NATIONAL ROUND TABLE ON THE ENVIRONMENT AND THE ECONOMY
TABLE RONDE NATIONALE SUR L'ENVIRONNEMENT ET L'ÉCONOMIE

NRTEE Official Reports Copyright and Reproduction Notice

All **NRTEE Official Reports** ("Works"), provided on this USB memory key and identified in the **NRTEE Official Reports List** folder, contain their individual copyright and reproduction notice. The notice in each of these Works is replaced and superseded by the following copyright and reproduction notice, effective February 22, 2013:

> **© This Work is protected by copyright and made available for personal or public non-commercial use and may be reproduced, in part or in whole, and by any means, and may be further distributed for non-commercial use, without charge or further permission. All users are required to indicate that the reproduction, whether in part or in whole, is a copy of a Work of the National Round Table on the Environment and the Economy (NRTEE). Reproduction, in whole or in part, of this Work for the purpose of commercial redistribution is strictly prohibited. Furthermore, no right to modify or alter in any manner the Work is hereby granted.**

Consultant Reports Copyright and Reproduction Notice

All **Consultant Reports** ("Works"), provided on this USB memory key and identified in the **Consultant Reports List** folder, were prepared for, or commissioned by, the National Round Table on the Environment and the Economy ("NRTEE") in support of its research efforts, and may or may not reflect the views of the NRTEE. Such Works may not contain a copyright notice as they were not intended for public release when they were so prepared or commissioned. In the absence of a copyright notice, and where a copyright notice may in fact appear, the following notice shall be read together with the Work and, where applicable, replace and supersede any existing copyright notice, effective February 22, 2013:

> **© This Work is protected by copyright and made available for personal or public non-commercial use and may be reproduced, in part or in whole, and by any means, and may be further distributed for non-commercial use, without charge or further permission. All users are required to indicate that the reproduction, in part or in whole, is a copy of a Work of the National Round Table on the Environment and the Economy (NRTEE). Reproduction, in whole or in part, of this Work for the purpose of commercial redistribution is strictly prohibited. Furthermore, no right to modify or alter in any manner the Work is hereby granted.**

RATIONALE AND PRELIMINARY FAMILY OF NATIONAL INDICATORS FOR SUSTAINABLE ENERGY PRODUCTION AND USE

A DISCUSSION PAPER

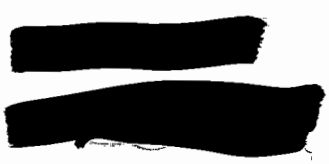
Submitted to:

The National Round Table on the Environment and the Economy

Submitted by:

Marbek Resource Consultants Ltd.
(Principal Author: George Matheson)
407-2211 Riverside Drive
Ottawa, Ontario K1H 7X5
Tel: 613-523-0784
Fax: 613-523-0717

August 1990



Marbek

CONTENTS

SECTION 1. INTRODUCTION

1.1 Background

The National Round Table on the Environment and the Economy (NRTEE) is developing performance indicators for sustainable energy production and use. As part of this process, the Round Table has commissioned a series of papers, of which this document is one. Specifically, this paper considers options for a preliminary family of macro-level, national energy indicators directed at senior decision/policy makers and the general public.

The pages that follow are intended to be a discussion starter. As such, this paper has deliberately been kept brief, and does not seek to address or resolve all issues relating to indicators development. Moreover, the paper does not address issues that are to be covered in companion documents being prepared for the NRTEE (specifically the issues of an overall conceptual framework, data availability, and the role of energy in economic performance and sustainable development).

Given the strict time and budget constraints under which this paper was prepared, and the fact that it is only a first step in a longer process, no external or peer review was undertaken prior to submission. Instead, the development of this paper consisted of an initial "brainstorming" meeting involving Marbek personnel, outside advisors, and NRTEE representatives; a limited literature review; preparation of a "Concepts Paper" for discussion at a second "brainstorming" meeting; and finally preparation of this paper.

1.2 Energy Indicators

It is widely accepted that we must transform our society into one that operates in accordance with the principles of sustainable development. Sustainable development indicators are conceived as a means of measuring our progress towards this goal (ie. the goal of bringing about a process of sustainable development).

