmental, operating/maintenance and capital costs and risks) through
- full cost (beyond LUEC) calculation of most cost-effective supply/CDM option
  - internalization of costs and risks by electricity suppliers
  - minimizing overall public costs and assumption of risks and liabilities
  - avoiding subsidization of specific suppliers or technologies (directly or via transfer of risk and liabilities to government or government agencies such as the OPA)
- maximization of efficiency of energy production, delivery and use including
  - exergy efficiencies through matching the quality of and with the needs of the use (end use matching)
  - maximizing primary to delivered energy efficiency including opportunities for multiple use (e.g. cogeneration); minimizing conversion and transmission losses, including attention to internalization and equitable distribution of risks, cost and impacts, quality of energy)
  - minimizing need for backups/reserve margin (recognizing desirable redundancy for system resilience)
  - stimulation of further conservation/efficiencies
  - maximizing use of underutilized existing facilities, resources and capacities and minimize requirement for additional supporting infrastructure, management
  - minimizing governance burdens/costs (regulatory, administrative, citizen monitoring, financial oversight, subsidies, acceptance of liabilities etc.)
- maximization of flexibility to pursue and adopt new technologies/techniques
  - maximizing potential for incremental adjustment
  - avoidance of locked in obsolescence
- local/regional effects on
  - max. multiple local/regional benefits from chosen options (e.g. desirable, diverse and durable employment, health and ecological enhancements, and infrastructure improvement)
  - contribution to growth redistribution
  - min. conflicts with current valued qualities, activities, opportunities
  - min. boom/bust effects
- provincial/national effects on
  - maximization of electrical energy demand reduction (at full costs not significantly greater than supply options)
  - min. econ/financial vulnerability

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- min. damages and risks to valued social and ecosystem components
- max. potential encouragement of and benefit from domestic innovations
- max. resources retained for other purposes
- discouragement of direct and indirect expansion of energy, material and carrying capacity demand

• global effects on
- contribution to reducing overall energy, material and ecological system demand
- demonstration case/tools for global practice
- trade and aid implications

Socio-Ecological Civility and Democratic Governance

What is the nature and significance of

• contribution to enhancement of governance capacity, including
- government capability (for consultation, planning, oversight, monitoring, and response) including supportive redundancy
- diverse private sector opportunity and innovative culture
- informed and enabled citizen engagement
- accessibility and transparency of decision making (e.g. relative accessibility of nuclear approval process versus deliberations on conservation initiatives)
- decision making transparency, comprehensibility and accessibility, process clarity

• contribution to understanding and capability, including
- enhancing social capital
- facilitating social learning
- building a "culture of conservation" (demand reduction and efficiency)
- accuracy of price message (e.g. full cost pricing)
- open deliberation on objectives)/ends (e.g. through scenario building and backcasting)

• encouragement of
- research and innovation
- adaptive design including technology and system flexibility
- capacity for response to opportunities and surprise

• minimization of
- threats to valued community qualities, features
- system (or component) vulnerability to security hazards (e.g. non-democratic security needs)
- governance and oversight requirements

• local/regional effects on
- demands on governance capacity (municipalities, NGOs)
- contributions to or stresses on social capital

• provincial/national effects on
- dependence on extra-provincial network (encouragement of interjurisdictional cooperation, vulnerability to decisions beyond local/provincial control)
- demands on governance capacity (immediate and in perpetuity)
- contributions for social capital
- promotion of innovation

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- global effects on
  - vulnerability to geopolitical risk (e.g. security/terrorism, fuel/technology access)

Prudence, Precaution and Adaptation

What is the nature and significance of

- contribution to technology and system reliability
  - minimization of system vulnerability to risks due to catastrophic events, technology failures
  - minimization of opportunity for damaging human error
  - minimization of exposure to, or likelihood of, resource shortage (fuel, wind or water flow or other power resource) or programme failure (e.g. poor public or industry response to conservation/demand mgmt initiatives)
  - minimization of vulnerability to grid upset
  - adequacy of measures to protect system security
  - ability to accommodate range of potential futures while promoting progress to a desirable future

- contribution to technology and system resilience
  - maximize modularity (distributed versus centralized components)
  - employ diversity of technologies, fuels, suppliers and facilities, etc.
  - maximize capacity to isolate failures and facilitate system recovery
  - minimize need for backups/reserve margin (recognizing desirable redundancy for system resilience)
  - availability of response options, including spare capacity (storage, back-up generation, additional temporary and longer term CDM), adjustable scale, etc.
  - effective monitoring and quick response capability (managerial and technical)
  - friendliness to innovation, minimum path dependence, ability to retain and pursue options
  - self-reliance combined with cooperative networks of support
  - contingency plans

- adaptive capacity and minimization of path dependency
  - ability to adapt to changing circumstances including externally generated ones , including environmental change (e.g. climate change impacts), economic recession or growth, structural economic change affecting electricity demand, political risks (e.g. policy shifts, geopolitical events)
  - ability to take incorporate new technological development
  - maximization of potential for incremental mid-course adjustment in face of changing circumstances (e.g. by adding system capacity in incremental steps with <5 year planning, approval and construction timelines
  - minimization of commitments to high path dependency large scale, capital intensive supply options with >5 year planning approval and construction timelines

- avoidance of economic risks
  - minimization of risk of project failure due to technological or management failure, regulatory, social licence, political factors
  - minimization of system level impact of individual project or technological failure through avoidance of over dependence on individual projects
  - minimization of risk of higher than predicted costs and delays (due to technical, management, economic, regulatory social, licence and political factors

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- retention of options to cancel/abandon individual projects that are seriously over budget or delayed via project modularity (minimize large centralized projects whose individual failure will throw the system/plan into crisis)

- avoidance of geopolitical risk
  - minimize political risk to fuel access or market risk where fuel is internationally traded commodity subject to international trade rules
  - minimize political risk to access to technology or market risks where there are competitive markets for technology and skills needed to deploy it
  - avoidance of choices that may contribute to proliferation of weapons of mass destruction,

- avoidance of security risks
  - minimize obvious targets for terrorist activity
  - minimize system dependence on individual facilities that may be vulnerable to terrorist attack or other failures/events
  - see minimization of geopolitical risks re: fuels or technologies above

- avoidance of extreme event risks
  - minimize possibilities for catastrophic accidents or other events with catastrophic effects

- sustainability of primary energy sources

- avoidance of uncertain but possibly significant damages (e.g. climate change impacts, health damages, etc.)

- local/regional effects on
  - minimize vulnerability to boom/bust effects
  - minimize contribution/vulnerability to cumulative stresses

- provincial/national effects on
  - minimize risk of catastrophic failure
  - minimize path dependency
  - maximize component and system resilience
  - maximize adaptive capacity
  - avoidance of network dependence but encouragement of cooperation and back up support

- global effects on
  - minimize contribution to global insecurity
  - minimize vulnerability to global insecurity
  - example for international adoption

Immediate and Long Term Integration

What is the nature and significance of

- potential to deliver multiple benefits (livelihoods/stewardship/equity/civility/precaution or environmental/economic/social/geopolitical)

- potential for mutually reinforcing benefits

- potential for avoiding trade-offs (see next section)

- local/regional effects on
  - potential for multiple, mutually reinforcing livelihood benefits

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- risk of mutually reinforcing cumulative negatives (e.g. boom-bust of multiple associated/induced projects)
- undesirable and avoidable trade-offs (e.g. short term development at the expense of longer term livelihood base)
- provincial/national effects on
- potential for multiple, mutually reinforcing benefits (e.g. centre for sustainable energy system innovations)
- risk of mutually reinforcing negatives (e.g. contribution to growth concentration)
- undesirable and avoidable trade-offs

- global effects on
  - potential for multiple, mutually reinforcing benefits (e.g. building of sustainable energy model for global applications)
  - risk of mutually reinforcing negatives (e.g. contribution to climate change, larger material/energy footprint)
  - undesirable and avoidable trade-offs

Trade-off rules

Does the technology/component/system maximize opportunities for multiple mutually reinforcing gains?

Are there likely to be significant adverse effects (e.g., damage or increased stress in a major area of existing concern, or reduction of prospects for resolving priority problems) that cannot be avoided without accepting more adverse effects elsewhere?

Are any trade-offs proposed where stronger mitigation efforts would be feasible?

Would any proposed trade-off displace significant adverse effects from the present to the future (and would this trade-off be unavoidable without displacing more serious adverse effects to the future)?

Have the proposed trade-offs been discussed in and accepted through an open, participative process?

Has each proposed significant trade-offs been explicitly and adequately justified by the proponent of the trade-off?

Appendix 2

Comparison of the OPA's "context specific evaluation criteria" with the comprehensive and specified set of sustainability-based planning and assessment criteria in Appendix 1

A2.1 The framework for comparison

In *Discussion Paper 6, Sustainability,* the OPA sets out and provides some details concerning its "context specific evaluation criteria": feasibility, reliability, cost, flexibility, environmental performance and societal acceptance. In Appendix 1, above, we have presented a set of sustainability-based planning and assessment criteria that were built on the generic requirements for progress towards sustainability but were elaborated for the particular case and context of integrated electrical power system planning in Ontario.

The table below compares the OPA's set of criteria with the comprehensive set of elaborated criteria presented in Appendix 1. The left column includes all to the Appendix 1 criteria. The second, third and fourth columns are used to record which comprehensive Appendix 1 criteria were incorporated fully, partially, or not at all in the OPA criteria set. The final column is used to record the relevant OPA criterion (marked with an asterisk*) or to provide other comment.

A2.2 Matrix of comprehensive criteria included, partially included or neglected in the OPA's IPSP criteria

Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	Fully included in IPSP criteria	Partially included in IPSP criteria	Largely or wholly neglected in IPSP criteria	Comments
	√	~	X	
Socio-Ecological System Integrity What is the nature and significance of				
• overall effects on rate of growth of electricity demand and consumption and associated activities likely to add to local to global scale system stresses			X	
• effects on biophysical and socio-biophysical systems and the provision of ecosystem goods and services - atmospheric (GHGs, smog and acid rain precursors, heavy metals, hazardous air pollutants incl. POPS and heavy metals); - water quality (releases of radioactive, conventional and hazardous contaminants to surface and groundwater, thermal change, flow change); - water quantity (consumption, impacts on surface and groundwater storage, flows and cycling); - waste generation (radioactive, hazardous, high volume); - habitats, ecosystems and landscapes (new access/stresses, connectivity/fragmentation)		~		* Env. performance
• effects on livelihood system resources - foodlands (soil quality, access, fragmentation) - fisheries (sport, commercial) - forests (recreation, hunting and trapping)		~		* Env. performance
• effects on human health - occupational (construction, fuel cycle, operation, post-closure) - individual and community (construction, operational, fuel cycle, post closure, extreme events; consider impacts on vulnerable populations)		~		* Env. performance
• effects on important/valued ecological, social and socio-ecological systems and system components, characteristics and capacities, including - human appropriation of primary productivity - communities' social and economic resilience including social capital, cultural and economic diversity, innovative and adaptive capacity, etc.) - culture of conservation		~		* Societal acceptance

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Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	**Fully included in IPSP criteria**	**Partially included in IPSP criteria**	**Largely or wholly neglected in IPSP criteria**	**Comments**
	√	~	X	
• effects on qualities maintaining socio-ecological system integrity - biodiversity, - social capital, cultural and economic diversity, cooperative governance linkages, innovative capacity - monitoring/feedback/response systems,			X	
• effects on areas of particular opportunity or concern (approaching thresholds, windows of opportunity, vulnerable sectors)			X	
• local/regional effects on - capacity of biophysical systems to deliver valued goods and services reliably into the future - social capital and livelihood resilience - infrastructure capacity - governance requirements/capacities - landscape aesthetics		~		* Feasibility * Societal acceptance
• provincial/national effects on - contribution to resilience/reliability of the power system and the Ontario socio-economy (including valuable ecosystem goods and services, durable employment, distribution of direct and induced opportunities and stresses, etc.) - air quality: smog, acid rain, air toxics, including transboundary pollutants, etc. - water quality, including contaminants/bioaccumulants, temperature, etc. - population and job distribution - economic development path/options - governance requirements/capacities		~		* Env. performance
• global effects on - climate change (GHG emissions, adaptive capacity, etc.) - security and risks (weapons proliferation, terrorist targets, risk of accidents, risks of systems failures, etc.) - Ontario's appropriation of global biocapacity		~		* Env. performance

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Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	Fully included in IPSP criteria	Partially included in IPSP criteria	Largely or wholly neglected in IPSP criteria	Comments
	√	~	X	
Livelihood Sufficiency and Opportunity What is the nature and significance of				
• effects on reliable provision of energy services through system including CDM		~		* Reliability
• effects on affordable provision of energy services, especially for crucial needs, disadvantaged interests		~		* Feasibility * Cost
• employment/livelihood opportunities - number, durability, security, diversity, quality, accessibility/proximity to needs, equity/appropriateness of distribution, safety, flexibility, spin-off potential - direct and induced - fit with anticipated needs - potential for capacity building (learning, social capital) - potential for innovation for sustainable livelihoods in CDM and renewables (solar and wind performance gains, storage, etc.) - market access for small producers		~		* Societal acceptance
• avoidance of boom and bust effects - plan/project design and scheduling - bridging provisions (capacity building, heritage funds) - diversification			X	
• associated economic development opportunities/risks (directly linked and induced) - quality - location (where opportunities are needed vs where growth is already a problem) - permanence vs boom/bust - spin-off opportunities, multipliers		~		*Societal acceptance
• local/regional effects on - community solidarity and governance capacity - adequacy and demands on local and regional services - growth management in GGH - job/development needs of rural and remote communities, First Nations - contribution to rural renaissance		~		* Societal acceptance
• provincial/national effects on - livelihoods beyond Ontario (life-cycle effects, trade opportunities, etc.)			X	

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Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	**Fully included in IPSP criteria**	**Partially included in IPSP criteria**	**Largely or wholly neglected in IPSP criteria**	**Comments**
	√	~	X	
• global effects on - transfer of beneficial technologies - opportunity for technology/trade advancement			X	
Intragenerational Equity (distribution of costs and risks in the present) What is the nature and significance of • overall effects on consumption, wealth and resource access gaps between the first and fifth quintile of the population			X	
• equity effects of (re)distribution of risks, costs, benefits and opportunities among income groups, genders, age groups, regions, indigenous/non-indigenous people, areas of growth and decline, including - positive openings (e.g. durable economic development opportunities) - opportunities foregone (e.g. allocation of transmission capacity to one generation source)		~		* Societal acceptance
• distribution of effects on key quality of life considerations (health, valued employment, respected knowledge, community security, access to opportunity, influence in decision making, durable economic development opportunities, etc.)		~		* Societal acceptance * Env. performance
• allocations of costs/risks to those who benefit little or not at all from the system		~		* Societal acceptance
• effects on externalization or internalization of risks, costs and benefits on distribution of risks, costs and benefits among investors, suppliers, consumers and governments (i.e. taxpayers)			X	
• social and economic effects of electricity costs and pricing among suppliers, consumer groups (who wins, who loses)		~		* Cost
• local/regional effects on - employment for local or transient or outside people - opportunities for small producers - new governance burdens for local authorities and residents		~		* Societal acceptance

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Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	**Fully included in IPSP criteria**	**Partially included in IPSP criteria**	**Largely or wholly neglected in IPSP criteria**	**Comments**
	√	~	X	
• provincial/national effects on - special needs of rural areas, First Nations, declining communities - concentration or dispersion of influence on energy policy and practice • global effects on - wealthy nations' responsibility for major GHG cuts and other reduction of energy, material and ecological system demand - food vs fuel		~	 X	* Societal acceptance
Intergenerational Equity What is the nature and significance of • long term enhancements of opportunities (technological advantages, developed social capital, stimulation of innovation, resilient systems, etc.) • long term costs, risks and other burdens (costs, risks, debts, wastes requiring long-term/permanent management, decommissioning/rehabilitation needs, permanent damages (health, landscape, ecosystem productive capacity), security and safety risks, etc.) transferred to future generations • shrinking or foreclosure of options for future generations (e.g. depletion of non-renewable resources or renewable resource capital base). • distribution of long term positives and negatives (e.g. overall effects on future consumption, wealth and resource access gaps between the first and fifth quintile of the population) • capacity and provisions for use of near term benefits as bridge to more long term sustainable options (e.g. from non-renewable to renewable supply sources) • intergenerational distribution aspects of - residual gains and losses, openings and risks - long term effects on expanding or closing the gap between rich and poor		 ~ ~ ~	 X X X	 * Cost * Reliability * Societal acceptance

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Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	Fully included in IPSP criteria	Partially included in IPSP criteria	Largely or wholly neglected in IPSP criteria	Comments
	√	~	X	
• local/regional effects on - permanent changes (e.g. in landscapes, ecological system impairment) - long term management responsibilities, risks, costs (e.g. wastes) • provincial/national effects on - decommissioning and rehabilitation costs - residual wastes/risks and associated management burdens - potential for residual debt • global effects on - overall and distributional results of long term climate effects, and effects on overall energy, material and ecological system demand - depletion of non-renewable resources, - impairment of biophysical and/or social system resilience - global (in)equities - global security (vs armed conflict, scarcity/deprivation, vulnerability to economic and biophysical hazards,...)		~	X X	* Env. performance
Efficiency, Cost-Effectiveness and Resource Maintenance What is the nature and significance of • contribution to overall reduction of material, energy and ecological system demand - particular focus on maximum reduction of electricity demand and associated footprint • sustainability of primary energy sources • maintenance/enhancement of - ecological base for delivery of ecological goods and services - renewable resource base - non-renewable resources (including through effective bridging) - social capital and other community goods • minimization of costs (lifecycle, full costs basis including legacy, environmental, operating/maintenance and capital costs and risks) through		~ ~ ~	X	* Cost * Reliability * Feasibility

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Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	Fully included in IPSP criteria	Partially included in IPSP criteria	Largely or wholly neglected in IPSP criteria	Comments
	√	~	X	
• full cost (beyond LUEC) calculation of most cost-effective supply/CDM option - internalization of costs and risks by electricity suppliers - minimizing overall public costs and assumption of risks and liabilities - avoiding subsidization of specific suppliers or technologies (directly or via transfer of risk and liabilities to government or government agencies such as the OPA) • maximization of efficiency of energy production, delivery and use including - exergy efficiencies through matching the quality of and with the needs of the use (end use matching) - maximizing primary to delivered energy efficiency including opportunities for multiple use (e.g. cogeneration); minimizing conversion and transmission losses, including attention to internalization and equitable distribution of risks, cost and impacts, quality of energy) - minimizing need for backups/reserve margin (recognizing desirable redundancy for system resilience) - stimulation of further conservation/efficiencies - maximizing use of underutilized existing facilities, resources and capacities and minimize requirement for additional supporting infrastructure, management - minimizing governance burdens/costs (regulatory, administrative, citizen monitoring, financial oversight, subsidies, acceptance of liabilities etc.) • maximization of flexibility to pursue and adopt new technologies/techniques - maximizing potential for incremental adjustment - avoidance of locked in obsolescence • local/regional effects on - max. multiple local/regional benefits from chosen options (e.g. desirable, diverse and durable employment, health and ecological enhancements, and infrastructure improvement) - contribution to growth redistribution - min. conflicts with current valued qualities, activities, opportunities - min. boom/bust effects • provincial/national effects on - maximization of electrical energy demand reduction (at full costs not significantly greater than supply options)		~ ~ ~ ~	X	* Cost * Reliability * Reliability * Flexibility * Societal acceptance

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Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	**Fully included in IPSP criteria**	**Partially included in IPSP criteria**	**Largely or wholly neglected in IPSP criteria**	**Comments**
	√	~	X	
- min. econ/financial vulnerability - min. damages and risks to valued social and ecosystem components - max. potential encouragement of and benefit from domestic innovations - max. resources retained for other purposes - discouragement of direct and indirect expansion of energy, material and carrying capacity demand • global effects on - contribution to reducing overall energy, material and ecological system demand - demonstration case/tools for global practice - trade and aid implications			X	
Socio-Ecological Civility and Democratic Governance What is the nature and significance of • contribution to enhancement of governance capacity, including - government capability (for consultation, planning, oversight, monitoring, and response) including supportive redundancy - diverse private sector opportunity and innovative culture - informed and enabled citizen engagement - accessibility and transparency of decision making (e.g. relative accessibility of nuclear approval process versus deliberations on conservation initiatives) - decision making transparency, comprehensibility and accessibility, process clarity		~		* Societal acceptance
• contribution to understanding and capability, including - enhancing social capital - facilitating social learning - building a "culture of conservation" (demand reduction and efficiency) - accuracy of price message (e.g. full cost pricing) - open deliberation on objectives)/ends (e.g. through scenario building and backcasting)		~		* Societal acceptance
• encouragement of - research and innovation			X	