The task of developing such indicators, however, is made complex by many factors, the most significant being the lack of agreement as to what sustainable development is (except at the most abstract level, as embodied in the Brundtland definition) and the challenging (if not impossible) task of selecting a manageable set of indicators that reliably reflect the extraordinarily complex nature of our society and economy.

Given this, it is useful to attempt to develop indicators for a more specific topic: sustainable energy production and use. In doing so it must be recognized that movement towards more sustainable energy production and use is only a component of progress towards the goal of sustainable development.

As is noted above, this paper focuses on "macro level" indicators; that is, indicators that suggest how Canada as a whole, or major elements of Canadian society, are doing with regard to the sustainability of energy production and use. This implies relatively aggregated data (which can be problematic in a country as large and diverse as Canada).

SECTION 2. GUIDELINES: CONSIDERATIONS IN THE SELECTION OF INDICATORS

Prior to identifying specific indicators, it is necessary to define the scope of discussion. For this purpose, the following guidelines are suggested:

2.1 Definition of an Indicator

The term "indicator" has come to mean different things to different people. On the one extreme, "... its meaning appears to have been expanded to the point where it is commonly used as a synonym for data."[1] Similarly, the term has found widespread usage in relation to state-of-the-environment reporting, where the collected data are often referred to as indicators.

For the purposes of this paper, however, a narrower definition has been adopted. Specifically, our indicators consist of only a few salient pieces of data which provide a general picture of the sustainability of energy production and use, as opposed to a detailed record. The difference between this definition of "indicator" and the broader usage is one of degree, not of kind, but it is an important distinction.

2.2 "Bottom Line" Indicators

The needs of the primary audiences (senior decision/policy makers and the general public) imply a need for indicators that present the "bottom line" -- that is, progress towards the goal of sustainable development rather than detailed analysis of contributing factors.

This is an extremely important point. There is a tendency to expect too much of indicators. For instance, many writers suggest that indicators should reflect the impact of specific policy initiatives. At least for the indicators under discussion here, we argue that this is both unrealistic and inappropriate. Indicators can tell us how we are doing, but should not normally be expected to tell us why a particular outcome has arisen. In other words, indicators are meant to be indicative rather than explanatory; they are not meant to be an analytical tool. Where indicators point to a failure to achieve a desired outcome, more detailed analysis to indicate the source of the failure is implied. Such analysis would no doubt require baseline and current data beyond that captured in the indicators as such.

2.3 Outcomes, Not Factors

Given the "bottom line" orientation just referred to, we believe the focus should be on indicators that measure outcomes directly (eg. energy use per capita) rather than those that measure contributing factors (eg. the penetration of specific technologies, government spending on conservation, etc.). That said, indicators that deal with such factors can be useful surrogates when data relating to outcomes is unavailable (a situation that is most likely to arise when relatively disaggregated data is required).

2.4 International Comparisons

The ability to make international comparisons is important as a means of making the indicators engaging, but is problematic. Such comparisons depend upon the availability of similar types of data in all countries with which comparisons are to be made, yet data availability varies from country to country. Moreover, even apparently similar data may not be directly comparable. Even where the data is technically comparable, structural differences in economies between countries may make comparison of absolute values inappropriate.

---

[1] Gélinas, Ron and Jan Slaats (1989). *Selecting Indicators for State of the Environment Reporting (Draft)*. SOE Reporting Branch, Environment Canada.

Thus, while the ability to make international comparisons is desirable, it should not be a requirement in the development of the first generation of energy indicators (see point 2.8 below). In the longer term, comparisons of rates of change in key indicators will likely be more meaningful than absolute values, at least in the case of macro-level data.

2.5 Indicators or Indices?

It is theoretically possible to combine or aggregate data from a series of indicators to produce a dimensionless index of sustainability (similar in some respects to the Dow Jones industrial average or to air pollution indices). While the development of a single index of the sustainability of energy production and use is an attractive idea in principle, it too is problematic in practice. First, it is debatable whether a reasonable index of this sort could be defined (and unlikely that such an index, if defined, would have sufficient credibility to be useful). Moreover, unlike most common indices, "sustainability of energy production and use" is an abstract concept that is likely to be less well understood than its component parts. Finally, as is pointed out by various authors, the methodological challenges in aggregation, such as the risk of double counting, are significant.

In view of all of the above, the goal in developing the first generation of energy indicators should not include the development of an aggregated index.

2.6 Indicators, Not Targets

Energy indicators should, as has been discussed, indicate how we are doing with regard to sustainability of energy production and use. Over time, indicators should not only tell us "where we are", but also how quickly we are moving towards or away from the general goal of sustainable development. It is equally true that indicators alone can not tell us whether the current situation or the rate of change is satisfactory. In order to make this judgement, targets need to be established -- targets for both the end point and the rate of change.

That said, the establishment of targets is clearly a separate issue from the development of indicators. As such, the question of targets is not discussed further in this paper.

2.7 Data Availability and Credibility

At the risk of stating the obvious, it is worth noting that the indicators selected must meet a number of criteria, including the following:

- The required data must be available or it must be reasonable to assume that the data could be acquired
- The data must be inherently credible (scientifically sound)
- The data must be a reliable indicator of larger trends (ie. it must provide meaningful information on the characteristic it seeks to represent).

Clearly, the indicators selected must also be readily understood by the target audiences -- decision/policy makers and the general public. To the degree they are understood, the indicators will inform, influence decision-making, and enhance the accountability of decision-makers regarding progress towards sustainability. The general point -- the need for the indicators to be understandable -- reinforces the need for simplicity suggested by several of the points previously made.

2.8 An Iterative Process

Finally, the development of the family of energy indicators should be an iterative process, improving over time. Demanding perfection prior to initial adoption would likely ensure that no proposals are ever accepted. The history of the development of macro-level environmental

indicators (a complex but probably simpler task than developing indicators of sustainability) supports this conclusion: although considerable effort has been applied, there are few results.[2]

Development of a family of indicators on an iterative basis, on the other hand, would allow data collection and publication to begin in the near term, in parallel with the development of the next, improved generation of indicators. This process produces tangible results in a reasonable time frame, and allows actual experience with the first generation of indicators to shape future generations.

SECTION 3. A FRAMEWORK FOR SELECTING ENERGY INDICATORS

Based in part on the guidelines presented above, this section outlines a framework for a family of indicators.

3.1 Sustainable Development

"Sustainable development" is a larger concept than "environmentally and economically sustainable development", in that the latter does not necessarily consider social, cultural, ethical, or political sustainability. Thus, it could be argued that indicators of sustainability in energy production and use should look beyond the economic and environmental dimensions to consider factors such as social equity. However, it is our view that indicators that address such issues are more appropriately and practically associated with indicators of sustainable development in general, and as such we do not propose such indicators for energy specifically. In other words, our indicators focus on the narrower topic of environmental and economic sustainability of energy production and use.

While the economic and environmental dimensions of sustainability are interlocked, organizationally it is useful to consider these two aspects separately.

3.2 Environmental Sustainability

First, we believe that two generic characteristics of energy production and use must be considered in order to measure *environmental* sustainability (or, more precisely, changes in each of these two characteristics must be considered in evaluating progress towards the goal of environmentally sustainable energy production and use). The characteristics are:

1) Quantity of energy produced and used
2) Environmental impact per unit of energy production or use.

It is our view that, over time, changes in the data showing declining energy use and declining environmental impact per unit would clearly indicate progress towards sustainability, provided the economic indicators outlined below show similar trends.[3] We therefore propose to develop indicators to measure the two characteristics; our proposed indicators are listed in Section 4.

---

[2] See, for instanoe, VHB Research & Consulting (1989). *Indicators and Indices of the State of the Environment.* Prepared for Environment Canada and Statistics Canada. The authors also note that "...the traditional approach to developing environmental indicators has been too concerned with coverage and not enough with convenience, too much with theory and not enough with utility."

[3] This statement should not be seen as implying that the goal of sustainable development requires energy use to decline, ultimately, to zero. What the statement does imply, however, is that our energy consumption could be reduced significantly without imposing unacceptable costs, and that doing so would enhance sustainability.