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Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	Fully included in IPSP criteria	Partially included in IPSP criteria	Largely or wholly neglected in IPSP criteria	Comments
	√	~	X	
- adaptive design including technology and system flexibility - capacity for response to opportunities and surprise • minimization of - threats to valued community qualities, features - system (or component) vulnerability to security hazards (e.g. non-democratic security needs) - governance and oversight requirements • local/regional effects on - demands on governance capacity (municipalities, NGOs) - contributions to or stresses on social capital • provincial/national effects on - dependence on extra-provincial network (encouragement of interjurisdictional cooperation, vulnerability to decisions beyond local/provincial control) - demands on governance capacity (immediate and in perpetuity) - contributions for social capital - promotion of innovation • global effects on - vulnerability to geopolitical risk (e.g. security/ terrorism, fuel/technology access)		~	X X X	* Societal acceptance
Prudence, Precaution and Adaptation What is the nature and significance of • contribution to technology and system reliability - minimization of system vulnerability to risks due to catastrophic events, technology failures - minimization of opportunity for damaging human error - minimization of exposure to, or likelihood of, resource shortage (fuel, wind or water flow or other power resource) or programme failure (e.g. poor public or industry response to conservation/demand mgmt initiatives) - minimization of vulnerability to grid upset - adequacy of measures to protect system security - ability to accommodate range of potential futures while promoting progress to a desirable future		~		* Feasibility * Reliability * Flexibility

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Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	Fully included in IPSP criteria	Partially included in IPSP criteria	Largely or wholly neglected in IPSP criteria	Comments
	√	~	X	
• contribution to technology and system resilience - maximize modularity (distributed versus centralized components) - employ diversity of technologies, fuels, suppliers and facilities, etc. - maximize capacity to isolate failures and facilitate system recovery - minimize need for backups/reserve margin (recognizing desirable redundancy for system resilience) - availability of response options, including spare capacity (storage, back-up generation, additional temporary and longer term CDM), adjustable scale, etc. - effective monitoring and quick response capability (managerial and technical) - friendliness to innovation, minimum path dependence, ability to retain and pursue options - self-reliance combined with cooperative networks of support - contingency plans • adaptive capacity and minimization of path dependency - ability to adapt to changing circumstances including externally generated ones , including environmental change (e.g. climate change impacts), economic recession or growth, structural economic change affecting electricity demand, political risks (e.g. policy shifts, geopolitical events) - ability to take incorporate new technological development - maximization of potential for incremental mid-course adjustment in face of changing circumstances (e.g. by adding system capacity in incremental steps with <5 year planning, approval and construction timelines - minimization of commitments to high path dependency large scale, capital intensive supply options with >5 year planning approval and construction timelines • avoidance of economic risks - minimization of risk of project failure due to technological or management failure, regulatory, social licence, political factors - minimization of system level impact of individual project or technological failure through avoidance of over dependence on individual projects		~ ~ ~		* Feasibility * Feasibility * Feasibility * Flexibility

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Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	**Fully included in IPSP criteria**	**Partially included in IPSP criteria**	**Largely or wholly neglected in IPSP criteria**	**Comments**
	√	~	X	
- minimization of risk of higher than predicted costs and delays (due to technical, management, economic, regulatory social, licence and political factors - retention of options to cancel/abandon individual projects that are seriously over budget or delayed via project modularity (minimize large centralized projects whose individual failure will throw the system/plan into crisis)				
• avoidance of geopolitical risk - minimize political risk to fuel access or market risk where fuel is internationally traded commodity subject to international trade rules - minimize political risk to access to technology or market risks where there are competitive markets for technology and skills needed to deploy it - avoidance of choices that may contribute to proliferation of weapons of mass destruction,			X	
• avoidance of security risks - minimize obvious targets for terrorist activity - minimize system dependence on individual facilities that may be vulnerable to terrorist attack or other failures/events - see minimization of geopolitical risks re: fuels or technologies above		~		* Reliability
• avoidance of extreme event risks - minimize possibilities for catastrophic accidents or other events with catastrophic effects		~		* Reliability
• sustainability of primary energy sources		~		* Reliability
• avoidance of uncertain but possibly significant damages (e.g. climate change impacts, health damages, etc.)		~		* Reliability
• local/regional effects on - minimize vulnerability to boom/bust effects - minimize contribution/vulnerability to cumulative stresses			X	
• provincial/national effects on - minimize risk of catastrophic failure - minimize path dependency - maximize component and system resilience - maximize adaptive capacity		~		* Flexibility

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Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	**Fully included in IPSP criteria**	**Partially included in IPSP criteria**	**Largely or wholly neglected in IPSP criteria**	**Comments**
	√	~	X	
- avoidance of network dependence but encouragement of cooperation and back up support • global effects on - minimize contribution to global insecurity - minimize vulnerability to global insecurity - example for international adoption			X	
Immediate and Long Term Integration What is the nature and significance of • potential to deliver multiple benefits (livelihoods/ stewardship/equity/civility/precaution or environmental/ economic/social/geopolitical)			X	
• potential for mutually reinforcing benefits			X	
• potential for avoiding trade-offs (see next section)			X	
• local/regional effects on - potential for multiple, mutually reinforcing livelihood benefits - risk of mutually reinforcing cumulative negatives (e.g. boom-bust of multiple associated/induced projects) - undesirable and avoidable trade-offs (e.g. short term development at the expense of longer term livelihood base)			X	
• provincial/national effects on - potential for multiple, mutually reinforcing benefits (e.g. centre for sustainable energy system innovations) - risk of mutually reinforcing negatives (e.g. contribution to growth concentration) - undesirable and avoidable trade-offs			X	
• global effects on - potential for multiple, mutually reinforcing benefits (e.g. building of sustainable energy model for global applications) - risk of mutually reinforcing negatives (e.g. contribution to climate change, larger material/energy footprint) - undesirable and avoidable trade-offs			X	

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Elaborated sustainability-based criteria for evaluations and decisions in integrated power system planning in Ontario	Fully included in IPSP criteria	Partially included in IPSP criteria	Largely or wholly neglected in IPSP criteria	Comments
	√	~	X	
Trade-off rules				
Does the technology/component/system maximize opportunities for multiple mutually reinforcing gains?			X	
Are there likely to be significant adverse effects (e.g., damage or increased stress in a major area of existing concern, or reduction of prospects for resolving priority problems) that cannot be avoided without accepting more adverse effects elsewhere?			X	
Are any trade-offs proposed where stronger mitigation efforts would be feasible?			X	
Would any proposed trade-off displace significant adverse effects from the present to the future (and would this trade-off be unavoidable without displacing more serious adverse effects to the future)?			X	
Have the proposed trade-offs been discussed in and accepted through an open, participative process?			X	
Has each proposed significant trade-offs been explicitly and adequately justified by the proponent of the trade-off?			X	

A2.3 Summary and assessment

The comparison of the comprehensive set of context specific sustainability criteria developed by the project team with the criteria developed by the OPA reveals that the OPA's criteria fail to address fully any of the eight core criteria identified by Gibson et.al. Where there is coverage of some elements of the criterion, it is incomplete and sometimes merely marginal and incidental.

The OPA's treatment of intra and intergenerational equity, and immediate and long-term integration is especially deficient, although major gaps also exist with respect to socio-ecological integrity, livelihood sufficiency and opportunity, efficiency and cost-effectiveness, and prudence, precaution and adaptation.

None of the core trade-off requirements is addressed in the OPA's approach.

Appendix 3

Sustainability analysis of IPSP components: supply technologies, conservation/demand reduction and transmission

This appendix summarizes the findings of an exercise applying the elaborated sustainability criteria from Appendix 1 in evaluations of the main supply and conservation/demand management components of the IPSP. It is presented here for illustrative purposes. Generally, however, the exercise points to preferences for system components and overall system design characteristics that are different from those proposed by the OPA on the basis of its more limited set of criteria.

A3.1 Nuclear: generic

Criteria Category	Advantages	Disadvantages
Socio-ecological system integrity	Generally lower lifecycle greenhouse gas intensity per kWh than conventional fossil fuels (coal and natural gas) [51] Low emissions of conventional pollutants (smog and acid rain precursors) at site of electricity generation.	Undermines investment in energy efficiency and lower-impact energy systems (UK sustainable development commission) Large upstream impacts, particularly due to uranium mining and milling, Mining and milling cause severe impacts on surface water and groundwater quality; contamination of surrounding environment and biota with toxic and radioactive contaminants; and the generation of high volumes of tailings that require perpetual active management. Nuclear power generation results in extremely hazardous and difficult to manage downstream waste streams; including highly radioactive waste nuclear fuel, and large quantities of lower level radioactive wastes from plant decommissioning. These wastes require management over extremely long time frames for security, safety and environmental reasons. Power plant operation and maintenance emits contamination and radioactive elements into air and water, including tritium. Health impacts of these emissions are highly contested. "Nuclear energy workers" exposed to higher levels of radiation exposure than would be acceptable to the public. High occupational risks in uranium mining. Significantly elevated health risks to consumers of "country" food in vicinity of mine/mill operations due to contamination with radionuclides. Unique and uniquely severe accident, security and weapons proliferation risks. Nuclear power generation releases large amounts of cooling water at temperatures higher than the local water temperature. This temperature difference creates ecological stress and impairs local ecosystem function.

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Criteria Category	Advantages	Disadvantages
Livelihood Sufficiency and Opportunity	Modest levels of permanent high value employment in remote and rural areas associated with mining, refining, and power plant operation. Uranium mining is currently a major employer of aboriginals. Power plant construction and refurbishment are major projects providing significant employment. Depending of selected reactor technology, there is a possibility of development of reactor export industry on basis of domestic market.	History of poor reliability in Ontario has affected overall system reliability. Risk of increased electricity costs due to high capital costs and risks associated with facility construction and delay. Boom and bust character of employment opportunities during reactor construction and refurbishment. There is uncertainty concerning the viability of a reactor export industry.
Intragenerational Equity	Nuclear facilities (such as mines, fuel production and generating stations) may support remote and low growth or depopulating regions through modest levels of long-term high wage employment. This helps local infrastructure and economies.	Majority of socio-ecological impacts and risks are upstream and downstream of sites of electricity production and consumption. Southern Ontario receives the benefits of nuclear power (both from electricity and employment at generating stations), but key environmental and health impacts related to mining and milling are in Northern Saskatchewan (and historically in Northern Ontario). High occupational risks in uranium mining. Most mine employees are aboriginal. Most nuclear generation employment is relatively short term in construction. Nuclear power removes abilities of other generating options from supplying the grid (such as decentralized generators), and reduces investment opportunities in renewable energy (especially for First Nations). Economic viability of nuclear projects relies on ability to externalize liabilities and risks onto ratepayers and taxpayers (this has intergenerational equity impacts as well as many key costs and risks are transferred to the future).

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Criteria Category	Advantages	Disadvantages
Intragenerational Equity	Nuclear power has the potential to avoid electricity associated GHG emissions (and by implication climate change impacts) relative to some other electricity sources.	Environmental, safety, security and financial risks associated with the management of long-lived waste streams are borne by future generations. These wastes include mine tailings, waste nuclear fuel, and refurbishment and decommissioning wastes; and the full extent and costs of these risks are largely unknown. Transfer of weapons proliferation risks onto future generation via waste fuel. Ecosystem reclamation responsibility and risks transferred to future generations. High path dependency (70+ year facility planning and operational lifecycle) of nuclear power locks system into a centralized power system over several generations.
Resource Maintenance, Cost Effectiveness and Efficiency	Nuclear power generation is associated with low operating costs. Nuclear plants are designed to operate best at baseload.[14] Nuclear fuel is compact and it is easy to maintain large inventories.	Nuclear power requires centralized power system models, which are less efficient, and more path dependent. Furthermore, the centralized power system models negatively impact other generating technology deployment, and reduce public participation in electricity generation. Concerns regarding long-term supply of high-grade uranium for fuel, particularly in context of global nuclear expansion. Fuel supply expansion options (e.g. reprocessing) are associated with major economic environmental, security and weapons proliferation risks. Dramatic rises in fuel costs over past six years highlight short term uranium shortage. Nuclear power associated with high and rising capital costs, long construction timelines, and a history of serious delays and cost overruns. Externalization of risks and liabilities related to nuclear power have hidden full costs of electricity from nuclear and undermined cost effectiveness. Nuclear power fails the market test: there is no private capital investment without guarantee of market for output, return on investment, ability to externalize construction cost and delay, fuel cost risks and liabilities for accidents, waste management and decommissioning. Large scale of generating facilities requires large reserve margins. Nuclear power generation has low operational flexibility. Low planning flexibility and high path dependency due to high capital costs and long planning, approval, and construction timelines.

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Criteria Category	Advantages	Disadvantages
Socio-ecological civility and democratic governance		Effective regulatory functions require high level of technical expertise, and is not accessible to citizen engagement. "Standing" of debt and lack of full cost accounting reduce transparency in electricity costs and decision making Guaranteed market for nuclear power reduces market opportunities for other supply and demand management options. Power system centralization reduces interactions between citizens and electricity. Embedded risk of weapons proliferation. Encouragement of nuclear power in less stable countries increases security and weapons proliferation risks.
Prudence, Precaution and Adaptation	Low geopolitical risk fuel source. However, rising uranium prices have demonstrated market risks.	History of poor reliability in Ontario. Failures, such as NAOP, have thrown system into crisis due to large centralized nature of generating assets. Undermines resilience: non-modular, highly centralized, non-diverse – relies on single fuel and technology; large scale of generating assets requires increased reserve margin. High path dependency and low adaptive capacity due to very long planning and construction timelines, high capital investment, long-facility lifetime (70 + year lifecycle). High risk of significantly higher than planned costs and delays. Risks of high consequence project failure. Unique and uniquely severe accident, security and weapons proliferation risks. Concerns about long-term supply of high-grade uranium ore have led to increased uranium price, and serve to highlight market risks. Further market and political risks include technology and skills access. Centralized systems can suffer centralized blackouts[13], and nuclear plants require longer startup times after a shutdown.[15]

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Immediate and long term integration
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Key trade offs
Low GHG emissions versus high short term (mining and milling, fuel production) and long-term (tailings, waste rock and spent-fuel management) damages and threats to socio-ecological systems. Low generating emissions versus very high upstream emissions and impacts and extensive legacy risks and costs. Low operating costs versus high capital costs and risks, and uncertain long-term costs and liabilities. High energy output versus path dependence and lack of modularity or adaptive capacity. Maintenance of status quo versus improving power system resilience based on a different operating paradigm. Low geopolitical fuel source risk versus safety, security and weapons proliferation risks.

A3.2 Nuclear: specific to refurbished

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Decommissioning waste generation deferred into the future.	Generation of radioactive and hazardous wastes in refurbishment process.
Livelihood Sufficiency and Opportunity		Boom and bust cycles associated with nuclear refurbishment.
Intragenerational equity		
Intergenerational equity	Refurbished nuclear plants have reduced path dependency compared to new-build.	
Resource Maintenance, Cost Effectiveness and Efficiency	Uses existing generation and transmission infrastructure, which reduces environmental footprint compared to new-build. Reduced path dependency due to shorter planning, approval and construction timelines, lower capital investment, shorter expected facility lifetime. Reduced economic risk due to lower capital costs, shorter project timelines.	
Socio-ecological civility and democratic governance	Does not require new technological expertise on part of regulatory agencies.	
Prudence, Precaution and Adaptation	Shorter plant lifetime (25 years) reduces path dependency when compared to new build (60 year lifetime) Design based on mature technology with, therefore, less uncertainty.	Refurbished facility may be less reliable than new build.
Immediate and long term integration		

A3.3 Nuclear: specific to new build

Criteria	Advantages	Disadvantages
Socio-ecological system integrity		Radioactive waste due to decommissioning.
Livelihood Sufficiency and Opportunity	Depending on which technology is chosen, new-build may create the potential for an enhanced nuclear export industry.	
Intragenerational Equity		
Intergenerational equity		Higher path dependency associated with new-build than with refurbishment.
Resource Maintenance, Cost Effectiveness and Efficiency	Designed to be more efficient than refurbished.	New-build carries higher risks of cost overrun, delay, and project failure.
Socio-ecological civility and democratic governance		New-build may require new technological expertise on part of regulatory agencies.
Prudence, Precaution and Adaptation	New builds may carry less risk than restarting a refurbished plant. Built to accept a larger range of input fuels than refurbishment.	Longer plant lifetime (60 years) increases path dependency with respect to refurbishment. Many of the new input fuels for new-build have higher waste and CO_2 emissions intensity, and a higher risk of weapons proliferation.
Immediate and long term integration		

A3.4 Nuclear: new-build compared to refurbished – key trade offs

Key trade offs	Higher efficiency versus less path dependency. Greater range of input fuels versus cleaner and safer fuels. New and uncertain technology with potential benefits versus older mature technology with better understood risks.

A3.5 Coal

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Does not generate extremely hazardous long-lived waste streams requiring perpetual care and presenting major security and weapons proliferation risks.	All forms of coal mining and extraction (including open-pit, surface, and mountaintop) lead to serious landscape disturbance and ecological harm. Mining, processing, and transport releases coal dust, a known air pollutant. Generating plants are the highest emitters CO_2 (861 g-CO_2-eq per kWhr-elec, compared to 65 for nuclear), a major cause of global warming. No viable emission control technology for CO_2 emissions from Ontario coal plants. Generating plant emissions also include particulate matter, SO_x, NO_x, and heavy metals. Some of the environmental and health impacts of these include acid rain and smog (both locally and globally). Abatement technologies do currently exist for non-GHG emissions. Waste fly ash from coal generation contains toxic heavy metals.
Livelihood Sufficiency and Opportunity	Major employer in Nanticoke, Lambton, Atikokan and Thunder Bay. Potential for research and development into clean coal technologies. Low fuel and operating costs result in low cost electricity. Low-cost electricity is important for major industrial electricity consumers in Ontario.	Risk of boom bust cycling of coal mining towns. New methods of coal extraction more mechanized, which may reduce boom bust cycling, but will harm employment opportunities instead. Coal mining linked with many respiratory ailments. Generating plant emissions incur large public health cost, with a LUEC of $113 per MWh, which harms livelihoods. Emissions also contribute synergistically to many other ailments.
Intragenerational Equity	Primary environmental and health impacts of electricity production borne by present consumers (except GHG emissions).	Upstream impacts of coal mining occur well away from Ontario electricity consumers. Negative distribution of costs to regions with a dependence on coal plants for employment. Citizens living nearby coal plants bear the cost of reduced air quality.[7] Agricultural industry negatively impacted by acid rain and ground level ozone.
Intergenerational equity	Large world coal supplies will allow coal-fired generation to provide a reliable and abundant source of electricity for future generations.	CO_2 emission will have lasting impacts due to global warming. Coal extraction and mining creates permanent landscape and ecological impacts that must be borne by future generations.

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Criteria	Advantages	Disadvantages
Resource Maintenance, Cost Effectiveness and Efficiency	Large supply of coal remaining, with estimates between 100-1000 years. Low fuel and operating costs. Coal remains cheaper than natural gas, even while including environmental costs. Coal fired generation is a well-understood technology with high reliability, low construction cost and delay risks with existing technologies.	Low cost of coal-fired electricity may encourage consumption and discourage reduction in energy demand. Conventional coal combustion a low efficiency (35% primary energy to electricity) energy source. Retrofitting current coal plants not cost effective – could cost $3 billion for an emissions reduction of only 0.5 percent. Current calculations of cost do not include carbon costs and other environmental considerations. New coal-based technologies (such as IGCC) carry high economic costs and technological risks.
Social ecological civility and democratic governance	Research and development into clean coal technology can foster public private partnerships (especially for carbon capture and storage) Power Worker's Union represents coal plant workers, and have input into political and commercial decisions.	Coal mining is a purely private activity with little external input, or opportunities to change. Dependence on coal removing opportunities for emerging renewable technologies. Carbon capture storage options within Ontario extremely limited.
Prudence, Precaution and Adaptation	Coal as a power source carries little supply or generation risks. Coal fired generation is a highly reliable energy source with low fuel and operating costs. Low economic risks with existing technologies. Low geopolitical risk fuel source (although some market risk). Low security and accident risks, no weapons proliferation risks.	Even with retrofits, coal-fired plants will remain a major source of CO_2. New coal technologies (such as IGCC) are not commercially proven and carry long-term uncertainties. Generally coal-generating stations are non-modular due to economies of scale.