3.3 Economic Sustainability

The characteristics which must be considered in order to measure the economic sustainability of energy production and use are less obvious than those for environmental sustainability. As a point of departure, we would argue that:

- Macro-level indicators of the performance of the economy as a whole, while theoretically pertinent to the issue at hand, are nevertheless an inappropriate component of the required family of energy indicators. First, traditional economic indicators do not measure sustainability. Second, even if adequate indicators of sustainability of the economy as a whole were to be developed, it does not necessarily follow that they would provide useful guidance concerning the sustainability of any particular component of the economy (such as energy production and use).

- At the other end of the spectrum, indicators that focus on the health of the energy industry would also be an inappropriate component of the family of indicators -- most fundamentally because *apparent* health of the industry is influenced by a host of factors that are unrelated to long-term economic sustainability (such as the macro-economic policies of the government of the day or politics in the Middle East).

Implicit in the above two points is the suggestion that the required indicators of economic sustainability should focus on the resource base supporting energy production and use, rather than on the somewhat volatile industry and economy that is built on that base. Specifically, we suggest that two generic characteristics be considered for indicator development:

1) Long term resource availability
2) Energy productivity of the economy.

These two characteristics require elaboration. Long term resource availability refers to the "life expectancy" of the energy sources in use. In principle it should reflect characteristics such as reserves of non-renewable resources, extent of use of renewable resources, and less tangible variables such as national self sufficiency. Energy productivity of the economy refers to the economic "mileage" we derive from our energy resources.

It is our view that, over time, changes in the data showing increases in long term resource availability and in energy productivity of the economy would indicate progress towards sustainability in energy production and use, provided the environmental indicators outlined above show similar trends. We therefore propose to develop indicators to measure these two characteristics; our proposed indicators are listed in Section 4.

3.4 Summary and Qualifications

In summary, it is suggested that the proposed family of indicators of environmentally and economically sustainable energy production and use could consist of indicators that measure: the quantity of energy produced and used; the environmental impact per unit of energy production or use; long term resource availability; and the energy productivity of the economy.

These characteristics are somewhat different than those suggested by the Round Table as an initial list for consideration in the development of the indicators. However, the characteristics suggested here incorporate the Round Table suggestions, albeit within a revised and expanded framework.

It is, of course, possible to debate whether our proposed characteristics adequately describe sustainability, but a more significant problem arises in the attempt to find indicators that adequately address certain of the characteristics. This is the focus of the next section.

SECTION 4. SELECTION OF INDICATORS

For each of the four characteristics outlined above, this section includes an exhibit that provides:

- A brief discussion of key conceptual issues
- A listing of recommended indicators
- A short "shopping list" of other possible indicators
- A list of selected methodological issues requiring consideration.

For each of the recommended indicators, a series of options for disaggregation is also presented. There is no intended implication that all of the listed options should be a part of the "family" of indicators; the degree to which disaggregated data is required deserves further consideration.

Canada imports and exports large quantities of energy, which complicates development of a number of the required indicators. For clarity of presentation, therefore, the four exhibits just described focus on domestic energy use and on that portion of our energy production that serves domestic needs. A fifth exhibit considers indicators that are concerned with the portion of our production that is exported. (It is worth noting that the policy responses to unsustainable domestic energy use may be entirely different from the responses to unsustainable energy exports; separating export-related indicators in this way might therefore be considered logical as well as convenient.)

EXHIBIT 1

CHARACTERISTIC: QUANTITY OF ENERGY PRODUCED AND USED[4]

DISCUSSION:

As noted above, this exhibit focuses on domestic energy usage; the question of additional production for export is addressed in Exhibit 5.

Two specific issues warrant discussion:

1. Primary vs. secondary energy usage

The term primary energy refers to energy commodities at the point of production, whereas secondary energy refers to energy as delivered to the point of use. In principle, indicators of energy usage could use either primary of secondary energy data.

In part because there are methodological issues associated with how primary energy is calculated, but more importantly because data relating to energy at the point of use is likely to be more meaningful to most users of the indicators, use of secondary energy data is recommended (Indicators 1.1 & 1.2 below). However, because the relationship between primary and secondary energy is not constant (overall, the efficiency of the conversion is declining), it is also appropriate to include an indicator that addresses the primary/secondary ratio (Indicator 1.3 below).