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Immediate and long term integration
Even accounting for the addition of unproven clean-coal technology; the environmental and health impacts of coal mining and generation require the ultimate phase out of coal generation.
However, the low cost, high reliability, and moderate plant lifetime of coal-fired generation make it an ideal bridging technology between the current centralized nuclear-powered energy grid to a more decentralized energy grid powered by renewable energy.
The increase in electricity cost associated with the phasing out of coal may reduce electricity usage, thereby reducing the need for investment in generating infrastructure.
Key trade offs
High reliability, low operating cost, low fuel supply, security, geopolitical risk electricity supply versus very high GHG emissions and high emissions of smog and acid rain precursors and heavy metals.
Abundant supply of coal versus other technologies with shorter supply (or renewable supply) but less greenhouse gas emissions.
Lower electricity rates of coal combustion versus the public and environmental health impacts of fuel extraction and plant operation.
Loss of employment in coal mining and generation versus a greater expected gain of employment for renewable and conservation technologies.
Maintaining coal generation in Ontario versus helping set a worldwide precedent for phasing out coal.

A3.6 Natural gas: generic

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Natural gas produces less CO_2, SO_2, NO_X, and particulate matter per kWh than conventional coal fired generation. Furthermore, there are no emissions of heavy metals. Does not generate extremely hazardous long-lived waste streams requiring perpetual care and presenting major security and weapons proliferation risks.	Natural gas has significant upstream impacts including landscape fragmentation, and contamination of surface and groundwater. These effects are further compounded with the flaring of 'sour' gas, which is becoming increasingly common as high-quality supplies diminish. PM emitted from natural gas plants are dangerously small and consequently have greater health impacts than particulates from coal. Diminishing supplies of natural gas are requiring extraction from ecological sensitive areas (such as northern regions) or areas subject to geopolitical risk, such as the Middle East. Natural gas pipelines can affect migratory patterns. Pipeline construction is a major cause of long-term landscape damage. Ecological impacts increase with shift to 'unconventional' gas e.g. landscape fragmentation and water removal associated with coal-bed methane, increased transportation and liquification associated GHG emissions with LNG. Natural gas extraction also causes ecological contamination due to drilling fluid, drill cuttings, rigwash and other associated wastes. Transport of liquefied natural gas by ocean tankers poses risk of catastrophic accident.
Livelihood Sufficiency and Opportunity	Natural gas generation is reliable, flexible, and modular, and contributes to system reliability. Natural gas extraction, processing a major economic activity in western Canada. Pipeline construction may serve to increase training of First Nations workforce. Potential for distributed economic development via cogeneration, micro-turbines.	Upstream economic benefits concentrated in western Canada. Short term price volatility may result in increased electricity costs depending on role in electricity system. Natural gas extraction and pipeline development poses significant risk for boom and bust cycles. For example Mackenzie Valley Pipeline is expected to create several thousand short term jobs compared to several dozen long term jobs.

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Criteria	Advantages	Disadvantages
Intragenerational Equity	By locating the gas plants near the demand centers, the benefits and costs of natural gas generation are combined (i.e. consumers experience environmental and health impacts of electricity generation. Gas projects are developed on market or request for proposal basis: they do not require externalization of construction cost risks, long-term liabilities.	Major upstream impacts and benefits of natural gas generation occur outside of Ontario. Natural gas supplies may reside on First Nations lands, and there is a risk of violated land claim rights. Natural gas used for power production reduces supply, and increases cost, of natural gas for home heating and other purposes. Increased home heating prices may unfairly disadvantage poorer homeowners.
Intergenerational equity	Natural gas has lower GHG emissions compared to coal-fired generation.	Natural gas is a non-renewable resource, and therefore future generations will bear the impact of diminishing supplies and reduced energy security. Potential for long-term upstream landscape damage.
Resource Maintenance, Cost Effectiveness and Efficiency	High degree of modularity allows for citing of generating plants near load centers, which reduces both transmission losses and grid stress, and provides voltage support. High operational flexibility of natural gas plants allow for better response to load fluctuations and unanticipated problems or refurbishment with baseload generators. Potential for high conversion efficiency in combined cycle (55%) and cogeneration (90%) applications.	There are concerns regarding the long-term conventional supply of natural gas in North America. Subject to short term price volatility. Low conversation efficiency (35%) in single cycle applications As international conventional supplies of natural gas diminish while demand increases, there will be increased competition for the resources. Natural gas used for peaking requirements is less cost effective than most conservation and demand management measures.
Social-ecological civility and democratic governance	Potential for widespread distributed, small scale generation/cogeneration applications.	First Nations communities have often been excluded from negotiations concerning pipeline construction. Ontario natural gas resources only contribute 2 percent to provincial demand, which reduces ability for local stakeholder engagement. Decreasing national reserves are further reducing democratic governance and supply must be sourced internationally. The nature of natural gas distribution pipelines is conducive to market monopolization.

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Criteria	Advantages	Disadvantages
Prudence, Precaution and Adaptation	High reliability, contributes to system resilience via modularity, high operational flexibility (SCGT and CCGT). High adaptive capacity and low path dependence given modularity, scalability, operational flexibility, well established and relatively short planning, approval and construction timelines. Low construction cost and delay risks. Does not require externalization of construction risks, and accident and long-term liabilities. Gas generating facilities constructed on market basis. Low security risks, no weapons proliferation risks. Natural gas transmission pipelines are considered to be the safest method of freight transportation.	Short terms price volatility and long-term supply concerns as conventional North American gas reserves decline. Non-North American gas supplies subject to geopolitical risk. Some potential for catastrophic events upstream (well blowouts), LNG transportation accidents. Generating facility location tied to gas grid access.
Immediate and long term integration		
With an operational lifetime of approximately 20 years, natural gas provides a low path dependent technology that may be used to bridge from the current centralized nuclear-powered energy grid, to a more decentralized energy grid powered by renewable energy. The lack of long-term supply, coupled with the increased environmental and economic impact of low quality gas resources, requires that natural gas be planned for as an intermediate technology.		
Key trade offs		
Reliable, efficient, low emission, and highly flexible and adaptable generating technology versus short-term fuel price instability risk and long-term supply concerns. Benefits of training northern and First Nations communities versus ecological impact and lack of stakeholder involvement in the North.		

A3.7 Natural gas: specific to single cycle (SCGT)

Criteria	Advantages	Disadvantages
Resource Maintenance, Cost Effectiveness and Efficiency	Lower capital costs than CCGT. Can quickly ramp up production to full capacity, which allows for load following.	Higher operating costs than CCGT/ Lower fuel efficiency than CCGT (approximately 35 percent). More CO_2 emissions per kWh than CCGT (506 g-CO_2 per kWh)/
Prudence, Precaution and Adaptation	High operational flexibility.	

A3.8 Natural gas: specific to combined cycle (CCGT)

Criteria	Advantages	Disadvantages
Resource Maintenance, Cost Effectiveness and Efficiency	Lower operating costs than SCGT. Higher fuel efficiency than CCGT (approximately 55-60 percent). Less air emissions per kWh for SCGT (303-331 g-CO_2 per kWh).	Higher capital cost than SCGT. Operation of CCGT plants vulnerable to climate change impacts as due to higher temperature cool-ing water. Lower operational flexibility than SCGT, work best in intermediate and baseload applications.

A3.9 Natural gas: specific to combined cycle with CHP

Criteria	Advantages	Disadvantages
Resource Maintenance, Cost Effectiveness and Efficiency	Less air emissions per kWh compared to CCGT and SCGT (202-227 g CO_2 per kWh). Heating output of CPH plants reduce transmission and generating requirements through energy displacement.	Operation of CPH plants vulnerable to climate change impacts as due to higher temperature cooling water.
Social-ecological civility and democratic governance	Potential for distributed generation development via cogeneration, microturbines, etc.	
Key trade offs between SCGT, CCGT and CHP		
Greater peaking abilities of SCGT versus higher operating costs and reduced efficiency. Higher efficiency of CCGT and CHP plants versus higher construction costs and lower operational flexibility.		

A3.10 Hydro: large scale (including storage)

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	No risks or impacts associated with a fuel cycle. Does not generate extremely hazardous long-lived waste streams requiring perpetual care and presenting major security and weapons proliferation risks. Decommissioning of dams restores natural flow regimes, increases biodiversity and connectivity. Dams have low risk of accidents. Dams have very low carbon emissions per kWh, with the brunt of them arising during construction (in the materials) and land-use changes (cutting or flooding of trees).	Damning rivers transforms biophysical river characteristics by changing the flow regime and disconnecting ecological systems. This can cause great ecological damage, and impact species composition and migratory patterns. Reservoirs build up silt deposits through sedimentation, which may become toxic and are released when dams are decommissioned, causing downstream damage. Hydro dams are long lived, and thus ecological impacts will occur over a period of 75-100 years. Large reservoirs make cause reservoir-induced seismicity. Construction and maintenance of access roads creates new environmental impacts in relatively undisturbed landscapes.
Livelihood Sufficiency and Opportunity	Large hydro is a very reliable, low cost source of electricity Large hydro is a good source of employment for highly trained engineers and contractors. Large hydro helps the competitiveness of various industries, such as pulp and paper, smelting, and food processing through low electricity costs. Large hydro developments in Northern Ontario may offset employment losses due to closure of the coal plants.	Reservoir creation increases concentration of methyl-mercury (a strong neurotoxin that readily bio-accumulates in food chains), and can negatively impact humans. Large hydro projects employ less people per kWh than other renewable technologies, and construction is often outsourced. Most large hydro projects lead to boom and bust cycles, as the brunt of employment is during dam construction, which may take 7-10 years. Large hydro impacts tourism opportunities (such as canoeing and fishing) that rely on free flowing rivers. Large hydro reduces opportunities for distributed small hydro ventures that may have been procured through the standard offer program. Large hydro power affects First Nations by altering their traditional hunting and trapping lands, and contaminating their food supply (for example, via methyl mercury)

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Criteria	Advantages	Disadvantages
Intragenerational Equity	Hydro provides economic opportunities in remote locations.	Northern Ontario will suffer a disproportionate amount of social and ecological risk due to hydro development, while the benefit of cheaper electricity will be enjoyed by Southern Ontario. Imported hydro-electricity from Northern Manitoba and Quebec shift the environmental and social cost of electricity to other provinces and communities. Planning for large hydro diverts social capital in local communities. Decision making concerning large hydro largely in the control of the OPA and OPG, with controlled input from local residents. Downstream communities forced to deal with ecological and health issues arising from large hydro dams. Cumulative impacts of hydro extend well beyond focal system.
Intragenerational Equity	Future generations benefit from hydro dams, as there is no fuel cost and low operation and maintenance cost. This makes hydro inflation proof. Hydro leaves many vestigial structures (roads and canals) that often have a positive legacy. Large hydro can serve as a storage facility for intermittent renewables, such as wind, and thus may facilitate large scale integration of intermittent renewable generation into electricity systems.	Construction of dams removes future opportunities for traditional practices, historical sites and recreational activities. Certain ecological impacts from reservoirs are irreversible, despite decommissioning. Hydro increases appropriation of water, at a time when humans are already appropriating 50 percent of water (although not a consumptive use). The long life of hydro dams increases path dependency and reduces the opportunities for other renewable technologies in the future. Hydro access roads and associated access contribute to long-term adverse ecological effects.

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Criteria	Advantages	Disadvantages
Resource Maintenance, Cost Effectiveness and Efficiency	Hydro is 90 percent efficient at electricity generation, which is far superior to most other technologies. Large hydro dams with pumped storage can complement other renewable technologies. Pumped hydro is dispatchable and also allow for on-demand electricity generation. Large hydro provides frequency regulation. Large hydro generates electricity at a very competitive cost.	Hydro is often located far from demand centers, and transmission losses can reach 8 percent. Large hydro can require large scale transmission line upgrades or construction. Large hydro can contribute to a centralized power system paradigm, depending on system role. Large dams are often subject to cost overruns due to uncertainty in geotechnical site conditions.
Social-ecological civility and democratic governance	Hydro offers a diverse array of private sector opportunities, albeit primarily during the design and construction phase.	Large hydro dams generally do not contribute to local governance capacity, as decision-making is not performed at the local level. Large hydro offers few opportunities for citizen engagement. Large hydro dams alter traditional livelihoods and cultural practices, and may cause great social tension and problems in indigenous communities.
Prudence, Precaution and Adaptation	Hydro strengthens the reliability, predictability, and resilience of the electrical power system. It can also track base and peak load demand. Potential to increase reliability and resilience via storage capacity, potential to facilitate larger scale integration of intermittent renewables via storage capacity. Hydro can be relied upon during periods of energy instability and transition, which is indicative of the next 20 years in Ontario. Low geopolitical risks, and low security and accident risks.	Climate change impacts on hydro in Ontario uncertain (primarily in the form of changes in precipitation patterns). This uncertainty is greatly compounded by the long lifespan of a dam. Hydro is associated with a high path dependency given large investment and long lifetime of large dams. Potential for cost-overruns and delays in large projects.

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Immediate and long term integration
Large hydro has the potential to deliver multiple and mutually reinforcing benefits, as it is a cost-effective renewable energy that is efficient, reliable, predictable and flexible; and is capable of providing both baseload and peaking. Large hydro may mutually reinforce intermittent renewable energy technologies such as wind power, and help buffer the system during the phase-out of non-renewable fossil and nuclear fuels. The social and ecological effects of large hydro dams are relatively long-term, and provide added risk in the face of increasing climate variability.
Key trade offs
Increase in system reliability, resilience, and flexibility, low electricity costs, low emissions, storage potential facilitating larger intermittent renewable integration due to large dams and reservoirs versus the ecological and social impacts of the dams. Potential synergistic relationship between hydro and intermittent renewable resources versus higher path dependency due to long dam lifetimes. Low electricity costs supports industrial and personal activities versus boom and bust cycle relating to dam construction. Long term supply of cheap and reliable power versus intragenerational inequity in distribution of risks. Potential for First Nations economic development versus potential destruction of First Nations traditional and cultural practices.

A3.11 Hydro: small-scale and micro-scale (<10 MW)

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Greatly reduced biophysical impacts as there is no damning and flooding of the river. Small hydro requires little area, and rarely causes shoreline flooding.	Risk of water and air pollution during construction. Some risk of forest fires. Transmission lines reduce land availability. Cumulative impact of many small hydro plants compared to one large plant is unknown, and likely quite context dependent.
Livelihood Sufficiency and Opportunity	Small projects provide local opportunities for knowledge development and short-term employment. Small projects provide greater development opportunities for First Nations and other remote communities.	Small hydro is still a minor contributor to employment, and some facilities may be remotely operated.
Intragenerational Equity	Greater equality in distribution of benefits and risks since both are more localized. On a local scale, small hydro may reduce dependence on diesel generators for electricity.	
Intergenerational equity	Future generations will benefit from longevity of small hydro operations. Similar to large hydro, small hydro has very low operation and maintenance costs, and thus future generations will benefit from little stranded debt. Long term impacts of small hydro are localized and less severe than large hydro.	Climate change may have long term impacts on the viability of small hydro.
Resource Maintenance, Cost Effectiveness and Efficiency	Small hydro very efficient at electricity conversion. Small hydro is modular and thus supply can be built in accordance with demand.	Reduced system reliability as small hydro is generally not dispatchable and is subject to changing river flow patterns. Small hydro does not contribute to system flexibility since it cannot be controlled, and is particularly sensitive to precipitation patterns. Small hydro generally costs more per kW of capacity than large hydro, and transmission distances are limited.

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Criteria	Advantages	Disadvantages
Social-ecological civility and democratic governance	Small hydro has the potential to foster local governance and participation in energy management. Small hydro can enhance local social networks, and promote cooperation.	
Prudence, Precaution and Adaptation	Due to its modularity, small hydro is not as path dependent as large hydro. Decommissioning of small hydro will likely produce less irreversible impact than large hydro. Small hydro is quite invulnerable to political and geopolitical disruptions.	

Immediate and long term integration
Small hydro has the potential to deliver multiple and mutually reinforcing benefits, as it is a cost-effective renewable energy that is efficient, reliable, predictable, and modular; and does not increase the path dependency of the electrical system.

Key trade offs
Less concentrated focal impact versus more diffuse impact spread over a larger area.
Increased system modularity due to small incremental additions versus reduced system flexibility and resilience due to less operational control.
Distributed power generation versus limited ability for long distance transmission.
Increased stakeholder involvement versus increased electricity costs.

A3.12 Wind

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Social-ecological impacts of wind are relatively marginal compared to non-renewable technologies. Wind has little to no operational dependence on fossil fuels, and is not subject to fuel cycle impacts and risks. Can be integrated within other land uses, such as agriculture Upstream and downstream lifecycle impacts limited primarily to steel requirements. Turbine operation does not emit greenhouse gases. Turbine production not a contributor to smog or acid rain or air pollution. Storage technologies required for large scale integration (e.g. batteries, pumped storage) may have significant impacts/risks of their own.	Turbine operations can harm and/or kill birds and bats, and may disrupt migratory patterns Turbines have micro-climate effects. Turbine construction can cause soil erosion.
Livelihood Sufficiency and Opportunity	Wind creates more jobs per kWh than traditional energy generation technologies[1] Construction of wind turbines could benefit Ontario's steel industry. Wind power could provide added revenue for agricultural sector, with farmers either leasing land or purchasing their own turbines[1] The permanent jobs required for turbine operation and maintenance do not suffer boom and bust cycles. Wind power has less externalities than conventional generation, which results in less burden placed on the general public. Potential for Ontario to become an exporter of wind technology.	Once operational, wind turbines provide few (2-5) jobs per MW of installed capacity.
Intragenerational Equity	The price of wind-generated electricity is competitive to conventional generating technologies, and thus a switch to wind energy would not unduly raise the price of electricity.	Residents located near wind turbines and farms may suffer from flicker effect, noise pollution, and reduced landscape esthetics.

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Criteria	Advantages	Disadvantages
Intergenerational equity	Wind power requires upfront payment costs (with little marginal costs) and thus there is less debt stranding than certain conventional technologies. Limited decommissioning cost at end of turbine life: construction materials are fully recyclable, and there is no need for storage of long-term residuals. Modularity of wind power reduces path dependency. Wind power has a low ecological footprint, and no operational CO_2 emissions, which means that future generations will not be harmed by current wind production.	Large wind farms may require long-term contracts (such as in British Columbia), which may affect the electricity choices of future generations.
Resource Maintenance, Cost Effectiveness and Efficiency	Wind power has short energy payback period (compared to fossil fuels which can never pay back their input energy) Wind generated electricity is economically competitive to conventional electricity sources, and this includes greater internalization of costs [3]. There is far more potential wind than current and projected power requirements. Wind power is modular and can be added incrementally as required Wind works well with solar PV in that wind generates more in the winter, whereas solar PV generates more in the summer. Wind has low lifecycle resource requirements than conventional generation. Furthermore, there are no fuel cycle impacts, costs and risks. Wind is a renewable flow resource that cannot be overdrawn. Small-scale wind turbines may be located at the point of consumption, reducing transmission costs and grid loading.	Significant portion of wind potential requires transmission over long distances (from Northern to Southern Ontario), which may increase transmission losses. However, offshore wind farms would not require long transmission lines, as they may be placed closer to major demand centers. Wind is an intermittent energy source, and suffers from a lower capacity factor than conventional generation. This can be managed through the use of storage, coupling with pumped hydro, or coupling with hydrogen production. Wind is an extensive (diffuse) technology and impacts may affect a large area. However, wind generation is not an exclusive land use. It can coexist with other land uses such as agriculture, urban/industrial uses Limited potential for grid integration without enhanced grid management and storage technology. Offshore wind turbine construction can affect fisheries and may cause local habitat loss and disturb nearby sediments. Wind farm access roads can affect wildlife movement.

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Criteria	Advantages	Disadvantages
Social ecological civility and democratic governance	Community and cooperative wind projects allow for stakeholder expansion, especially in currently economically sensitive areas (such as First Nations communities and farming communities). Risks associated with wind power are not offloaded onto the ratepayer, and instead they remain with the owner. Wind power allows for greater independence from fuel prices, which are currently volatile and rising. Since wind is decentralized, there are more stakeholders than many conventional technologies. Individuals, such as farms, may generate their own power through government incentive programs (net metering and RESOP), allowing for a further expansion in the energy stakeholder base.	Large wind projects limit participation in decision making compared to smaller wind projects.
Prudence, Precaution and Adaptation	High modularity, diversity of sites and technologies contributes to system reliability and resilience. The modularity of wind permits for expansion when needed, and therefore allows energy planners to follow recent trends (as opposed to long-term predictions). With supply coming from the entire province, the intermittency of wind is greatly reduced. High adaptive capacity and low path dependency Low economic risk since construction timelines and costs are well understood. A short construction lead-time for wind allows adaptation to changing circumstances, and does not require externalization of construction cost and accident risks and long-term liabilities. Very low geopolitical, security, accident risks.	The intermittency of wind requires the development of a stronger and more reliable transmission grid. Smart Grid technology is one such possibility. The current grid and energy generation paradigm is large-scale, centralized generation, and wind requires a shift of thinking towards distributed generation. Climate change impacts on Ontario wind regime uncertain.