---

[4] This characteristic encompasses two of the areas identified by the NRTEE for indicator development (efficient end use and efficient conversion from source to end use).

2. Intensities

In addition to indicators that reflect total energy use (Indicator 1.1 below), it is useful to include indicators that reflect energy intensity (for instance, energy use per capita). Such intensities (Indicator 1.2 below) provide an improved picture of our energy use, but have an inherent limitation. Specifically, they do not measure changes in the variable used to define the intensity. For instance, if energy use per passenger-kilometre was selected as an indicator for the transportation sector, it would tell us something about the technical efficiency of our transportation system but not about changes in the number of passenger-kilometres (which could have as much impact on sustainability as technical efficiency).

This problem is inherent in the use of intensities as indicators, but we do not believe it precludes their use. It does imply, however, that any intensities chosen must be carefully considered. For instance, for the present purposes, a more appropriate measure of intensity in the passenger transportation sector might be energy use per capita. This indicator tells us how we are doing, overall, in the sector -- which, as noted above, energy use per passenger-kilometre does not. It is true that energy use per capita does not tell us why changes are occurring, but we have argued in Section 2.2 that we should not expect our indicators to do so.

In fact, it is appealing to consider the use of per capita data to indicate intensities in all energy using sectors, in part because this would conceptually simplify the family of indicators. However, energy use in some sectors is heavily influenced by import/export activity; in these cases, per capita indicators have the potential to mislead (unless the data is manipulated to correct for this factor).

(Note: One commonly used intensity figure relates energy use to GDP. This relationship is addressed in Exhibit 4.)

PROPOSED INDICATORS:

INDICATOR 1.1:	ENERGY USE
Indicator:	National energy use (GJ)[5]
Disaggregation:	Regional use (GJ)
	Sectoral use (GJ)
INDICATOR 1.2:	ENERGY INTENSITY
Indicator:	National energy use per capita (GJ/capita)
Disaggregation:	Regional intensity (GJ/capita)
	Sectoral intensity:
	. Residential (GJ/capita)
	. Transportation (GJ/capita (passenger) and GJ/tonne-kilometre (freight))
	. Commercial (GJ/m^2 floor space)
	. Industrial (GJ/dollar produced)
INDICATOR 1.3:	EFFICIENCY OF PRIMARY/SECONDARY CONVERSION
Indicator:	National secondary/primary ratio (dimensionless)
Disaggregation:	Secondary/primary ratio by energy source (dimensionless)

[5] For convenience, gigajoules (GJ) are used as the standard energy unit throughout this paper.

OTHER POSSIBLE INDICATORS:

1. A number of indicators that do not relate directly to energy usage are sometimes proposed (for instance, penetration rates for energy conserving technologies, program expenditures, etc.). No such indicators are proposed here, given the premise outlined in Section 2.3 of this paper and the fact that available energy data would provide adequate and more pertinent information to the intended audience.

2. For Indicator 1.2: Various other disaggregated indicators are available, such as sectoral energy use per capita for the sectors where this is not already proposed (but see discussion above); GJ/household for the residential sector; etc.

SELECTED METHODOLOGICAL ISSUES:

1. Valuing of various energy sources in the calculation of primary energy (for instance, in such calculations hydroelectricity has traditionally been treated as if the power had been generated from coal -- a practice many analysts consider questionable)

2. Validity of data for both primary and secondary energy.

EXHIBIT 2

CHARACTERISTIC: ENVIRONMENTAL IMPACT PER UNIT OF ENERGY PRODUCED/USED

DISCUSSION:

As noted above, this exhibit focuses on domestic energy use; the question of the impacts of *additional* production for export is addressed in Exhibit 5.

Of the four characteristics for which indicators are proposed, environmental impact per unit of energy used is perhaps the most complex. Impacts to be considered include wastes produced, emissions, land-use issues, ecosystem stresses, etc.; these impacts must be considered for all stages of energy production and use.

As a result of this complexity, our recommended approach to the selection of indicators is to identify a set of major impacts which, because of their significance, could be considered indicative of overall impact. This approach has the virtue of reasonable simplicity, but conversely introduces the possibility of misrepresentation, given the wide range of environmental impacts that are necessarily ignored. (Note: Two alternative approaches were considered; see "Other Possible Indicators", below.)

An important methodological issue must be considered, whatever general approach is adopted. As is suggested above, the indicators selected must in principle reflect both the impacts of using energy and the upstream impacts of producing and delivering it. However, some of the upstream impacts occur outside Canada (for those energy commodities that we import), while some of the impacts that occur inside Canada are not attributable to Canadian energy use (for those commodities that we export).

The implied data problem is more apparent than real, however. While *aggregate* production impact data will not necessarily reflect accurately the impacts associated with domestic use, the required indicator deals with impact *per unit* of energy. Canadian averages for impacts

per unit of production can therefore be used as approximations in the suggested indicators. (This implies acceptance of two simplifying assumptions: that the average production impacts of energy produced for export and for domestic use are the same, and that average impacts of production are the same inside and outside Canada. These assumptions can be challenged, but we believe they are appropriate for at least the first generation of indicators.)

PROPOSED INDICATORS:

Selection of the "set of major impacts which...could be considered indicative of overall impact" requires more consideration than can be given in this short paper. The following is therefore a preliminary list of possibilities rather than a firm recommendation:

INDICATOR 2.1 GREENHOUSE GASES
Indicator: Greenhouse gases released per GJ of energy used (Tonnes of CO_2 equivalent/GJ)
Comment: Must account for releases during production, transportation, and use; should include at least CO_2, N_2O, and methane data, adjusted to CO_2 equivalence (vis a vis impact on global warming)

INDICATOR 2.2 OTHER AIR EMISSIONS (SO_x, NO_x, VOC, particulate, other?)
Indicator: Aggregate emissions per GJ of energy used (Adjusted tonnes/GJ)
Comment: Must account for releases during production, transportation, and use; weighting of various emissions is required.

INDICATOR 2.3 WASTE GENERATION (High and low level radioactive waste, mine tailings, refinery waste, ash, emission control wastes, etc.)
Indicator: Annual generation of wastes per GJ of energy used (Adjusted tonnes/GJ)
Comment: Must account for wastes generated during production, transportation, and use, but production wastes will predominate; weighting of various wastes is required.

INDICATOR 2.4 AREA OF LAND AFFECTED BY ENERGY PRODUCTION
Indicator: Land area committed to energy production per GJ of energy used (Adjusted hectares/GJ)
Comment: Weighting of different energy related land uses is required, based on nature of use (e.g. pipeline vs open pit mine) and sensitivity of land (e.g. tundra vs urban)

DISAGGREGATION: Each of the above indicators could, in principle, be disaggregated by energy source and/or regionally (or bioregionally).

OTHER POSSIBLE INDICATORS:

1. Alternatives or additions to the specific indicators listed above include effluents discharged to water, marine spills, occupational health and safety statistics, etc.

2. As an alternative approach, the use of surrogate indicators (such as investment by industry in abatement ($/GJ) and compliance record vis a vis environmental and occupational health and safety legislation) was considered, but rejected as providing less detailed and reliable information than the recommended approach set out above.

3. Use of an "impact index" was also considered. This concept involves the calculation of an index for each particular energy source, and the tracking of changes in that index over time. (Ideally, the indices for different energy sources would be comparable, allowing aggregation; at least in the near-term, however, this seems unrealistic.)

The index might be developed as follows:

- For each energy source, a group of independent experts would be asked to identify the key environmental impacts; to assign relative weights to each (weight should reflect the importance of the *type* of impact, not the extent of the impact); and to identify measurable variables that would allow monitoring of the extent of each identified impact (on a national basis).

- At any given time, the index could be calculated for each energy source, based on the agreed upon weights (which would be fixed) and the measured extent of each impact (which would vary).

Such an impact index would, in principle, be an appropriate indicator of overall environmental impact, and could be readily converted to identify impact per unit of energy produced/used. In our view, however, development of such an index is probably impossible in the near term, due in part to the difficulty of arriving at agreed upon weights. (A similar but, we believe, less challenging problem is associated with Indicators 2.1 -2.4).