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Immediate and long term integration
The large generating potential of wind means that combining wind power with an appropriate energy storage technology would allow wind to produce a significant portion of the baseload demand. The infinite supply of wind energy, combined with its low environmental impact, low price, low risk, and large potential for stakeholder involvement provide a set of mutually reinforcing gains that should be integrated into the long term energy planning of the province. Wind energy should be encouraged via the standard offer program, as it provides a decentralized renewable energy source that will help meet peak loading, and reduce transmission grid strain.
Key trade offs
Large sustainable, low-impact energy source versus intermittency and storage requirements. Economic competitiveness of wind versus requirements for grid upgrade. Very low emission generation versus local bird/bat mortality and potential habitat disruption. Low path dependency and high modularity versus current need for grid upgrade. Larger, more economically competitive, wind farms versus smaller, and costlier, wind farms that allow for greater public participation and broader distribution of benefits.

A3.13 Bioenergy: Energy cropping and Residue Harvesting

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Energy cropping has a low legacy cost, and there is little residual long-term ecological impact. Unharvested areas may be left fallow with no negative environmental harm. Energy crops and residues have negligible upstream waste impacts (such as toxic emissions found in conventional energy resource mining), Proper nutrient management may improve ecological system health (for example marginal lands).	Energy cropping often done as a monoculture, which harms biodiversity and increases risk of pest and disease outbreak Ontario lacks available land, so energy cropping will need to spread to marginal lands. Increased fertilizer and pesticide use required for energy cropping harms soil resilience and health. Fossil fuels required for fertilizers and pesticides represent an indirect, yet substantial, upstream waste impact. Energy crops require large amounts of freshwater, which many not be available and could reduce groundwater levels. Weak social-ecological feedback (or positive feedback) may cause resource to be overused. Greenhouse gas impacts depends greatly on past land use. Clearing land for energy cropping may incur a carbon debt over 100 years. Uncertainty with respect to NO_x volatilization during cropping may in fact increase CO_2 equivalent emissions compared to fossil fuels.
Livelihood Sufficiency and Opportunity	Great potential for lasting employment benefits, especially in rural regions. Economic benefits, however, are largely dependent on local ownership. Provides a stable income based on a stable price compared to food price volatility. Protect farmers against quota surpluses.	Bioelectricity production competing for resources with pharmaceutical and liquid fuels. Energy cropping may require changing land use from beef grazing Electricity generated via energy cropping and residue collection is more expensive than traditional generation. While, this will increase the cost of electricity in the grid, it will not be a large increase.
Intragenerational Equity	Distributed and limited nature of energy cropping reduces any negative impact on other generating technologies. Energy cropping has a great potential for distributed economic development, particularly in rural areas.	Internationally, energy cropping for biofuels is already causing a food versus fuel conflict. On-farm biogas is subsidized through the standard offer program and increases the price of electricity, which unfairly impacts the poorer homeowners.

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Criteria	Advantages	Disadvantages
Intergenerational equity	If performed in an ecological sound manner, energy cropping may provide lasting employment in rural areas.	Bioenergy cropping and residue harvesting may reduce soil health for future generations. Energy cropping may also remove food productive land from future generations, and create a food for fuel conflict. The uncertainty of greenhouse gas emissions may exacerbate climate problems for future generations. The limited agricultural land availability could lead to agricultural clearing of ecologically significant lands. This would have long-term ecological impacts, and lead to significant GHG emissions.
Resource Maintenance, Cost Effectiveness and Efficiency	Solar energy is the ultimate energy source for energy cropping and residue harvesting, and thus represents a renewable energy supply. Energy cropping offers multiple energy pathways and multiple end uses, thus increasing system flexibility and resilience. May be stored and used when needed, therefore providing dispatchable power production. This allows for mutually benefiting gains with other renewable energies, such as wind power. Electricity generation may be performed on a variety of scales (leading to increased modularity) and coupled with heat generation (for CPH) – this increases end-use efficiency Modularity and energy pathways allows for better end-use matching of energy, with leads to greater resource and cost effectiveness.	Energy cropping is predicated on industrial agricultural techniques, which may be impacted by climate change and fossil fuel volatility. Overuse of resource may lead to soil and resource mining. Use of fertilizers may have long-term impact on resource availability. Energy cropping, and agriculture, are acutely sensitive to climate change effects.

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Criteria	Advantages	Disadvantages
Social-ecological civility and democratic governance	Energy cropping and residue harvesting may help buffer small farmers from the deterioration of rural economies and provide them a stake in energy management. Bioenergy offers potential for private investment, as well as new research and development. May bring new value to agricultural lands, reducing the likelihood of further suburban sprawl. By including farmers into the energy supply mix, increases the potential for stakeholder involvement.	OPA is currently favoring large-scale bioenergy projects, thereby reduces multi-stakeholder/ community involvement.
Prudence, Precaution and Adaptation	Bioenergy is decentralized, modular, and offers grid voltage support increasing system reliability, resilience and adaptive capacity. The multiple energy pathways for bioenergy reduce path dependency and increases long-term system reliability. Energy cropping poses a low economic risks: the basic technologies and costs well established and understood. Providing an income for farmers now will prevent a rural exodus that may deprive future generations of farmers. Therefore, there is great prudence in this regard. Bioenergy has negligible geopolitical risk, as it relies on domestic fuel source. Very low accident, security risks; no weapons proliferation risks.	There is a risk that the environmental feedback structures will be too weak, or too long, to prevent resource mining. Similarly, there is the risk that as forest harvesting is increased, unit costs may decrease, which would create a positive feedback structure, and potentially lead to overuse. Climate change may affect future agricultural production and impact the potential for bioenergy cropping and residue collection.

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Immediate and long term integration
As a renewable solar derived energy source, energy cropping and residue harvesting have the potential to provide mutually reinforcing gains by providing dispatchable, distributed power generation, as well as distributed economic development in an area where it is needed. The uncertain ecological impacts of energy cropping and residue harvesting, as well as the potential for unsustainable resource mining require a precautionary and modest expectaion for long-term power supply.
Key trade offs
Small-scale distributed energy cropping with increased stakeholder engagement versus greater cost efficiency with large-scale farms. Renewable resource versus need to maintain sustainable safety margin to account for change, ignorance, and surprise. Modular and dispatchable power source versus higher unit electricity costs

A3.14 Bioenergy: forest harvesting

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Forest residue removal may reduce change of forest fires. Biomass generally burns cleaner than their fossil fuel counterparts, thereby lowering atmospheric emissions impacts. Forest harvesting has a low legacy impact, especially compared to conventional generating technologies. Forest harvesting has limited upstream waste impact (such as toxic emissions found in conventional energy resource mining)	Forest harvesting may impact long-term ecosystem function. Forest residues collected needed for wildlife cover, erosion control, protection of emerging seedlings and moisture management. Forests residues also required for nutrient, carbon, and energy cycling, which is critical for forest health. Forest residue removal could harm biodiversity. Weak social-ecological feedback (or positive feedback) may cause resource to be overused. Greenhouse gas impacts depends greatly on past land use.
Livelihood Sufficiency and Opportunity	Great potential for lasting employment benefits, especially in rural regions. Economic benefits, however, are largely dependent on local ownership.	Bioelectricity production competing for resources with pharmaceutical and liquid fuels.
Intragenerational Equity	First Nations communities have the potential to benefit from forestry harvesting, if performed in an equitable manner.	Northern Ontario will bear the ecological impact of forest harvesting, while Southern Ontario will gain from power production.
Intergenerational equity	If performed in an ecological sound manner, forest harvesting may provide lasting employment in rural areas.	Forest harvesting is only renewable with respect to energy income. There is as risk that energy mining will take place, which will reduce productive abilities of forests for future generations. Future generations may be negatively impacted by the reduced ecological functions that are a consequent of forest harvesting.
Resource Maintenance, Cost Effectiveness and Efficiency	Forest harvesting offers multiple energy pathways and multiple end uses, thus increasing system flexibility and resilience. May be stored and used when needed, therefore providing dispatchable power production. Electricity generation may be performed on a variety of scales (leading to increased modularity) and coupled with heat generation for CPH) – this increases end-use efficiency. Forestry harvesting is economically competitive to oil and gas on an energy basis. Dispatchability allows for mutually benefiting gains with other renewable energies, such as wind power.	Overuse of resource may lead to soil and resource mining. Forest harvesting is acutely sensitive to climate change effects. Proper forest resource maintenance requires placing environmental concerns above economic efficiency. Forest energy harvesting may need to allow forest system cycling (including natural forest fires) at the expense of energy generating potential.

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Criteria	Advantages	Disadvantages
Social-ecological civility and democratic governance	Forest energy offers potential for private investment, as well as new research and development.	OPA is currently favoring large-scale bioenergy projects which reduces multi-stakeholder involvement.
Prudence, Precaution and Adaptation	Bioenergy is decentralized and offers grid voltage support. The multiple energy pathways for bioenergy reduce path dependency and increases long-term system reliability. Forest energy has negligible geopolitical risk	Must plan for a minimum energy yield, which reduces potential short-term gains.
Immediate and long term integration		
As a renewable solar derived energy source, forest and residue harvesting have the potential to provide mutually reinforcing gains by providing dispatchable, distributed power generation, as well as distributed economic development in an area where it is needed. The uncertain ecological impacts of energy cropping and residue harvesting, as well as the potential for unsustainable resource mining require a precautionary and modest expectation for long-term power supply.		
Key trade offs		
Forests as a biomass source versus forests as an energy source versus ecological service functions of forests. Renewable resource versus need to maintain sustainable safety margin to account for change, ignorance, and surprise. Modular and dispatchable power source versus higher unit electricity costs.		

A3.15 Bioenergy: on-farm biogas

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Biogas digestion prevents methane emissions and reduces odour problems on farms. Biogas gas is a GHG neutral energy source. Biogas digestate improves nutrient management techniques by converting manure into a more usable form. This reduces surface runoff effects, reducing organic and pathogenic loading of waterways. Biogas digestate reduces dependence on fossil fuel fertilizers, and thus reduces the upstream lifecycle impacts associated with fertilizers. Energy crops and agricultural residues may also be digested, and this improves nutrient cycling on the farm. On-farm biogas may accept limited amounts of off-farm organic material, reducing need for land-filling.	If using energy crops and residues as an input, the ecological limits must be understood and respected.
Livelihood Sufficiency and Opportunity	Biogas provides an excellent new source of revenue for farmers, and may reduce or reverse the current trend of economic hardship. The capital cost an on-farm biogas plant is in line with many farm investments, while the payback period is far quicker. The limited provincial potential for biogas will not reduce investment in other renewable energy technologies.	The potential for on-farm biogas in Ontario is currently limited by transmission capacity, as some grid capacity is being held aside for other generating resources.
Intragenerational Equity	If performed in an ecological sound manner, energy cropping may provide lasting employment in rural areas.	Biogas generated electricity is more expensive that traditional generating technologies, and thus the poorer homeowners must bear the added expense.
Intergenerational equity	Biogas helps improve soil conditions, which allows future generations the opportunity to continue using the soil. Biogas is a renewable resource and thus future generations are not impacted by the need to seek a new energy source.	

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Resource Maintenance, Cost Effectiveness and Efficiency	Biogas offers multiple energy pathways and multiple end uses, thus increasing system flexibility and resilience. May be stored and used when needed, therefore providing dispatchable power production. Dispatchability allows for mutually benefiting gains with other renewable energies, such as wind power. Biogas may also provide methane for the natural gas pipeline.	Biogas is predicated on industrial agricultural techniques, which may be impacted by climate change and fossil fuel volatility. On-farm biogas is closely coupled with agriculture, and therefore is sensitive to many of the same climate change variations as agriculture. Electricity generated via on-farm biogas is more expensive than conventional generating technologies. However, the positive externalities of biogas, such as being GHG neutral, counterbalance this added expense.
Social-ecological civility and democratic governance	Biogas offers potential for private investment, as well as new research and development. Biogas allows farmers a stake in provincial energy management.	Current government mandated transmission grid limitations prevent wider scale adoption of biogas, and therefore reduce stakeholder involvement.
Prudence, Precaution and Adaptation	Bioenergy is decentralized and offers grid voltage support. The multiple energy pathways for biogas reduce path dependency and increases long-term system reliability. Biogas energy has negligible security, accident or geopolitical risks, and represents a domestic energy supply.	

Immediate and long term integration

As a renewable solar derived energy source, on-farm biogas has the potential to provide mutually reinforcing gains by providing, distributed power generation and voltage support, as well as distributed economic development in an area where it is needed.

The anaerobic digestion pathway also provides an alternative pathway to traditional energy cropping and residue harvesting that has greater respect for the environmental limits of agricultural soil, as well is lower GHG emissions.

On-farm biogas should be greatly encouraged through the standard offer program, and seen as a long-term viable alternative to combustion of energy crops and agricultural residues.

Key trade offs

Modular and dispatchable power source versus higher unit electricity costs

Investment in on-farm biogas versus investment in other farm related infrastructure.

Decentralized energy and voltage support versus need for increased transmission capacity in key biogas areas.

A3.16 Bioenergy: digestion of biosolids and organic municipal solid waste

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Reduces organic loading of landfills, which in turn reduces methane emissions from landfills. Treated biosolids and municipal organics may be used as fertilizers, and thus lead to nutrient management improvements in soil.	
Livelihood Sufficiency and Opportunity	Digestion of biosolids and organic wastes provides value to an otherwise waste product. Digestion of organic wastes promotes landfill diversion.	
Intragenerational Equity	The limited provincial potential for biosolids and organic municipal waste will not reduce investment in other renewable energy technologies.	
Intergenerational equity	Digestion of biosolids and municipal solid waste will aid to reduce future landfill needs. Digestion of biosolids and municipal solid waste may be incorporated into a multifaceted waste management plan serving future generations.	
Resource Maintenance, Cost Effectiveness and Efficiency	Electricity generation may be performed on a variety of scales (leading to increased modularity) and coupled with heat generation (for CPH). Biosolids and organic municipal waste present a currently untapped resource. Great potential for recycling nutrients and energy within the social-ecological system. These plants may be located near populated areas, which reduces transmission requirements. Biosolids and organic municipal waste are insensitive to climate change	May reduce incentive for source reduction of waste, as resource is contingent on continued organic supply. On-farm biogas may compete for same resource base.
Social-ecological civility and democratic governance	Biosolids and organic digestion allows municipalities a larger stake in their energy management. There is great potential for private enterprise in the waste-to-energy sector. Digestion may be part of a multifaceted waste management strategy.	
Prudence, Precaution and Adaptation	Bioenergy is decentralized and offers grid voltage support. Negligible geopolitical risk Insensitive to climate change	

Immediate and long term integration

The digestion of biosolids and municipal organic wastes should be integrated into the long-term energy supply plan due to the mutually reinforcing benefits of waste reduction, energy generation, nutrient cycling and local economic development.

Key trade offs

Dedicated biosolids and organic municipal waste biogas plants versus supplying biosolids and organic municipal waste to on-farm biogas and landfill gas.

A3.17 Bioenergy: landfill gas

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Reduces methane emissions from landfills, thereby reducing global warming potential of current landfills.	
Livelihood Sufficiency and Opportunity	Combustion of landfill provides value to an otherwise harmful waste product.	Dependence on landfill gas may cause boom and bust cycling as the energy supply is limited. Landfill gas may deter organic diversion from landfills,
Intragenerational Equity	The limited provincial potential for landfill gas will not reduce investment in other renewable energy technologies.	
Intergenerational equity		Initiates dependence on an ideally non-renewable resource.
Resource Maintenance, Cost Effectiveness and Efficiency	These plants may be located near populated areas, which reduces transmission requirements. Landfill gas has a negative energy cost, and is therefore the cheapest form of available energy.	May reduce incentive for source reduction of waste, and thereby encourage continued landfilling. Limited and finite resource.
Social-ecological civility and democratic governance		
Prudence, Precaution and Adaptation	Landfill gas is decentralized and offers grid voltage support. Negligible geopolitical risk	

Immediate and long term integration

Landfill gas provides mutually reinforcing benefits, including low-cost electricity, local economic development, voltage support, and GHG emissions reduction.

Landfill gas is ideally a non-renewable energy source and should therefore be included only into the short-term energy plan. Long-term energy plans should encourage waste recycling and diversion, so as to reduce future landfilling requirements.

Key trade offs

Development of future landfill gas versus increased efforts for source reduction and waste diversion.

A3.18 Solar photovoltaic

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Solar energy is an unlimited renewable resource. No emissions or pollutants released during generation. Low lifecycle GHG emissions. Solar PV has little to no operational dependence on fossil fuels, and is not subject to fuel cycle impacts and risks. Solar has great potential for being placed on roofs, which does not compete for land use. Furthermore, when placed on roofs, solar PV may help reduce urban heat island effect compared to black roofing. Lifecycle SO_2 and NO_x emissions among lowest in energy generation technologies. There is no risk of environmental catastrophe associated with solar PV. Solar PV has a strong potential to replace high impact/low efficiency peaking technologies (e.g. SCGT or imported coal fired electricity), and their associated socio-ecological impacts.	Depending on technology assumptions and material choice, solar PV may have higher lifecycle GHG emissions than other renewable energy technologies. Some solar PV systems are built with non-renewable components with toxic properties (e.g. selenium) that have upstream and downstream waste impact, and are subject to material shortages. Solar PV is a diffuse technology, which means that greater land area is required for a given power output. This is especially problematic for solar farms, which may compete with other valued land uses. For solar PV to contribute to baseload and intermediate load requires some form of storage technology, and the associated ecological impact.
Livelihood Sufficiency and Opportunity	The adoption of solar PV aids in the diversification of electricity supply, which helps maintain price stability. Reducing dependence on fossil fuels can lead to economic development. There is a potential for research and development into solar PV technology, of which the Universities of Waterloo and Toronto are prime examples. Solar PV has great potential for community economic development, as it is a form of distributed generation.	Employment related to solar PV is generally linked to construction and installation and may have the potential for a boom and bust industrial development. However, it would be many years before the market reached saturation. Development of a Canadian (or Ontario) solar PV industry would be hindered by competition from existing European manufacturers, particularly Germany. (confirm?) Manufacturing of solar PV cells may involve handling of toxic substances posing occupational risks to factory workers. Solar PV has a high cost per kWh, and this may hinder economic development.

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Criteria	Advantages	Disadvantages
Intragenerational Equity	Solar PV offers a decentralized energy solution for rural communities. The elimination in air emissions during power generation improves air quality in urban and suburban areas, improving local livelihoods, and reducing the public health care strain caused by conventional generation (such as coal).	The high upfront cost of solar PV places the uptake burden onto middle and upper income homes. Adoption of solar PV may remove employment opportunities for traditional energy technologies. Adoption of solar PV may increase the price of electricity, which may unfairly burden poorer families, and industries.
Intergenerational equity	Solar PV reduces lifecycle GHG emissions compared to fossil fuel power generators, thus removing some of the burden placed on future generations. Solar PV is not path dependent, and therefore does not lock future generations into a specific electricity future. Solar PV allows communities to develop their own energy independence, which can lead to long-term social gains. Adoption of solar PV reduces geopolitical risk.	
Resource Maintenance, Cost Effectiveness and Efficiency	Solar PV is complementary with wind power in that wind generates more energy in the winter, and solar PV generates more energy in the summer. Solar PV has potential to be used for summer peak shaving, reducing the need for natural gas peaking plants. Solar energy will never be exhausted, and thus solar PV represents an energy conversion technology based on an unlimited resource. Solar PV may be located near the load center, reducing strain on the transmission grid. The energy payback period of solar PV is quite long, however, it is still preferable to fossil fuels and nuclear which have no energy payback. Solar PV is superior to other technologies in reflecting the true price of electricity, thus allowing for realistic calculations of cost effectiveness. Solar PV systems suffer few mechanical breakdowns, as they contain no moving parts. They also require little ongoing maintenance.	Solar energy is intermittent, and unless coupled with storage of some kind, operates at a low capacity factor. Solar PV construction depends on limited (and sometimes scarce) resources. However, new research is working to alleviate these limitations. Solar PV is not economically competitive with other generating technologies, except in a peaking role. Investment in solar PV may be at the expense of other renewable energies. Solar PV conversion efficiency is low compared to other energy technologies.