SELECTED METHODOLOGICAL ISSUES:

1. Adequacy of emissions, waste, and land use data and/or of our understanding of its significance

2. Relative weighting of different emissions, wastes, and land uses.

EXHIBIT 3

CHARACTERISTIC: LONG TERM RESOURCE AVAILABILITY[6]

DISCUSSION:

At any given time, long term resource availability is a function of a number of factors, including:

- Levels of energy consumption
- The mix of energy sources (renewable and non-renewable)
- The economically accessible reserves of each non-renewable resource, which in turn is dependent on physical reserves, current energy prices, and technology.

In other words, long term resource availability will increase as a result of 1) declining energy consumption; 2) changes in the energy mix towards renewables and/or towards those non-renewables with relatively large reserves; and 3) increases in economically accessible non-renewable reserves. Any indicator developed to measure long term availability should therefore address all of these factors.

One indicator that achieves this goal is: the portion of our energy consumption that is met by sources that are either renewable or have reserves adequate to meet current levels of Canadian

---

[6] This characteristic encompasses one of the areas identified by the NRTEE for indicator development (sustainable supply -- energy mix/timely conversion to sustainable sources).

use for more than a given number of years (say 50 years). Because of its conceptual simplicity, this is the indicator we recommend below.

Calculation of reserves is perhaps the major methodological challenge associated with this indicator. Reliance on supply curves that plot reserves against price offers one option. Using these curves as a tool, the approximate life expectancy of each non-renewable energy resource can be calculated based on current annual Canadian usage and current energy prices (or other prices, as appropriate).

As noted above, this exhibit focuses on domestic energy use; the question of *additional* production for export is addressed in Exhibit 5. However, in calculating the available reserves at a given energy price, the it may be appropriate to reduce the reserves by the amount of any *committed* exports.

Finally, there are other dimensions to the question of resource availability, including national self-sufficiency, regional self-sufficiency, and security of supply. In fact, the indicator proposed here directly measures long term national self-sufficiency and could, through regional disaggregation, address the question of regional self-sufficiency (an important issue given the size of Canada and the great variation in energy resources across the country). The question of security of supply is not covered.

PROPOSED INDICATORS:

INDICATOR 3.1	PROPORTION OF ENERGY USE MET BY ABUNDANT RESOURCES
Indicator:	Proportion of energy use met by resources that are renewable or have reserves adequate to meet current levels of Canadian use for more than (say) 50 years (%)
Comment:	Reserves should be determined based on current energy prices. A second version of this indicator could incorporate reserves available at higher energy prices (say 125% of current)
Disaggregation:	Regional proportion (%) Sectoral proportion (%)

OTHER POSSIBLE INDICATORS:

1. An indicator of energy "richness" -- a measure of the diversity of energy sources making a significant contribution to Canada's energy balance

2. An indicator of security of supply, particularly on a regional basis. The indicator might address oil storage and delivery capacity, vulnerability of electrical transmission and generation, etc. Note, however, that security of supply is more related to short run dislocation than to long term sustainability.

SELECTED METHODOLOGICAL ISSUES:

1. Reliability of data concerning reserves

2. Definition of renewability (particularly given that existing data concerning renewable energy use does not distinguish sustainable from non-sustainable usage)

3. Selection of primary or secondary energy data.

EXHIBIT 4

CHARACTERISTIC: ENERGY PRODUCTIVITY OF THE ECONOMY

DISCUSSION:

A somewhat traditional indicator of the energy productivity of the economy is the size of the Gross Domestic Product (GDP) per GJ of energy consumption. This is not an ideal indicator because the GDP itself is imperfect -- but the wide acceptance and use of GDP suggests that it serve as at least an initial basis for the required energy productivity indicator.

It is worth noting that one of the important criticisms of the use of GDP in energy analysis is of limited significance in the present context. According to Schipper, for instance, "...use of the energy-GDP ratio can give very misleading signals about changes in energy efficiency."[7] The reason for Schipper's conclusion is that factors other than (technical) efficiency influence the ratio -- most importantly, structural changes in the economy. For our purposes, however, it is in fact desirable that the indicator reflect these structural changes.