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Criteria	Advantages	Disadvantages
Social-ecological civility and democratic governance	The adoption of locally sourced renewable energy allows the provincial government greater energy independence. Small-scale solar PV allows homeowners to take part in energy generation, and thus expands the stakeholder base. Solar PV is well suited for cooperative engagement, and this has been seen already in Ontario (for example WISE and CREW). This helps foster sustainable community values that extend beyond solar energy. Solar PV allows remote communities to achieve energy independence, allowing for greater local governance. Solar PV, combined with the standard offer program, allows individual homeowners the opportunity to become involved with energy generation.	High costs of solar PV cells limit individual stakeholder involvement to the middle and upper classes.
Prudence, Precaution and Adaptation	Solar can be quite reliably forecasted, thus improving system reliability. Coupled with geographical deployment, variability can be further reduced. Solar PV is modular and therefore capacity can be added as required. Solar PV is not path dependent, and has short planning, approval and construction timelines. In combination with storage technology, solar PV can provide resilient baseload capacity Coupled with a storage technology, solar PV can provide dispatchable power, and contribute to system resilience. There is no risk of environmental catastrophe associated with solar PV. Solar PV is associated with no geopolitical and security risks, and has no risk of weapons proliferation.	The high capital costs of solar require policy support to drive adoption.

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Immediate and long term integration
Solar PV should be encouraged via the standard offer program, as it provides a decentralized renewable energy source that will help meet peak loading, and reduce transmission grid strain. Furthermore, by combining solar PV with storage technology, then solar PV may also contribute to baseload requirements. The infinite supply of solar energy, combined with its low environmental impact, low risk, and large potential for stakeholder involvement provide a set of mutually reinforcing gains that should be integrated into the long term energy planning of the province.
Key trade offs
Highly modular, low-impact technology versus high unit cost per MW and kWh. Virtually emission free energy at point of generation versus higher manufacturing and decommissioning impacts. Distributed resource located near demand versus intermittency. Potential to couple with storage and other technologies versus increased unit costs. Low path dependency versus reduced ability to provide baseload power.

A3.19 Conservation and demand management

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Reduces and/or eliminates socio-ecological system and health impacts by reducing need to construct and operate supply resources. This is especially the case with peak power supply. Reduces and/or eliminates the impacts associated with transmission and distribution of supply resources. CDM has virtually no upstream ecological impacts or land use implications.	Accelerated capital stock turnover may generate additional and/or premature waste streams. May increase the amount of certain difficult to manage waste streams. For example, fluorescent light bulbs contain mercury.
Livelihood Sufficiency and Opportunity	CDM, including self-generation and demand response, improves reliability of electricity system. CDM employment opportunities are regionally broad, long-lasting, and require minimum employee relocation. CDM jobs tend to be locally based. Some CDM measures, such as smart meters, encourage high skilled labour in Ontario. CDM options are more employment intensive than supply options. CDM creates over 35 person years of employment per million dollars invested; well beyond the abilities of any generating technology. These numbers are still contested, however. Comes in small increments which allow it to be ramped up or down to match load forecast changes that emerge over time. Ontario has an extensive cost effective CDM potential. This reduces overall system costs and electricity prices by displacing more expensive supply options. CDM avoids fuel and generation technology related market and geopolitical risks. CDM mitigates the so-called "market power" of selected generators, and reduces their ability to "game the market." Potential for improvements in overall housing quality via CDM investments. This has positive impacts for "healthy housing."	Local electricity distribution companies earn revenue based on power usage, and this creates a disincentive to implement CDM. Lower income consumers may lack access to capital needed to implement CDM investments. Uncertainty regarding the ability of CDM to deliver reduction when needed.

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Criteria	Advantages	Disadvantages
Intragenerational Equity	CDM measures often maintain employment locally, thus allowing for a more equal distribution of the benefits across the province. CDM increases overall productivity and efficiency of the economy.	Some financing via rate base may be needed to realize CDM potential, as not all users are equally capable of achieving CDM implementation. Load shifting, and time-of-use charges, may unfairly burden vulnerable consumers, as they have lower discretionary loads. An energy efficient technology may not be cost-effective for a specific consumer, even if it is cost-effective for the average consumer.
Intergenerational equity	CDM measures reduce long-term environmental externalities associated with generation and transmission. CDM stimulates long-term employment, as opposed to boom and bust cycles. Increases long-term productivity and competitiveness of the economy, reduces vulnerability to fuel related market and geopolitical risks. CDM ultimately reduces resource use, which maintains a larger resource base for future generations. CDM minimizes path dependency of future generations.	Risk of future supply shortfall if planned CDM potential not realized.
Resource Maintenance, Cost Effectiveness and Efficiency	Conservation measures maintain the resource base for future generations. Energy efficiency can be applied in a modular fashion, which increases resilience and adaptive capacity, and reduces path dependency. CDM measures reduce the need for investment in new supply, transmission and distribution infrastructure, thereby reducing overall system costs. CDM measures avoid the conflict between longevity of supply infrastructure, and the short-term horizons of decision-making. Extensive CDM activities cost-effective in Ontario relative to supply options.	Some systems and appliances are replaced before their lifecycle is over, which creates retroactive inefficiencies. Demand response does not reduce overall demand. Risk of rebound effect, whereby the money saved from CDM measures may be used in increase consumption in another manner.

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Criteria	Advantages	Disadvantages
Social-ecological civility and democratic governance	CDM measures are essential to building a "culture of conservation", and encourage engagement in the energy system. There are many opportunities for private investment in CDM design and implementation. CDM encourages adaptive design. CDM allows communities the opportunity to seek internal improvements, often with increased stakeholder engagement. CDM measures emphasize learning, experimentation, and locally developed rules, all which increase local governance initiatives. CDM emphasizes collective responsibility, as well as a more integrated use of market and social mechanisms to reduce demand. CDM measures allow individuals to participate in decision making through their purchases and consumption habits. This allows them to make choices and decisions based on values and/or preferences.	CDM requires proactive governance for implementation, however this is no different than many other energy technologies (for example nuclear power). Ontario lacks an effective institutional focal point for CDM activities and policies. Due to the distributed nature of economic benefits, CDM lacks industry support compared to high capital generating projects.
Prudence, Precaution and Adaptation	CDM increases system reliability and resilience. As mentioned above, CDM measures may be applied in a scaleable and modular fashion, thereby increasing adaptive capacity and reducing path dependency. CDM measures (such as smart meters) may help the electrical system self-regulate. CDM measures favor self-reliant systems and avoids over-connectedness. CDM reduces demand on primary energy sources, particularly non-renewables. This reduces vulnerability to energy price increase and volatility. CDM eliminates and/or avoids economic, geopolitical, accident and security risks associated with supply options.	There is no single governing authority for CDM measures, and this makes CDM program adaptation difficult to maintain. CDM performance is difficult to monitor, and long-term response must be assessed against predictions. Risk of future supply shortfall if planned CDM potential not realized. CDM programs are sensitive to policy shifts and political risks.

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Immediate and long term integration
In accordance with the ministerial objectives, and guided by a positive sustainability outlook, CDM measures should be given full priority over conventional generation technologies.
Immediate and near-term integration of CDM measures should be made to the maximum extent available, while still respecting the need for cost effectiveness.
Long-term integration of CDM measures should be planned for now, with the understanding that expected future increases in energy supply price and volatility will improve the cost-effectiveness of CDM.
Integration of CDM measures, both near-term and long-term, requires a concerted and proactive government effort, and this is no different than other generating technologies.
Key trade offs
Potential for reduced future energy requirements and associated impacts and risks (environmental, economic, security, accident, geopolitical) and increased system resilience, reliability, adaptive capacity versus uncertainty of program effectiveness.
Increased emphasis on community based energy solutions versus increased need for proactive governmental involvement.

A3.20 Transmission

Criteria	Advantages	Disadvantages
Socio-ecological system integrity	Grid design can indirectly influence GHG emissions by favoring one right-of-way route (or energy source) over another.	Construction of right of way passages requires deforestation, and right-of-way passages and access routes cause habitat fragmentation. Maintenance and construction of right-of-way passages increase the risk of forest fire, and a cause of slope instability. Herbicides used during the maintenance of right-of-way passages cause water and soil contamination, thereby impacting aquatic and terrestrial life. Heavy machinery required for right-of-way construction damages hydrological system. Removal of riparian vegetation during right-of-way maintenance and construction may lead to increased water temperatures, which impact ecological function.
Livelihood Sufficiency and Opportunity	Transmission line upgrades and right-of-way construction may provide local community members the opportunity for appropriate training and education.	Grid design and transmission capacity control may impact opportunities for development of renewable technologies, favoring current generating technologies instead. Transmission line upgrades and right-of-way construction often associated with boom and bust economic cycles. Capital cost required for transmission line upgrades may increase the unit cost of electricity. Transmission line costs may be prohibitive for remote or northern communities. Agricultural lands may be damaged or devalued by construction of right-of-way passages. Transmission lines may hinder tourism industry. Transmission lines and right-of-way passages may inhibit First Nations traditional land use patterns.

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Criteria	Advantages	Disadvantages
Intragenerational Equity	New grid design may favor more distributed generation, which may benefit more citizens through increased ability to participate in energy supply.	Grid design may have impacts on tourism, traditional land use, local forestry, farming, and land value for owners. Some communities may suffer the opportunity cost of transmission line construction (as well as the indirect cost of the generating technology) while the gains will likely be enjoyed elsewhere. Grid design may or may not service remote communities. Grid design may hinder the development of First Nations renewable energy resources.
Intergenerational equity	The degree of modularity of future grid design may enable future local economic development.	Grid design may create path dependency, which may unfairly impact future generations. Grid complexity and degree of centralization may impact future generations' capacity to effectively manage the risks and stresses related to the transmission system. Costs associated with new transmission stations, corridors, and upgrades all may increase the cost of electricity for future generations. Grid management and planning is an indirect cause of long-term socio-ecological effects; such as enabling nuclear power over renewable energy technologies. Transmission line planning and construction may have long-term impacts on First Nations traditional practices. Grid centralization may subject future generations to greater climate induced electricity impacts. Transmission line construction and maintenance may impact future ecosystem function.
Resource Maintenance, Cost Effectiveness and Efficiency	Grid right-of-way design may encourage more renewable energy sources. Appropriate grid design may encourage conservation, thereby improving resource maintenance.	Increased grid complexity may increase maintenance and construction requirements and reduce system efficiency. Grid centralization and consequent long-distance transmission lines increase energy loss, reduce system efficiency, and consequently increase energy use. Transmission line construction and maintenance may impact future ecosystem function.

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Criteria	Advantages	Disadvantages
Social-ecological civility and democratic governance	Great potential for research and innovation into new grid technologies. New grid designs may expand the participatory base of energy planning and transmission.	Grid design may impact stakeholder involvement by removing incentives for participation. Increased grid complexity may increase the complexity of environmental impacts associated with electricity generation and transmission. If First Nations are excluded from decision making, traditional knowledge may be discounted. Stakeholder involvement and grid design create a positive feedback cycle, which may exclude new participation.
Prudence, Precaution and Adaptation	A grid design favoring a large range of energy sources increases reliability and flexibility. Increased grid modularity may reduce transmission line congestion and improve grid performance, and reduce impact of power outages. A grid designed to be safe-fail as opposed to failsafe reduces the risk of a large-scale system failure, and is thereby more prudent.	Transmission lines and grid planning are path determinative and may reinforce path dependency. Increased grid size and complexity increases the maintenance and repair required, and reduces grid adaptability. Newer, more modular grid designs are unproven and system level problems may emerge.

Immediate and long term integration
The transmission grid and the generating technologies must be designed as an interdependent energy supply system. Choices made in transmission system have direct effects on the enabling of specific generating technologies, and vice versa.
Key trade offs
Centralized grid with large generating stations with known weaknesses versus with decentralized energy generation with uncertain emergent system properties. More efficient modular grid design versus increased cost of modular grid construction. Ability of transmission line construction to enable renewable technologies versus potentially sensitive ecological location of renewable resources. A system designed to be fail-safe versus a system designed to be safe-fail.

A3.21 Summary and assessment

Among all of the potential system components, CDM options tend to offer the greatest potential to advance sustainability with respect to all eight core criteria, while avoiding the need for major trade-offs. Low impact renewable energy sources, which avoid the ecological, economic, security and geopolitical risks associated with all non-renewable supply options (uranium, coal and natural), while offering a high level of potential resilience and adaptive capacity, increasingly competitive cost profiles and low cost risks, also have significant potential to advance sustainability by playing a major role in Ontario's future electricity system.

Large scale hydro presents more complex challenges with respect to a sustainability assessment. Assessments of large scale hydro will necessarily be site specific and acceptability will depend on the particular circumstances. On the one hand, large scale hydro generally offers the potential for large scale, low emission, low cost supply, which given the projects' storage potential could facilitate larger scale integration of lower impact, but intermittent renewables into the province's electricity system. On the other hand, large hydro can be associated with major landscape impacts, ecological effects and significant socio-economic and cultural impacts in remote communities.

Natural gas supply options, particularly the higher efficiency options of cogeneration and combined cycle natural gas offer reliable, efficient, low emission, and highly flexible and adaptable generating technology, but are subject to cost risks with respect to short-term fuel price instability risk and to long-term supply concerns.

Coal-fired electricity offers a high reliability, low operating costs, low fuel supply, security, and minimal geopolitical risk electricity supply option. However, it is also associated with very high GHG emissions and high emissions of smog and acid rain precursors and heavy metals, as well as major landscape impacts associated with its extraction. These significant and long-term adverse effects make an early phase-out of coal-fired electricity desirable from a sustainability perspective.

Nuclear power's one significant potential contribution to sustainability flows from its low GHG emissions relative to conventional fossil fuel powered supply options (e.g. direct combustion of coal, and single cycle and combined cycle natural gas). However, this potential advantage must be weighed against very significant short term (mining and milling, fuel production) and long-term (tailings, waste rock and spent-fuel management) socio-ecological system impacts, high capital costs and risks, uncertain legacy costs and liabilities associated with waste management and facility commissioning.

Nuclear performs particularly poorly in the area of prudence, precaution and adaptive capacity. The technology relies on large, centralized facilities with very long planning, construction and operational lifetimes. The result is very high path dependency and low adaptive capacity. The technology is also associated with unique and uniquely severe safety, security and weapons proliferation risks. From the perspective of advancing sustainability these features of nuclear indicate that its role in future electricity systems should be minimized to the greatest extent possible.

Appendix 4

Sustainability-based comparison of the OPA's IPSP with the WWF/Pembina *Renewable is Doable* alternative

A4.1 Alternative power system plan options

The OPA's proposed IPSP represents one overall integrated power system plan option for Ontario. Many alternatives are possible and some may be preferable in light of sustainability criteria. One alternative is the *Renewable is Doable* proposal, set out by the World Wildlife Fund Canada and the Pembina Institute. This appendix provides a sustainability-based comparative analysis of the IPSP and *Renewable is Doable* proposal. This analysis applies the specified sustainability criteria presented in Appendix 1 and depicts the major differences between both plans in light of the sustainability criteria.

The comparison merits more detailed analysis and review than has been possible. It is presented here for illustrative purposes. However, it is clear from the comparison that the differences between the compared options are clearly significant. Some comments on the overall implications are provided at the end.

A4.2 IPSP and *Renewable Is Doable* illustrative comparison

Criterion	IPSP	Renewable is Doable	Comments
Socio-Ecological System Integrity			
	IPSP's chief net sustainability gain over status quo comes from coal phase-out, if achieved.	RisD's chief net sustainability gains come from coal-phase out, reduced/eliminated nuclear role, reduced gas contribution.	
What is the nature and significance of • overall effects on rate of growth of electricity demand and consumption and associated activities likely to add to local to global scale system stresses	Fails to pursue full "achievable" potential to reduce electricity demand via CDM	Aims to reduce electricity demand by pursuing full identified "achievable" CDM potential.	
• effects on biophysical and socio-biophysical systems and the provision of ecosystem goods and services - atmospheric (GHGs, smog and acid rain precursors, heavy metals, hazardous air pollutants incl. POPS and heavy metals); - water quality (releases of radioactive, conventional and hazardous contaminants to surface and groundwater, thermal change, flow change); - water quantity (consumption, impacts on surface and groundwater storage, flows and cycling); - waste generation (radioactive, hazardous, high volume); - habitats, ecosystems and landscapes (new access/stresses, connectivity/fragmentation)	General failure to consider full life-cycle impacts associated with individual fuel sources, thereby underestimates the significant risks and benefits associated with non-renewable sources (nuclear, coal, and gas) and renewable sources respectively. Reduces direct atmospheric and upstream landscape impacts via coal phase-out. Reduction in long-term impacts via GHG emission reduction from coal phase-out. Severe and very long-term upstream impacts on water systems and habitats associated with heavy dependence on nuclear. Severe and very long-term upstream environmental and health risks associated with uranium mine/mill waste rock and tailings. Very long-term downstream environmental, safety, security and weapons proliferation risks associated with nuclear fuel waste.	Significantly reduces risks and impacts associated with fuel cycles due to reduced reliance on non-renewable sources (nuclear, coal, and natural gas). Significantly reduces direct atmospheric, upstream and downstream landscape impacts via phase-out of coal component, reduction or phase-out of nuclear component, and reduction of natural gas component.	

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Criterion	IPSP	Renewable is Doable	Comments
	Very long-term downstream environmental, safety, security and weapons proliferation risks associated with nuclear fuel waste. Upstream landscape and atmospheric impacts from natural gas extraction and processing, particularly re: "sour" gas. Potential for increasing upstream impacts (landscape, groundwater and transportation) associated with natural gas component as supply shifts from conventional to unconventional (e.g. coal-bed methane and LNG) sources.		
• effects on livelihood system resources - foodlands (soil quality, access, fragmentation) - fisheries (sport, commercial) - forests (recreation, hunting and trapping)	Radionuclide contamination of "country" food, including fish, in vicinity of uranium mine/mill operations.	Landscape impacts from increased access to previously inaccessible sites, and potential land fragmentation from transmission enhancements associated with large hydro, and distributed renewable projects. Potential reliance on bioenergy fuels that appropriate agricultural land for fuel crops. See comment.	Bioenergy effects depend heavily on feedstock selection.
• effects on human health - occupational (construction, fuel cycle, operation, post-closure) - individual and community (construction, operational, fuel cycle, post closure, extreme events) - vulnerable populations	Reduces population health impacts from air pollution associated with coal phase-out. High occupational health risks associated with uranium mining, with disproportionate effects on First Nations who constitute 50% of the workforce. Significantly increased health risks to consumers of "country" food in vicinity of uranium/mine mill operations.	Reduces life cycle and direct population health impacts from coal phase-out, nuclear reduced/phase-out nuclear component, reduced natural gas component. Eliminates substantial occupational risks associated with uranium and coal mining.	The most significant of the radionuclides with respect to nuclear generation in Ontario is tritium (3H), a radioactive isotope of hydrogen that is a carcinogen, mutagen, teratogen (causes

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Criterion	IPSP	Renewable is Doable	Comments
	Highly contested health risks associated with routine and accidental releases of radiation and radionuclides from nuclear fuel cycle operations and nuclear power plants. See comment. This includes exposure to radioactivity through direct gamma radiation exposure from the tailings, inhalation of radioactive particulates, and ingestion of radionuclides through the food chain. See comment. Risk of major and extensive population health impacts associated with serious accident or incident at nuclear generating facilities.		cancer, DNA mutations, and birth defects). Candu reactors employed in Ontario generate large quantities of tritium as a reaction product in the coolant (deuterium or heavy water) and have a history of leakage. This has resulted in the release of tritium into the air and water, especially into the Great Lakes. The current Ontario Drinking-Water Quality Standard for tritium, 7,000 becquerels per litre, much higher than level judged acceptable in other jurisdictions in the United States and Europe.[52]
• effects on important/valued ecological, social and socio-ecological systems and system components, characteristics and capacities, including - human appropriation of primary productivity - communities' social and economic resilience including social capital, cultural and economic diversity, innovative and adaptive capacity, etc. - culture of conservation	Reduced landscape impacts associated with coal-phase-out. Potential for increased landscape impacts due to greater long-term role of coal bed methane in natural gas supply. Limits increases in social capital and economic diversity from renewable energy and CDM by allotting the bulk of the grid's capacity to large, centralized power generation.	Fosters social capital in the form of networks for sustainable energy capacity building and culture of conservation. Uncertainty as to what extent system will rely on biofuels that appropriate primary productivity.	

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Criterion	IPSP	Renewable is Doable	Comments
• effects on qualities maintaining socio-ecological system integrity - biodiversity, - social capital, cultural and economic diversity, cooperative governance linkages, innovative capacity - monitoring/feedback/response systems	Perpetuates impacts from uranium mining and natural gas extraction. Reliance on large projects inhibits opportunities for building social capital around maintenance of ecological and economic integrity.	Minimizes impacts on biodiversity and enhances social capital and economic diversity via reduction/elimination of non-renewable fuel cycles.	
• effects on areas of particular opportunity or concern (approaching thresholds, windows of opportunity, vulnerable sectors)	Significantly increased health risks to First Nations communities and other consumers of "country" food in vicinity of uranium/mine mill operations. Limitation of sustainable economic development opportunities and community projects and their associated benefits in rural and First Nations communities.	Allows for greater share of power generation that can be integrated with other land uses, such as agriculture. Creates opportunity for the presently weakened local manufacturing sector (e.g. auto industry) to develop renewable technologies that will benefit socio-ecological integrity and provide jobs.	
• local/regional effects on - capacity of biophysical systems to deliver valued goods and services reliably into the future - social capital and livelihood resilience - infrastructure capacity - governance requirements capacities - landscape aesthetics	Perpetuation of mine tailings, radionuclides, and nuclear waste material will continue to contaminate or threaten to contaminate land, air and water. Allocation of most existing and transmission capacity to large, centralized generating facilities (nuclear and natural gas) limits opportunities to connect renewable energy projects to the grid. See comment. Very limited public influence concerning effects of large facilities on landscape aesthetics.	Builds social capital around community power projects that prioritize reducing ecological footprints of energy generation, and strengthen local economic development. This requires greater governance capacity at the local level. Vulnerability to some community concerns about renewable project aesthetics.	For the purpose of the current Renewable Energy Standard Offer Program (RESOP) and the Clean Energy Standard Offer Program (CESOP) reviews, areas of limited capacity (Yellow Zones) are being treated as those of no capacity (Orange Zones). This has

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Criterion	IPSP	Renewable is Doable	Comments
			effectively halted a number of renewable energy projects underway in the Yellow Zone and there is considerable uncertainty about when and if the development of these projects will be continued. The OPA has indicated it will review the situation only upon completion of the current competitive procurement process initiatives, RES III, CHP II and III.[53]
• provincial/national effects on - contribution to resilience/reliability of the power system and the Ontario socio-economy (including valuable ecosystem goods and services, durable employment, distribution of direct and induced opportunities and stresses, etc.) - air quality: smog, acid rain, air toxics, including transboundary pollutants, etc. - water quality, including contaminants/bioaccumulants, temperature, etc. - population and job distribution - economic development path/ options - governance requirements/ capacities	Heavy reliance on nuclear potentially hinders meeting provincial GHG emission reductions targets due to operational unreliability of nuclear and potential for delays in refurbishment and construction of generating facilities. See comment. Risks to reliability/resilience of power system due to heavy reliance on nuclear. Reduces regional and transboundary air pollution, including particulate matter, SO_x, NO_x, and heavy metals associated with coal generation (if phase-out achieved) Perpetuates health risks associated with routine and accidental releases of radionuclides from nuclear facilities (e.g. tritium to drinking water supplies of large urban centres). Displaces the majority of risks to socio-ecological systems and human health from uranium and gas procurement from Ontario to western provinces, mainly northern Saskatchewan and Alberta.	Facilitates meeting provincial GHG emissions reduction targets via coal-phase out and reduced natural gas component. Reduces regional and transboundary air pollution, including particulate matter, SO_x, NO_x, and heavy metals associated with gas and coal generation relative to IPSP.	Nuclear generation generally has lower lifecycle GHG intensity per kWh than conventional fossil fuels. It is important to note, however, that GHG emission estimates for nuclear are highly variable. Delays in nuclear facility construction or refurbishment could necessitate the continuation of coal-fired generation past its phase-out date of December 31, 2014. It could also result in natural gas-fired plants

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Criterion	IPSP	Renewable is Doable	Comments
			being operated at much higher capacity rates in order to phase-out coal. Both scenarios would result in increased GHG emissions.
• global effects on - climate change (GHG emissions, adaptive capacity, etc.) - security and risks (weapons proliferation, terrorist targets, risk of accidents, risks of systems failures, etc.) - Ontario's appropriation of global biocapacity.	Reduces GHG emissions to mitigate global climate change via coal phase-out (if achieved) Contributes to nuclear weapons proliferation risks and maintains potential targets for terrorist attacks that would incur severe and widespread damage.	Reduces GHG emissions via reduced gas component and more rapid coal phase out relative to IPSP. Contributes to the expansion of the global renewable energy market, a key element in climate mitigation strategies.	
Livelihood Sufficiency and Opportunity			
What nature and significance of • effects on reliable provision of energy services through system including consideration of CDM as well as supply	Heavy dependence on nuclear, in light of past experience in Ontario, raises reliability concerns in terms of operational underperformance and construction costs overruns and time delays.	Enhances the provision of reliable energy services by pursuing achievable CDM potential identified by the OPA, including self-generation and demand response. Combines the operational flexibility and reliability of large hydro and gas with diverse renewable generation.	
• effects on affordable provision of energy services, especially for crucial needs, disadvantaged interests	Potential for increased electricity costs due to coal phase out and heavy reliance on nuclear, particularly in light of past and current experience of serious cost-overruns on nuclear construction and refurbishment projects. Risks of short-term price volatility and long-term supply concerns associated with natural gas.	Smaller increase in electricity price increases than IPSP. Greater potential for reducing energy costs from income generated by locally owned renewable projects and CDM. Removes cost overrun risks associated with large nuclear projects, reduces natural gas demand.	

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Criterion	IPSP	Renewable is Doable	Comments
• employment/livelihood opportunities - number, durability, security, diversity, quality, accessibility/ proximity to needs, equity/ appropriateness of distribution, safety, flexibility, spin-off potential, direct and induced - fit with anticipated needs - potential for capacity building (learning, social capital) - potential for innovation for sustainable livelihoods in CDM and renewables (solar and wind performance gains, storage, etc.) - market access for small producers	Allocation of large portion of base-load demand to nuclear limits market opportunity for producers using all other supply and demand side technologies. Limited potential for distributed economic development from small-scale renewable generation through RESOP. See comment. Fails to maximize durable and regionally broad CDM employment opportunities. A relatively large portion of the durable in-province employment opportunities would be concentrated at a few major facilities, especially nuclear generating plants.	Opens the market to small producers in rural areas, First Nations lands, and remote areas. Provides opportunities for locally based and long-lasting jobs as well as income from distributed renewables through RES OP. Maximizes achievable CDM options, which are more employment intensive than supply options.	The OPA has recently made significant changes to RESOP, most notably, to prohibit companies from dividing large projects into 10 MW components in order to benefit from the program. The OPA is now limiting the size of projects that qualify to 10 MW, with no more than 50 MW of capacity under development at any time. While this can be seen as "opening the field" to small projects, it has also resulted in large renewable projects losing access to feed-in tariffs considered key to their implementation.
• avoidance/mitigation of boom and bust effects - plan/project design and scheduling - cumulative boom-bust potential, severity - mitigation steps (e.g. scheduling, diversification) - bridging provisions (capacity building, heritage funds)	Significant risk of boom and bust cycles of employment and spin-off activities associated with major new build or refurbishment projects (nuclear, large hydro and large natural gas).	Mitigates boom and bust effects by creating more lasting employment and stable income opportunities via CDM, renewable and cogeneration elements. Less emphasis on once-only mega-projects.	
• associated economic development opportunities/risks (directly linked and induced) - quality	Depending on selected reactor technology, there is a possibility for development of reactor export industry on basis of domestic market, although viability of such an industry, even with extensive government support, is doubtful.	Opportunity for domestic CDM services and renewable manufacturing industry, especially wind turbines, due to steel industry in southern Ontario. Renewable	In Germany, jobs in renewable energy plant production and maintenance reached 249,300 in 2007. It

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Criterion	IPSP	Renewable is Doable	Comments
- location (where opportunities are needed vs where growth is already a problem) - permanence vs boom/bust - spin-off opportunities, multipliers	Plan does not include strategy for development of domestic renewable energy manufacturing/services industry.	manufacturing may face strong international competition from more established suppliers. See comment.	is estimated as many as 400,000 people could be employed in the renewable energy industry by 2020. In addition, there were 4,300 jobs in renewable energy-related research, scientific funding bodies, public relations and local government in 2006.
• local/regional effects - community solidarity and governance capacity - adequacy and demands on local and regional services - growth management in GGH - job/development needs of rural and remote communities, First Nations contribution to rural renaissance	Bulk of durable local employment confined to highly skilled labourers in southern Ontario, who work at nuclear generating facilities.	Increases durable employment opportunities due to increased CDM targets that are regionally distributed and locally based.	
• provincial/national effects on livelihoods beyond Ontario (life-cycle effects, trade opportunities, etc.)	Out-of-province employment opportunities related to mining uranium and gas extraction and processing. Some loss of out of province employment associated with coal-phase out.	Provides opportunity for knowledge transfer to other provinces, currently evident in out-of-province interest in RESOP.	
• global effects on - transfer of beneficial technologies - opportunity for technology/trade advancement	Depending of selected reactor technology, there is a possibility for development of reactor export industry on basis of domestic market, although viability of such an industry, even with extensive government support, is doubtful. Plan does not include strategy for development of domestic renewable energy manufacturing/services industry with associated export potential.	Opportunity for importing renewable technologies and expertise from international renewable energy leaders such as Germany. Potential future opportunity for Ontario to export its manufactured goods and expertise, although international markets are becoming more competitive, and there are currently players in Europe.	

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Criterion	IPSP	Renewable is Doable	Comments
Intragenerational Equity (distribution of costs and risks in the present)			
What nature and significance of • overall effects on consumption, wealth and resource access gaps between the first and fifth quintile of the population	Social impacts of increased electricity costs without mitigation strategy, including increased energy poverty, reduced consumer power, and enlarged gap between first and fifth quintile of the population.	Social impacts of increased electricity costs could be mitigated by increased community ownership and the RESOP. Reduced electricity cost increases relative to IPSP. Underlying policy work has considered need for CDM strategies targeted at low income consumers.	
• equity effects of (re)distribution of risks, costs, benefits and opportunities among income groups, genders, age groups, regions, indigenous/non-indigenous people, areas of growth and decline, including - positive openings (e.g. durable economic development opportunities) - opportunities foregone (e.g. allocation of transmission capacity to one generation source)	Major upstream risks and impacts of nuclear and gas occur outside of Ontario (principally Saskatchewan and Alberta) as well as the economic benefits associated with natural gas extraction and uranium mining. Path dependency of nuclear power generation forgoes opportunities for the present generation to benefit from maximized economic development potential associated with distributed renewables and CDM. Fails to address North/South inequity in Ontario in terms of energy poverty. Nuclear power benefits southern Ontario in terms of durable, high-paying jobs and the prioritization of the southern transmission grid. Risk of rights violations concerning Aboriginal land claims issues and existing agreements. See comment.	No externalization of construction cost risks and long-term liabilities required for renewable, gas, cogeneration that are core of plan. Cost of transmission upgrades and high initial investments in renewable technology borne by present generation taxpayers and consumers. Greater equity in terms of the distribution of environmental and health impacts. Small-scale, distributed renewable and gas generation tend to be located near centers of demand. Eliminates air pollutants and GHGs from coal phase-out to improve air quality, particularly in urban and suburban areas, faster than IPSP.	The Northern Rivers commitment stipulates that there will be no power facility development >25 MW in the basins of the Albany, Attawapiskat and Winisk Rivers. Development <25 MW can proceed only if it is proposed by the local Aboriginal communities. The Moose River Basin commitment means the Ontario government is banning hydro development in the Moose River Basin until a co-planning process is developed with affected First Nations.

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Criterion	IPSP	Renewable is Doable	Comments
		Phase-out of nuclear power reduces present public health risks from uranium mining and nuclear generation. Northern dams component may conflict with Aboriginal land claims issues and existing agreements. See comment.	
• distribution of effects on key quality of life considerations (health, valued employment, respected knowledge, community security, access to opportunity, influence in decision making, durable economic development opportunities, etc.)	Environmental/health risks and economic benefits of upstream aspects of nuclear and gas fuel cycles occur outside of Ontario. Durable economic development opportunities in Ontario largely associated with large nuclear and gas facilities in Southern Ontario. Limited opportunities for public influence in decision making in large project development.	Both negative effects and benefits of the system are concentrated in Ontario. Distributed generation tends to be concentrated close to load centres, and associated risks and benefits (durable employment opportunities, social capital, and governance) tend to be localized.	
• allocations of costs/risks to those who benefit little or not at all from the system	Large burden of risks associated with upstream aspects of nuclear and gas components borne by remote First Nations communities.	More equitable distribution of risks and benefits on local, regional, and national scales. Greater economic development opportunities in rural areas.	
• effects on externalization or internalization of risks, costs and benefits on distribution of risks, costs and benefits among investors, suppliers, consumers and governments (i.e. taxpayers)	Viability of nuclear components rests on ability to externalize risks and liabilities to electricity consumers and taxpayers.	Greater internalization of costs and benefits. No externalization of construction cost risks and long-term liabilities required for renewable, gas, cogeneration that are core of plan.	
• social and economic effects of electricity costs and pricing among suppliers, consumer groups (who wins, who loses)	Increased electricity costs due to coal-phase-out, large reliance on nuclear and short-term natural gas volatility may negatively affect large industrial electricity consumers. Increased electricity costs may adversely affect low-income consumers in the absence of effective mitigation strategies.	Reduced electricity costs relative to IPSP (on basis of Provincial Auditor's assessment of nuclear refurbishment costs.	

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Criterion	IPSP	Renewable is Doable	Comments
• local/regional effects on - employment for local or transient or outside people - opportunities for small producers - new governance burdens for local authorities and residents	Does not provide significant durable local employment outside of communities hosting existing nuclear facilities. Reduces market share for small producers due to heavy dependence on large centralized facilities (nuclear and natural gas).	Increases the market share for small renewable energy producers. Wide-ranging knowledge transfer and capacity development associated with renewables and CDM on local and regional scales. Requires greater local governance capacity.	
• provincial/national effects on - special needs of rural areas, First Nations, declining communities - concentration or dispersion of influence on energy policy and practice	Fails to maximize economic development opportunities from renewables and CDM, which could benefit rural and First Nation communities. Large gap in practical ability for different segments of society to exert influence in governance related to nuclear.	Increases economic development opportunities from renewables and CDM, which could benefit rural and First Nation communities	
• global effects on - wealthy nations' responsibility for major GHG cuts and other reduction of energy, material and ecological system demand - food versus fuel	Reduces GHG emissions via coal phase out (if achieved) but maintains high demand from ecological systems affected by uranium and natural gas production.	Increases biofuel production, which (depending on the feedstocks used) could contribute to the emerging international food versus fuel conflict.	
Intergenerational Equity			
What nature and significance of • long term enhancements of opportunities (technological advantages, developed social capital, stimulation of innovation, resilient systems, etc.)	High path dependency (70+ year facility planning and operational life-cycle) of large nuclear component locks in large portion of system in terms of potential for innovation, and technological advances over several generations. Large size and long-life cycle of nuclear component reduces opportunities for innovation, development of other technologies, including renewable generation and CDM in the long term.	Greatly reduced path dependency. Modularity of renewable systems allows for future generations to guide the evolution of their power system. Enhances long-term economic opportunities and social benefits, particularly through the creation of localized markets supplied by in-province manufacturers.	

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Criterion	IPSP	Renewable is Doable	Comments
	Little or no apparent integration between IPSP and long-term economic development strategy for province.	Enhances long-term opportunities to build social capital around renewable systems and CDM initiatives.	
• long term costs, risks and other burdens (costs, risks, debts, wastes requiring long-term/permanent management, decommissioning/ rehabilitation needs, permanent damages (health, landscape, ecosystem productive capacity), security and safety risks, etc.) transferred to future generations	Shifts significant environmental, safety, and security risks and costs to future generations via requirements for long-term/perpetual management of nuclear related upstream (e.g. tailings, waste rock) and downstream (waste fuel, refurbishment and decommissioning) wastes. Permanent landscape and water impacts associated with uranium mining. Economic (beyond predicted decommissioning costs) and physical risks associated with nuclear facility decommissioning and waste fuel management transferred onto future generations. Mitigates risk of long-term climate change impacts by reducing GHG emissions via coal phase out (if achieved) Reduces permanent landscape impacts associated with coal extraction.	Generates cumulative effects from large hydro generation (also contained in IPSP) and fragmentation from distributed systems. Leaves no debt to future generations as renewables are characterized by up front, not operating and legacy costs. Therefore, generating systems get cheaper over time. Mitigates risk of long-term climate change impacts by reducing GHG emissions. This is combined with a reduced ecological footprint from nuclear, coal and gas fuel cycle impacts.	Waste nuclear fuel will require management for 1 million years. The Nuclear Waste Management Organization estimates that it will take over 300 years to implement its adaptive management program.
• shrinking or foreclosure of options for future generations (e.g. depletion of non-renewable resources or renewable resource capital base).	Depletes peaking conventional Canadian natural gas supplies, allocates the bulk of electricity system nuclear generation (high path dependency/long-term lock-in effect) re: large portion of electricity system.	Modularity of renewable technologies and their inexhaustible fuel sources will not reduce options for future generations. Potential for short/medium-term path dependency associated with long-term contracts, but still much shorter time scale than nuclear projects. Large scale hydro retained from IPSP implies limited path dependent element.	

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Criterion	IPSP	Renewable is Doable	Comments
• distribution of long term positives and negatives (e.g. overall effects on future consumption, wealth and resource access gaps between the first and fifth quintile of the population)	Transfers significant long-term risks and liabilities to future generations (upstream and downstream nuclear related wastes, nuclear facility decommissioning, landscape disruptions in support of consumption by present generations. Large nuclear component limits opportunities for alternative paths for future generations. Risks of higher long-term electricity costs due to price/ supply risks related to uranium and natural gas.	No/reduced transfer of long-term risks and liabilities to future generations via reduction/phase out of nuclear component. Lasting employment associated with distributed generation and CDM.	
• capacity and provisions for use of near term benefits as bridge to more long term sustainable options (e.g. from non-renewable to renewable supply sources)	Construction boom associated with nuclear refurbishment and new build, and subsequent lock-in to nuclear dominated system likely impede bridging to other sources.	Provides the capacity to bridge to long term sustainable options by maintaining reliability of large hydro and gas, and integrating renewables on a large scale.	
• intergenerational distribution aspects of residual gains and losses, openings and risks long term effects on expanding or closing the gap between rich and poor	Fails to mitigate ecological losses (upstream and downstream impacts) and economic burdens (waste management, decommissioning, potential debt) on future generations. Forgoes or minimizes opportunities to enhance rural and First Nations community economic development through distributed renewable generation and CDM.	Minimizes ecological losses and economic burdens on future generations. Enhances opportunities for rural and First Nations economic development through distributed renewable generation and CDM.	
• local/regional effects on - permanent changes (e.g. in landscapes, ecological system impairment) - long term management responsibilities, risks, costs (e.g. wastes)	Permanent landscape changes associated with upstream fuel elements (uranium, coal, gas) outside of Ontario. Minimizes permanent changes in landscapes in Ontario, with exception of large hydro projects in the north. Long-term nuclear waste fuel management and decommissioning responsibilities transferred to future Ontario residents.	May increase permanent changes in landscapes due to requirement for extensive transmission enhancements. Retains large scale hydro components from IPSP.	

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Criterion	IPSP	Renewable is Doable	Comments
• provincial/national effects on - decommissioning and rehabilitation costs - residual wastes/risks and associated management burdens - potential for residual debt	Risks of higher than estimated decommissioning and rehabilitation costs associated with nuclear and large hydro. Nuclear incurs residual generational wastes as well as residual debt borne by Ontario taxpayers.	Except for large hydro, no significant decommissioning and rehabilitation costs or residual wastes or debt.	
• global effects on - overall and distributional results of long term climate effects, and effects on overall energy, material and ecological system demand - depletion of non-renewable resources, - impairment of biophysical and/or social system resilience - global (in)equities - global security (versus armed conflict, scarcity/deprivation, vulnerability to economic and biophysical hazards,...)	Contributes to mitigation of global climate change via coal phase out if achieved. Depletes non-renewable resources that require detrimental extraction processes (particularly uranium and shift towards unconventional natural gas) Large nuclear component has potential to contribute indirectly to the proliferation of material and technologies used for weapons of mass destruction. A large reinvestment in nuclear technology by Ontario will make it more difficult to deny access to nuclear materials and technologies elsewhere, including areas of high weapons proliferation and security risks. Large nuclear facilities are widely acknowledged as potential targets for terrorist activity.	Contributes to mitigation of global climate change and to phasing out of high risk/high cost non-renewable energy sources.	
Efficiency, Cost-Effectiveness and Resource Maintenance			
What nature and significance of • contribution to overall reduction of material, energy and ecological system demand - particular focus on maximum reduction of electricity demand and associated footprint	Fails to pursue full “achievable” potential to reduce electricity demand via CDM. Fails to pursue full potential for development of low-impact renewable and conventional technologies, particularly wind, solar PV, and cogeneration Allocates large portion of electricity system to relatively high impact, non-renewable technologies (i.e. nuclear and low efficiency gas).	Aims to reduce electricity demand by pursuing full identified “achievable” CDM potential.	

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Criterion	IPSP	Renewable is Doable	Comments
• sustainability of primary energy sources	Long-term fuel supply concerns with regards to high-grade uranium and conventional natural gas. High environmental, security, weapons proliferation and economic risks associated with nuclear fuel reprocessing if pursued (N.B. no existing capacity to do this in Canada).	Except for natural gas, energy sources are renewable, therefore, inexhaustible and free of cost.	
• maintenance/enhancement of - ecological base for delivery of ecological goods and services - renewable resource base - non-renewable resources (including through effective bridging) - social capital and other community goods	Reliance on nuclear and natural gas adversely affect delivery of ecological goods and services at sites where uranium is mined and gas is extracted. Reduced upstream impacts associated with coal extraction due to coal phase-out. Long-term non-renewable fuel supply depletion concerns with regards to high-grade uranium and conventional natural gas. Centralization of power system reduces public participation and opportunities to build social capital. Contention above health and other issues surrounding nuclear generation can divert and/or fragment social capital.	Minimal effects on ecosystem services except in the cases of large hydro and natural gas. Maintenance of resource base for future generations through CDM and high reliance on low-impact renewable sources. Distributed generation enhances social capital and local governance.	
• minimization of costs (lifecycle, full costs basis including legacy, environmental, operating/maintenance and capital costs and risks) through - full cost (beyond LUEC) calculation of most cost-effective supply/CDM option internalization of costs and risks by electricity suppliers - minimizing overall public costs and assumption of risks and liabilities - avoiding subsidization of specific suppliers or technologies (directly or via transfer of risk and liabilities to government or government agencies such as the OPA)	Fails to reduce costs by not maximizing CDM potential. Cost evaluations generally fail to employ lifecycle/full cost considerations. Significant cost risks associated with high dependence on nuclear (construction cost and delay) and legacy costs (waste fuel and decommissioning). Low operational costs with reliance on conventional sources (nuclear and large hydro). Viability of nuclear components rests on ability to externalize risks and liabilities to electricity consumers and taxpayers. Fails market test for investment. Also requires large reserve margin due to large size of generating facilities.	Pursues maximum CDM potential that has been identified as “achievable” thereby reducing overall system costs via less demand for new supply and transmission infrastructure. Overall, greater internalization of costs with high reliance on renewables due to: avoidance of fuel cycle impact costs and lower lifecycle resource requirements. Increased distribution infrastructure costs with “deep” green option, but LUEC still lower than IPSP.	

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Criterion	IPSP	Renewable is Doable	Comments
	Short term cost risks flowing from potential for short term natural gas price instability.		
• maximization of efficiency of energy production, delivery and use, including exergy efficiencies through - matching the quality of and with the needs of the use (end use matching); - maximizing primary to delivered energy efficiency including opportunities for multiple use (e.g. cogeneration); - minimizing conversion and transmission losses, including attention to internalization and equitable distribution of risks, cost and impacts, and quality of energy - minimizing need for backups/ reserve margin (recognizing desirable redundancy for system resilience) - stimulation of further conservation/ efficiencies - maximizing use of underutilized existing facilities, resources and capacities and minimize requirement for additional supporting infrastructure, management - minimizing governance burdens/ costs (regulatory, administrative, citizen monitoring, financial oversight, subsidies, acceptance of liabilities etc.)	Fails to pursue full "achievable" potential to reduce electricity demand via CDM. Focus on large supply option may provide disincentives for further conservation/efficiencies, particularly as plan contemplates reducing CDM programming over time. Overall, centralized systems are less efficient due to greater transmission losses and grid stress. High path dependency/low adaptive capacity due to high reliance on nuclear and large facilities generally (hydro, natural gas). Reliance on large facilities requires higher reserve margins. Heavy reliance on low efficiency single cycle gas facilities and failure to fully exploit high efficiency cogeneration potential. Nuclear refurbishment reduces requirements for transmission infrastructure. Also reduces path dependency due to shorter planning, approval and construction timelines, and shorter expected facility lifetime. Nuclear facilities require highly specialized regulatory capacity for oversight. Economic viability rests on ability to externalize risks and liabilities.	Pursues full identified "achievable" CDM potential maximizes efficiency of overall resource use. Modular efficiency of CDM increases resilience and adaptive capacity and reduces path dependency. Location of distributed generation near load centers reduces strain on the grid and transmission losses. Modularity of energy pathways associated with renewables, CDM, and natural gas allows for better end-use matching, greater resource and cost-effectiveness. Intermittent sources (wind, solar) associated with lower capacity factor than conventional sources (manageable through use of storage technology). Distributed renewable generation can increase the complexity of the grid, raising maintenance and construction costs and reducing efficiency.	

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Criterion	IPSP	Renewable is Doable	Comments
• maximization of flexibility to pursue and adopt new technologies/techniques - maximizing potential for incremental adjustment - avoidance of locked in obsolescence	Non-modularity of large, centralized generation impedes system's ability to adopt new technologies incrementally. Long planning and life-cycle for nuclear facilities (70+ years) associated with high path dependence, limited opportunities for incremental adjustment, high potential to be locked into obsolescence.	Modularity of distributed renewable and natural gas generation, and CDM maximizes potential for incremental adjustment and avoids technological lock-in/path dependency Large hydro for baseload and storage can assist with the integration of an array of renewable technologies, particularly wind.	
• local/regional effects on - maximization of multiple local/regional benefits from chosen options (e.g. desirable, diverse and durable employment, health and ecological enhancements, and infrastructure improvement) - contribution to growth redistribution - minimization of conflicts with current valued qualities, activities, opportunities - minimization of boom/bust effects	Focus on large centralized facilities carries high risk of boom/bust employment effects. Durable direct employment limited to existing nuclear sites. Enhances transmission near large facilities only.	Widespread distribution of economic growth and reduced boom/bust effects through distributed generation. Contributes to growth redistribution through the enhancement of transmission in remote locations. Maximizes benefits from technologies' ability to co-exist with other land and water uses (except natural gas). See comment.	Along with providing electricity, large hydro projects provide water for irrigation, industrial use and urban centres, flood protection, and opportunities for recreation. Wind and solar projects can be integrated with other land uses such as agriculture and residence.
• provincial/national effects on - maximization of electrical energy demand reduction (at full costs not significantly greater than supply options) - minimization of econ/financial vulnerability - minimization of damages and risks to valued social and ecosystem components - maximization of potential encouragement of and benefit from domestic innovations	Fails to pursue full "achievable" potential to reduce electricity demand via CDM. Heavy reliance on nuclear carries high risk of transferring liabilities and risks to ratepayers and taxpayers.	Pursues full identified "achievable" CDM potential maximizes efficiency of overall resource use. Encourages domestic innovation i.e. local manufacturing of renewable technologies.	

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Criterion	IPSP	Renewable is Doable	Comments
- maximization of resources retained for other purposes - discouragement of direct and indirect expansion of energy, material and carrying capacity demand			
• global effects on - contribution to reducing overall energy, material and ecological system demand - demonstration of case/tools for global practice - trade and aid implications	Fails to pursue full "achievable" potential to reduce electricity demand via CDM. Reliance on nuclear and natural gas does not reduce demands on materials and their corresponding ecosystems. Large nuclear component has potential to contribute indirectly to the proliferation of material and technologies used for weapons of mass destruction. A large reinvestment in nuclear technology by Ontario will make it more difficult to deny access to nuclear materials and technologies elsewhere, including areas of high weapons proliferation and security risks.	Minimizes demands on material and ecosystems. Commitment to renewable deployment and CDM enhances global market for renewables and creates possibility of knowledge transfer of technologies (on-grid and off-grid) to developing countries.	
Socio-Ecological Civility and Democratic Governance			
What nature and significance of • contribution to enhancement of governance capacity, including - government capability (for consultation, planning, oversight, monitoring, and response) including supportive redundancy - diverse private sector opportunity and innovative culture - informed and enabled citizen engagement - accessibility and transparency of decision making (e.g. relative accessibility of nuclear approval process versus deliberations on conservation initiatives)	Reservation of a high portion of baseload for nuclear reduces opportunity for market participation by other suppliers, innovation. Public deliberation/input on plan development is limited by centralized generation, and by nuclear procurement occurring via an end-run around the IPSP planning/approval process. High path dependency associated with large, centralized, long-lived generating facilities limits opportunities for incremental adjustment in response to public concerns/priorities. Accessibility of the decision-making process on nuclear limited particularly in context of limitations of federal EA scope and process. Nuclear component requires regulator with highly specialized technical and regulatory capacity.	Decentralization fosters local governance and participation in energy management. Potential for energy autonomy through government incentives (net metering and RESOP) increases number stakeholders, especially in economically sensitive areas such as First Nations and rural communities. Increases opportunities for private sector development and local innovation.	

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Criterion	IPSP	Renewable is Doable	Comments
- decision making transparency, comprehensibility and accessibility, process clarity			
• contribution to understanding and capability, including - enhancing social capital - facilitating social learning - building a "culture of conservation" (demand reduction and efficiency) accuracy of price message (e.g. full cost pricing) - open deliberation on objectives)/ends (e.g. through scenario building and backcasting)	Opportunities for social capital construction and social learning constrained by limited role of RESOP initiatives. Gradual decrease of CDM programming over time may undermine "culture of conservation" "Stranding" of debt, externalization of risks and liabilities and lack of full cost accounting associated with nuclear reduces transparency in energy costs and decision-making. Centralization of power system reduces interactions between citizens and electricity system.	CDM and distributed renewable generation emphasize collective/community responsibility, as well as market and social mechanisms that reduce demand. Maximizing CDM effectively builds a culture of conservation by empowering individuals to participate in decision-making through their purchases and consumption habits.	
• encouragement of - research and innovation - adaptive design including technology and system flexibility - capacity for response to opportunities and surprise	High path dependency, limited capacity to respond to opportunities and surprises, adapt to changing circumstances, and incorporate new technologies due to large nuclear component.	Encourages new research and development, adaptive design and implementation opportunities.	
• minimization of - threats to valued community qualities, features - system (or component) vulnerability to security hazards (e.g. non-democratic security needs) - governance and oversight requirements	Significant upstream impacts associated with uranium and gas fuel cycles, reduces upstream impacts associated with coal, if phase-out achieved. Focus on large centralized facilities increases security hazards. Large nuclear facilities are widely acknowledged as potential targets for terrorist activity. Security risks also associated with waste nuclear fuel. Nuclear component requires highly specialized, relatively inaccessible regulatory capacity. Large projects generally require extensive governance and oversight procedures.	Reduced fuel cycle socio-ecological impacts from coal phase-out, reduction/phase-out of the nuclear component, and a reduced natural gas component. Much lower security hazards associated with smaller, distributed facilities. Consequences of successful attack/serious incident much more limited than large centralized facilities.	

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Criterion	IPSP	Renewable is Doable	Comments
• local/regional effects on - demands on governance capacity (municipalities, NGOs) - contributions to or stresses on social capital	Large, centralized facilities generally not associated with contributions to social capital, ability of NGOs and municipalities to participate in governance very limited. Opportunities for construction of social capital strengthening of local governance capacity limited by limited role for SOC project, distributed generation.	Increases demands for energy governance on the part of municipalities and NGOs. Contributes positively to building social capital and bringing new value to agricultural communities.	
• provincial/national effects on - dependence on extra-provincial network (encouragement of interjurisdictional cooperation, vulnerability to decisions beyond local/provincial control) - demands on governance capacity (immediate and in perpetuity) - contributions for social capital - promotion of innovation	Nuclear component requires governance structures for nuclear waste fuel and other wastes into the far distant future. Does not fully develop potential for role of secure, out of province hydro supplies (e.g. Quebec and Manitoba) to contribute to baseload supply and integration of intermittent renewables. See comment. Opportunities for construction of social capital and strengthening of local governance capacity limited by restricted role for RESOP projects and distributed generation.	Currently, Ontario lacks an effective institutional focal point for CDM activities and policies. Fosters independence from fuel prices, which are currently volatile and rising. Contributes positively to forming social networks around renewable energy sources in Ontario, which could then be extended across Canada and to the United States.	The IPSP allows for hydropower imports between 2016 and 2019 from Manitoba and Quebec. Given the vast hydro potential of both these provinces and relative security of relying on such a supply, it is unclear why this potential is not maximized to increase Ontario's overall renewable capacity.
• global effects on - vulnerability to geopolitical risk (e.g. security/terrorism, fuel/technology access)	Enhances vulnerability to global terrorism, as nuclear facilities are widely acknowledged as potential targets for terrorist activity. Security risks also associated with waste nuclear fuel. Large nuclear component has potential to contribute indirectly to the proliferation of material and technologies used for weapons of mass destruction. A large reinvestment in nuclear technology by Ontario will make it more difficult to deny access to nuclear materials and technologies elsewhere, including areas of high weapons proliferation and security risks.	Minimizes vulnerability to geopolitical risks. Eliminates/reduces fuel access risks. Vulnerable to supply shortages associated with renewable technologies, particularly wind turbines.	

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Criterion	IPSP	Renewable is Doable	Comments
Prudence, Precaution and Adaptation			
What are the nature and significance of • contribution to technology and system reliability through - minimization of system vulnerability to risks due to catastrophic events, technology failures - minimization of opportunity for damaging human error - minimization of exposure to, or likelihood of, resource shortage (fuel, wind or water flow or other power resource) or programme failure (e.g. poor public or industry response to conservation/demand mgmt initiatives) - minimization of vulnerability to grid upset - adequacy of measures to protect system security - ability to accommodate range of potential futures while promoting progress to a desirable future	Heavy dependence on nuclear in spite of history of poor nuclear reliability in Ontario. Reliance on non-modular, large-scale, centralized technology increases system vulnerability to grid upset from individual facility failures. Potential for longer blackouts due to nuclear plants long startup times. Increased uranium prices, serve to highlight market risks stemming from concern over long-term supply of high-grade uranium ore. This is compounded by peaking supply of Canadian natural gas (long-term supply concerns) and short-term price volatility. High path dependency and low adaptive capacity of nuclear due to very long planning and construction timelines, high capital investment, and long-facility lifetime (70 + year lifecycle) fail to accommodate range of potential energy futures, particularly one founded primarily on renewables.	Diversity, scaleablility, and modularity of technologies minimizes vulnerability to grid upset from individual facility failures. As well, renders system able to accommodate a range of potential renewable energy futures. Minimizes likelihood of resource shortage, save natural gas and possible climate effects on the water supply. Relies on experiences of comparable jurisdictions in terms of estimated potential for renewable and CDM deployment, as well as, newer, more modular grid designs. Risk of future supply shortfall if planned CDM and renewable potential is not realized. Reliance on CDM increases vulnerability to policy shifts and poor public response to initiatives, as well as policy shifts. Relies to some extent on renewable deployment on territory that contradicts previous agreements with First Nations.	

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Criterion	**IPSP**	**Renewable is Doable**	**Comments**
• contribution to technology and system resilience through - maximization of modularity (distributed versus centralized components) - diversity of technologies, fuels, suppliers and facilities, etc. - maximization of capacity to isolate failures and facilitate system recovery - minimal need for backups/reserve margin (recognizing desirable redundancy for system resilience) - availability of response options, including spare capacity (storage, back-up generation, additional temporary and longer term CDM), adjustable scale, etc. - effective monitoring and quick response capability (managerial and technical) - friendliness to innovation, minimum path dependence, ability to retain and pursue options - self-reliance combined with cooperative networks of support - contingency plans	High path dependency of large nuclear component limits modularity and diversity of supply options to margins. Fails to maximize capacity to isolate failures and facilitate system recovery due to low modularity. Focus on large centralized facilities and a few main generation sources (nuclear, gas, and hydro) requires large reserve margin systems and does not foster greater self-reliance and cooperative networks.	Distributed components enhance modularity, thereby reducing path dependence and increasing flexibility of system. Need for storage due to increased reliance on intermittent sources (wind, solar, small hydro). Intermittency of wind and solar power requires substantial transmission grid enhancement i.e. Smart Grids. See comment. Reliance on distributed and community or individually owned generation fosters greater self-reliance and cooperative networks. Encourages innovation on both supply (renewables) and demand (CDM) sides.	Smart Grids are considered a key component in developing a system based on distributed renewable generation and storage. They employ digital two-way communication devices and computer based grid monitoring to enhance operator information and enable connection and disconnection of generators. They also incorporate artificial intelligence agent to guide grid operators and semi-autonomous agent software.
• adaptive capacity and minimization of path dependency including - ability to adapt to changing circumstances including externally generated ones, such as environmental change (e.g. climate change impacts), economic recession or growth, structural	Low adaptive capacity and high path dependency due to large nuclear component. Relies on capital-intensive supply options with long planning, approval and construction timelines (>5 years)	High adaptive capacity and low path dependency due to large distributed generation component. Except for large hydro, relies on supply options with short planning, approval and construction timelines (<5 years).	

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Criterion	IPSP	Renewable is Doable	Comments
economic change affecting electricity demand, political risks (e.g. policy shifts, geopolitical events) - ability to incorporate new technological development - maximization of potential for incremental mid-course adjustment in face of changing circumstances (e.g. by adding system capacity in incremental steps with <5 year planning, approval and construction timelines) - minimization of commitments to high path dependency large scale, capital intensive supply options with >5 year planning approval and construction timelines	Long facility planning and operational life-cycle (70+ years) of large nuclear component locks in large portion of system over several generations, restricting flexibility to respond to innovation and technological advances in other options. Significantly constrains ability to adapt to changing circumstances and make mid-course adjustments.	Short lead-times for renewable and CDM deployment, as well as their modularity, renders system adaptable to structural economic change affecting electricity demand, policy shifts, geopolitical events, etc.	
• avoidance of economic risks - minimization of risk of project failure due to technological or management failure, regulatory, social licence, political factors - minimization of system level impact of individual project or technological failure through avoidance of over dependence on individual projects - minimization of risk of higher than predicted costs and delays (due to technical, management, economic, regulatory social, licence and political factors - retention of options to cancel/abandon individual projects that are seriously over budget or delayed via project modularity (minimize large centralized projects whose	Experience shows high risk of construction cost overruns and delays associated with nuclear construction and refurbishment projects. Does not retain option of canceling or abandoning individual nuclear projects if over budget or behind schedule or in the event of project failure (e.g MAPLE). Instead risks externalized to tax and ratepayers. High dependence on cost-effective completion of individual projects to secure energy supply. Political risk of potential policy changes affecting support for nuclear, CDM and renewable plan components.	Low economic risk since construction timelines and costs are well understood. Fuel cost risks are reduced or eliminated. Avoids externalization of construction costs and long-term liabilities. Increased modularity and diversity of supply options retains option of canceling or abandoning individual projects in case of failure. Avoids dependence on individual projects to secure energy supply. Renewable and gas facilities constructed on market basis or limited price and market guarantees (e.g. RESOP).	Wind power development in particular has experienced supply shortages and rising prices due to record-breaking U.S. demand, tapped out manufacturing capacity and higher material costs. If the backlog persists it could present a serious impediment to small projects/ community power. Developers can face as long as a two-year wait for turbines.

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Criterion	IPSP	Renewable is Doable	Comments
individual failure will throw the system/plan into crisis)		Some risk of delays and cost increases due to dependence on international market for some equipment (e.g. wind generators). See comment. Political risk with of policy changes affecting support CDM and renewable plan components.	
• avoidance of geopolitical risk - minimization of political risk to fuel access and/or market risk where fuel is internationally traded commodity subject to international trade rules - minimization of political risk to access to technology and/or market risks where there are competitive markets for technology and skills needed to deploy it - avoidance of choices that may contribute to proliferation of weapons of mass destruction	Geopolitical risk of nuclear fuel supply access is limited due to Canadian supply. Likelihood of increased reliance on unconventional natural gas, particularly LNG introduces potential for geopolitical risks to supply. Market risks regarding uranium and natural gas supply as both are internationally traded commodities. Potential for increased exports to US of Canadian natural gas, global exports of uranium. Potential geopolitical risks related to access to non-Canadian nuclear technologies if chosen. Fails to avoid supply choice (nuclear) that may contribute to proliferation of weapons of mass destruction.	Greatly reduced fuel access risks. Risks shortage of workers skilled in renewable technologies and management of CDM initiatives. Technology supply risk with reliance on imported renewable technologies. No weapons proliferation risks.	
• avoidance of security risks - minimization of obvious targets for terrorist activity - minimization of system dependence on individual facilities that may be vulnerable to terrorist attack or other failures/events - minimization of geopolitical security risks re fuels or technologies	Nuclear facilities at risk of terrorist attacks that could cause severe and widespread damage. Focus on large centralized facilities increases risk of system upset due to terrorist attack or other failures/events. Waste nuclear fuel associated with security, weapons proliferation risks.	Eliminates potential for energy-based terrorist targets and minimizes geopolitical fuel or technological risks.	

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Criterion	IPSP	Renewable is Doable	Comments
• avoidance of vulnerability to uncertain but possibly significant damages - minimization of exposure to potential extreme events or catastrophic accidents - minimal possibilities for catastrophic damage from extreme events or accidents - minimization of risk of unanticipated health and ecological damage (e.g. long term effects of exposures to new phenomena)	Large nuclear component carries risks of catastrophic accidents/events. Focus on large centralized facilities increases risk of system upset due to terrorist attack or other causes of damage or failure. Fails to avoid potentially significant health and ecological damage incurred by exposure to radioactive materials. See comment.	Eliminates potential for exposure to catastrophic accidents. Minimal risk of unanticipated health or ecological effects.	Scientific understanding of health hazards associated with low level exposure to radiation is evolving rapidly; findings suggest that health risks have been significantly underestimated, particularly with respect to certain vulnerable populations (e.g. children).
• sustainability of primary energy sources	Limited identified reserves of high-grade uranium in Canada (40 years at current rate of consumption). Lower grade reserves available but exploitation associated with increased environmental and health impacts and risks. Conventional Canadian gas reserves in decline. Socio-ecological system impacts increase with shift to unconventional gas.	Reduces demand on non-renewable energy sources, thereby reducing strain on ecological systems and ratepayer vulnerability to fuel price increases.	
• local/regional effects on - minimization of vulnerability to boom/bust effects - minimization of contribution and vulnerability to cumulative stresses	Maintains vulnerability to boom-bust effects of large facility (nuclear, large hydro, large natural gas) construction. Systemic failure to consider climate change impacts on planned system.	Minimizes vulnerability to boom-bust effects.	
• provincial/national effects on - minimization of risk of catastrophic failure - minimization of path dependency - maximization of component and system resilience - maximization of adaptive capacity avoidance of network dependence but encouragement of cooperation and back up support	High path dependency, risk of catastrophic failure, limited resilience and adaptive capacity flowing from large nuclear component.	Distributed systems foster cooperative networks and provide multiple sources of back-up support.	

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Criterion	IPSP	Renewable is Doable	Comments
• global effects on - minimization of contribution to global insecurity - minimization of vulnerability to global insecurity - example for international adoption	Large nuclear component may increase global insecurity due to example set by large scale adoption of nuclear option; also renders Ontario vulnerable to global terrorism (nuclear facilities as targets)	Minimal contributions or vulnerability to risks global insecurity. Would set strong example for international adoption of renewable energy and CDM.	
Immediate and Long Term Integration			
What nature and significance of • potential to deliver multiple benefits (combining livelihoods, stewardship, equity, civility and precaution and/or ecological, economic, social and geopolitical gains)	The significant benefit of plan is its closure of coal-fired plants and associated reduction of GHG, other air pollutant emissions, and upstream impacts of coal extraction. Generally fails to deliver multiple benefits. This is largely due to the path dependent nature of a system so heavily reliant on nuclear power. Multiple benefits derived from portion of the supply mix allocated to renewables and CDM will be severely limited for multiple generations by political, financial, and institutional support of nuclear power, which has effectively been guaranteed a large portion of the Ontario electricity market. Delivers multiple detriments due to large nuclear component and associated character as a path dependent and inflexible system that externalizes significant economic and environmental risks, fosters intragenerational and intergenerational inequities, and contributes to global proliferation of material used in weapons of mass destruction.	Delivers multiple benefits in the form of a modular, adaptive, and reliable system characterized by local stewardship and ownership of energy supplies; increased opportunities for employment; potential for the establishment of a new manufacturing sector; more equitable distribution of risks and benefits within and between generations; widespread distribution of modular, scaleable, and environmentally benign technologies; avoidance of economic risks and externalized costs; and avoidance of security and geopolitical risks.	

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Criterion	IPSP	Renewable is Doable	Comments
• potential for mutually reinforcing benefits	No apparent strategy for maximizing mutually reinforcing benefits.	Employs a combination of technologies that produce mutually reinforcing gains, for example, by providing a reliable supply of baseload and peak power that has low biophysical impact, lower economic risk, and high potential for stakeholder involvement and employment opportunities. Large hydro and to a lesser extent natural gas, complement intermittent renewable energy technologies such as wind, solar, and small hydro power, helping to buffer the system during the phase-out of non-renewable fossil and nuclear fuels. Lower economic risk for consumers is positively reinforced by opportunity for income generation and employment. Low environmental risk of renewable technology (with the exception of large hydro) positively reinforces greater energy savings through CDM and the fostering of a culture of conservation. This in turn is reinforced by the high potential for the involvement of a variety of stakeholders in distributed renewable generation.	

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Criterion	IPSP	Renewable is Doable	Comments
• potential for avoiding trade-offs	Fails to avoid significant trade-offs with respect to biophysical and economic risks, as well as intra- and intergenerational inequities.	Avoids trade-offs associated with IPSP, but fails to avoid uncertainty with regards to the capacity of the province to make a dramatic shift in energy policy (from reliance on large, centralized system to one characterized by distributed generation).	
• local/regional effects on - potential for multiple, mutually reinforcing livelihood benefits - risk of mutually reinforcing cumulative negatives (e.g. boom-bust of multiple associated/induced projects) - undesirable and avoidable trade-offs (e.g. short term development at the expense of longer term livelihood base)	Generally sustains current/short term energy consumption at risk of transferring significant costs/risks onto the future, particularly associated with large nuclear component.	Strong potential for mutually reinforcing gains as more benefits in a distributed system are retained at the local and regional level.	
• provincial/national effects on - potential for multiple, mutually reinforcing benefits (e.g. centre for sustainable energy system innovations) - risk of mutually reinforcing negatives (e.g. contribution to growth concentration) - undesirable and avoidable trade-offs	Reinforcing benefits limited, because benefits flow from coal phase-out only. Potential benefits from CDM and renewable components not maximized due to failure to deploy their "achievable" potential.	Reduces undesirable trade-offs and has strong potential for mutually reinforcing benefits.	
• global effects on - potential for multiple, mutually reinforcing benefits (e.g. building of sustainable energy model for global applications)	Does not contribute to building sustainable energy model. Largely reproduces existing, centralized, non-renewable, high impact system with introduction of CDM and low-impact renewables at margin.	Contributes to sustainable energy model at a critical time when economic and biophysical costs related to fossil fuels and nuclear power are proving unsustainable.	

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Criterion	IPSP	Renewable is Doable	Comments
- risk of mutually reinforcing negatives (e.g. contribution to climate change, larger material/ energy footprint) - undesirable and avoidable trade-offs		For global advances in clean energy to be realized, industrially developed countries such as Canada can provide valuable leadership.	
Trade-offs			
What fundamental trade-offs are involved and what rationale is offered?	Benefits from coal phase out, and from the anticipated reliability and feasibility of proposed system components versus foregone opportunities for more CDM and renewables, high path dependency, low adaptive capacity, economic risks associated with nuclear, life-cycle impacts of nuclear and gas. Rationale offered: an increase in CDM is unreliable and an increase in renewables is not cost-effective.	Reduced non-renewable fuel cycle impacts and risks, economic development opportunities from distributed generation, higher adaptive capacity, and increased resilience, versus potentially decreased reliability and supply shortfall if potential of CDM/ renewables not delivered. Rationale offered: nuclear costs and unreliability, lifecycle impacts grossly underestimated, difficulty in grid integration of renewables overestimated.	
Does the technology/component/ system maximize opportunities for multiple mutually reinforcing gains?	Fails to maximize opportunities for mutually reinforcing gains from renewables and CDM by not deploying them to their full “achievable” potential. Failure to integrate components into mutually reinforcing gains, e.g. demand response to avoid low efficiency gas, hydro and storage to maximize potential contribution from intermittent renewables. Fails to fully exploit potential contribution from cogeneration to baseload.	Increases opportunities for mutually reinforcing gains from renewables and CDM by deploying them to their full “achievable” potential. Maximizes environmental benefits by eliminating upstream and downstream impacts from coal and nuclear generation and replacing their capacity with cleaner energy from renewables and gas. This is	

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Criterion	IPSP	Renewable is Doable	Comments
	Integration limited to nuclear baseload/low efficiency peaking gas relationship. Phase-out of coal reinforces gains from increased renewable and CDM deployment.	also reinforced by reducing demand through CDM. Sustainability is reinforced by an increase in more equitable and numerous employment opportunities associated with renewables and CDM, as well as opportunities for income from government incentives for micro generation (RESOP). An increase in hydropower suited for baseload facilitates the integration of wind power on a larger scale, also a reliable source of baseload. These are positively reinforced by greater deployment of solar power for peaking (especially in summer) instead of increases in gas, which is subject to uncertain prices and significant upstream impacts. Increases in lasting employment and cleaner generation are reinforced by the elimination of environmental and financial debt associated with nuclear power that result in intra- and intergenerational inequities.	
Are there likely to be significant adverse effects (e.g., damage or increased stress in a major area of existing concern, or reduction of prospects for resolving priority problems) that cannot be avoided without accepting more adverse effects elsewhere?	The choice of a path dependent, nuclear-based system could be avoided without accepting adverse impacts comparable in scope and scale. Socio-ecological impacts caused by increased access to remote areas via roads or transmission as a result of distributed generation would incur much less damage	Avoiding the adverse effects of a system reliant on nuclear and coal will incur negative impacts associated with re-designing the grid to accommodate a distributed system. These could include lack of sufficient domestic expertise	

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Criterion	IPSP	Renewable is Doable	Comments
	than upstream and downstream fuel cycle impacts from nuclear generation. The high potential for nuclear cost overruns and delays in construction, as well as continued hikes in natural gas prices could be avoided or abated (i.e. no nuclear new build and just refurbishment) by deploying the full “achievable” potential of renewable technologies and CDM. Avoidance of uncertainty and unfamiliarity associated with renewables, CDM, and a distributed system will forego their proven benefits in similar jurisdictions in terms of increased employment and income opportunities, as well as greater local governance for the creation of a durable culture of conservation. Fails to take opportunity to reduce significant adverse effects/risks associated with large nuclear and low-efficiency gas components through maximization of opportunities for CDM, low-impact renewables and cogeneration.	for such a design, increased land fragmentation, and higher transmission costs. The choice of pursuing a system (and technologies) largely unfamiliar to Ontario could result in societal and institutional doubt with regards to its feasibility, as well as mistakes that could be avoided with the deployment of familiar technology. Attempts to avoid/reduce adverse effects from nuclear and gas components, while maintaining elimination of coal.	
Are any trade-offs proposed where stronger mitigation efforts would be feasible? Would any proposed trade-off displace significant adverse effects from the present to the future (and would this trade-off be unavoidable without displacing more serious adverse effects to the future)?	Plan transfers significant risks/costs onto future generations, particularly with respect to large nuclear component. High path dependency limits future system options, waste (upstream and downstream) and decommissioning risks and liabilities transferred to future generations. Potential for coal phase-out be achieved without large commitment to nuclear not fully developed. The trade-off of nuclear new build, and its associated financial stress on provincial taxpayers and ecological degradation, and proliferation of dangerous materials, for reliable baseload that reduces GHGs is accepted in spite of other feasible options.	The trade-off of a system reliant on distributed renewable generation and maximized CDM, that has not yet been realized in Ontario, for increased socio-ecological integrity, greater employment and governance opportunities as well as intra- and intergenerational equity, maximizes mitigation efforts to the extent realized in similar jurisdictions.	

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Criterion	IPSP	Renewable is Doable	Comments
	These feasible options would include only refurbishing nuclear plants in order to avoid the full brunt of the above impacts while maximizing the full potential of energy demand reduction through CDM, and filling in required baseload capacity with renewables and imported hydro. This would also leave open the option of phasing out nuclear power altogether in the future. The above trade-off displaces significant financial and ecological upstream and downstream impacts of nuclear and, to a lesser extent, gas to future generations. It also displaces significant requirements for managing waste fuel, of which there is currently no feasible plan. Finally, the trade-off of path dependency for perceived feasibility deprives future generations of determining a viable system based on renewable energy and corresponding employment, governance, and industrial opportunities.	This trade-off does not displace negative effects from the present to the future. Vulnerability to political risk from policy shifts related to CDM and renewables, particularly at the provincial level. Stronger policy commitments/institutionalization in these areas may mitigate risks.	
Have the proposed trade-offs been discussed in and accepted through an open, participative process?	No.	No – although these were discussed internally through the development of proposal.	
Has each proposed significant trade-offs been explicitly and adequately justified by the proponent of the trade-off?	No.	No – although most key trade-offs associated with IPSP are avoided.	

A4.3 Key findings and implications from the illustrative sustainability-based comparison of the IPSP and Renewable is Doable options

The pursuit of a sustainable power system has the objective of multiple, durable and mutually reinforcing gains in progress towards sustainability arising from the interdependency of its components. This assessment has evaluated potential gains in sustainability based on the expected contribution of the IPSP and RisD plan options in light of sustainability criteria. The criteria are based on Gibson's eight generic criteria – socio-ecological integrity; livelihood and sufficiency; intragenerational equity; intergenerational equity; resource maintenance and efficiency; socio-ecological civility and democratic governance; precaution and adaptation; and immediate and long term integration – specified for the case and context of integrated power system planning in Ontario. To permit comparison the evaluation of the IPSP has been presented alongside an evaluation of the alternative supply mix scenario(s) outlined in the RisD report.

This assessment shows that the IPSP provides certain contributions to sustainability, most notably those stemming from moderate increases in CDM and renewable sources, and the phase-out of coal-fired generation by 2014. Overall, however, the IPSP does not maximize gains in the above criteria areas, largely because of its basis in nuclear power generation and its failure to pursue the full achievable potential of CDM and renewable energy. The findings suggest that power system planning using a more comprehensive set of sustainability criteria than that used by the OPA would point to a quite different package of plan components and overall plan than the OPA has proposed in its IPSP. By comparison the RisD option offers significant advantages from a sustainability perspective, enhancing the key sustainability gains that would be provided by the IPSP, while avoiding the undesirable trade-offs associated with the IPSP's large nuclear component.

The research points to four key areas of weakness in the IPSP as proposed.

1. Failure to pursue achievable CDM potential

The failure to pursue full achievable potential to reduce electricity demand and consumption via CDM measures undermines the performance of the IPSP in light of all eight criteria for sustainability. Reductions in energy demand and consumption reduce or eliminate socio-ecological system and health impacts, including long-term externalities associated with power generation and transmission. CDM is also more employment intensive than supply options and failure to maximize its potential forgoes long-lasting livelihood opportunities across the province. The full deployment of CDM measures is key to augmenting overall economic productivity and efficiency by eliminating the need for more expensive supply resources. It would also contribute to the maintenance of the resource base for the future. In addition, CDM emphasizes local governance over the use of market and social mechanisms to reduce demand, thereby fostering a locally driven culture of conservation. Finally, CDM increases the resilience and adaptive capacity of the system by reducing path dependency and vulnerabilities associated with fuel and generation technology related market and geopolitical risks. All of these advantages of CDM deployment benefit both present and future generations.

2. Failure to consider risks and impacts of technologies on lifecycle basis

Lifecycle analysis of the energy generation technologies employed in the IPSP is critical for understanding the full financial and environmental costs associated with their deployment. This is particularly relevant with regards to weighing generation options in terms of their adverse effects/risks and their advantages/benefits. Nuclear and natural gas generation both incur considerable upstream (before generation) and downstream (after generation) impacts, which have not been included in the IPSP and present a significant impediment to the sustainability of the system as a whole. Uranium mining is the cause of the most severe of the upstream damages and risks due to long-term effects on or threats to terrestrial and aquatic habitats as well as human health. Nuclear power results in very long-term downstream environmental, safety, security and weapons proliferation risks, including those associated with nuclear fuel waste. Natural gas extraction and processing cause upstream landscape, groundwater, and atmospheric impacts. These could be exacerbated as the supply shifts from conventional to unconventional sources of gas. The absence of lifecycle analyses of generation technologies obscures the advantages of renewable sources in terms of their lower or negligible of fuel cycle costs and minimal upstream and downstream impacts.

3. High path dependency and low adaptive capacity, due to high reliance on nuclear power

A system built around a large nuclear component will be "locked-in" to its design for several generations to come. This is due to the large, centralized, and non-modular nature of the main new facilities, which are expected (perhaps unrealistically) to have 70+ year facility planning and operational lifecycles. High path dependency of nuclear severely limits the system's capacity to adapt to changing circumstances and respond to problems and opportunities as they arise. Path dependency increases system vulnerability to grid upset from individual facility failures and to potential fuel supply shortages and price volatility. Furthermore, opportunities are foregone for incremental adjustment to shifts in societal concerns or priorities, public policy, technological advances, and grid innovations related to renewable energy. Choosing to pursue a nuclear-based system denies multiple generations to come a range of potential energy futures, in particular, those that are free of non-renewable resources and their corresponding costs and risks. Present and future generations will also be divested of the economic, industrial, and local governance development associated with an energy future founded on distributed renewable generation and CDM.

4. High economic risk due to the large nuclear component.

High financial risks related to nuclear construction, waste management, and decommissioning liabilities, as well as natural gas price volatility are major impediments to the economic sustainability of the IPSP. Past experience in Ontario has shown that nuclear projects have been plagued by cost overruns and construction delays, significantly increasing their overall cost. This is coupled with the fact that the IPSP does not retain the option of canceling or abandoning individual nuclear projects if they run over budget or behind schedule, or in the event of project failure (e.g MAPLE). Any extra costs that have not been factored into nuclear cost analyses have been, and will continue to be, absorbed by rate and taxpayers. There is substantial uncertainty about the costs of waste management and decommissioning liabilities and the OPA has completely omitted these critical aspects of nuclear power from the IPSP. If these costs were estimated and factored into the price per kWh of nuclear generation, the result would be a much different picture of the potential full cost and how the plan would impact the Ontario economy. Finally, increased uranium prices serve to highlight market risks stemming from concern over the long-term supply of high-grade uranium ore. This is compounded by peaking supply of Canadian natural gas (long-term supply concerns) and short-term price volatility. Should these trends continue through the plan period, they would have a significant impact on the overall cost of the IPSP.

Meaningful consideration of sustainability requirements would avoid these deficiencies. The analysis here suggests that a plan based on careful application of comprehensive, sustainability based criteria specified for power system planning in Ontario would differ substantially from the IPSP. It would support coal phase-out as in the IPSP, but in contrast to the IPSP would favour a system promising important additional sustainability benefits arising from a quite different package of plan components:

Fewer and less significant adverse present and future effects on socio-ecological integrity within and beyond Ontario achieved by pursuing the province's maximum achievable CDM potential, and increasing reliance on renewable supply resources that avoid the major upstream and downstream biophysical and social effects and the ecological, economic and political risks associated with uranium, coal and natural gas fuel cycles.

Increased system resilience, reliability and adaptive capacity and reduced cost risks achieved by placing greater emphasis on adding supply resources incrementally and employing technologies that have shorter planning and construction timelines (less than 5 years) and that can be deployed on a modular and distributed basis.

Greater system efficiency and cost-effectiveness achieved by reducing the role of low-efficiency uses of natural gas (e.g. single cycle gas turbines) though demand response measures and greater emphasis on high efficiency uses of natural gas, particularly cogeneration for intermediate and baseload supply.

Lower path dependency, fewer technological and economic risks, and greater adaptive capacity achieved by reducing the role of large centralized supply resources, particularly nuclear power plants, with long planning and construction timelines and long-facility lifetimes. Where nuclear resources are considered, refurbishment projects, with their lower path dependency, technological and economic risks, would be preferred over new build projects.

A plan with these characteristics, many of which are reflected in the *Renewable is Doable* proposal would still comply with the requirements of the Minister of Energy's June 2006 Supply Mix Directive. As the OEB has noted, the directive permits the IPSP to incorporate CDM and renewable components beyond the minimum levels specified in the directive. Similarly, the IPSP may limit the nuclear component to a level below the cap identified in the directive, while emphasizing high efficiency uses of natural gas.

Appendix 5

Authors and acknowledgements

Robert B. Gibson is a professor of Environment and Resource Studies at the University of Waterloo. He specializes in environmental policy issues, including decision making in environmental planning, assessment and regulation. His recent focus has been on the integration of broad sustainability considerations in land use decision making in urban growth management, corporate greening initiatives, special area management, and environmental assessments at the project and strategic levels. His book on *Sustainability Assessment* was published in 2005.

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