PROPOSED INDICATORS:

INDICATOR 4.1	ENERGY PRODUCTIVITY
Indicator:	Real Gross Domestic Product per GJ of energy consumption ($/GJ)
Disaggregation:	Regional ratio ($/GJ)
	Sectoral ratio ($/GJ)

OTHER POSSIBLE INDICATORS:

1. Percentage of GDP spent on energy (production and use)
2. A national primary/tertiary energy ratio (tertiary energy refers to the amount of useful work actually done by the energy delivered to users).
3. For Indicator 4.1: Use of a different economic indicator, such as employment or an improved GDP-type indicator (when it becomes available).

SELECTED METHODOLOGICAL ISSUES:

1. Selection of appropriate GDP data
2. Treatment of the energy contribution to GDP.

EXHIBIT 5

CHARACTERISTIC: INDICATORS ASSOCIATED WITH ADDITIONAL PRODUCTION FOR EXPORT

DISCUSSION:

Because Canada imports and exports large quantities of energy, there are significant differences between levels of energy production and of domestic energy use. In Exhibits 1-

---

[7] Schipper, Lee (1990). *Energy Saving in the U.S. and other Wealthy Countries: Can the Momentum be Maintained?* International Energy Studies, Lawrence Berkeley Laboratory.

4, indicators associated with the domestic market (including production and use) were proposed. This exhibit considers indicators associated with *additional* production for export.

In principle, such indicators should address the same characteristics as the indicators proposed for the domestic market (i.e. the quantity of energy; the environmental impact per unit of energy; long term resource availability; and the energy productivity of the economy). Each of these is addressed in turn below.

1. *Quantity of energy produced or used*

On a global basis, energy production levels are ultimately dependent on usage (although there is of course a feedback loop: supply influences price which influences demand). Moreover, from a global perspective the question of whether a given use is supplied from a foreign or domestic source is of secondary importance when considering *long term* sustainability.

Nevertheless, from the Canadian perspective, additional production for export is of consequence, and the impacts on sustainability from a national perspective are clearly related to the scale of the activity. Therefore, an indicator measuring additional energy production for export is required. Specifically, we propose an indicator that addresses *net exports* rather than gross, for two principal reasons. First, this "fits" with the indicators proposed in the previous exhibits, whereas a measure of gross exports would produce double counting within the family of indicators. Second, it is appropriate to regard off-setting imports and exports as convenient commercial arrangements rather than as factors to be considered in assessing sustainability.

Note that the indicator presented below refers to net energy exports. However, although Canada is a net exporter of energy at the aggregate level, this might not always be so. Moreover, at the level of individual commodities, considerable fluctuation in our import/export situation can be expected over time, and some regions of the country depend heavily on imported energy supplies. From this it follows that the net exports indicator could in some cases be a negative value.

2. *Environmental impact per unit of energy*

The same generic indicators outlined in Exhibit 2 (greenhouse gases, other air emissions, etc.) can and should be used to address the impacts of energy production for export. However, the actual data would require refinement to exclude the components of each impact associated with energy use (as distinct from production, transportation and other upstream impacts).

3. *Long term resource availability*

The same generic indicator outlined in Exhibit 3 (proportion of energy use met by abundant resources) can be adapted to reflect the impact of net exports (or net imports) on long term resource availability. Specifically, the indicator would compare Canadian reserves to the sum of annual domestic use and net exports (imports).

4. *Energy productivity of the economy*

The question of energy productivity of the economy is largely unrelated to the question of net exports. As such, we suggest that no further indicator is required to address this characteristic.

NOTE: There is substantial conceptual similarity between the indicators below and those presented earlier, but the two sets of indicators do speak to an entirely different set of policy issues. Accordingly, it may be worth developing the proposals below as part of the second generation of the family of indicators.

PROPOSED INDICATORS:

INDICATOR 5.1:	NET ENERGY EXPORTS
Indicator:	Net energy exports (GJ)
Disaggregation:	Net exports by energy source (GJ)
INDICATORS 5.2 - 5.5	ENVIRONMENTAL IMPACTS
Indicators:	Same as Indicators 2.1 - 2.4 in concept; however actual data would be different as it should exclude impacts of energy use.
Disaggregation:	None suggested
INDICATOR 5.6	PROPORTION OF ENERGY PRODUCTION MET BY ABUNDANT RESOURCES
Indicator:	Proportion of energy production (domestic use plus net exports) met by resources that are renewable or have reserves adequate to meet current levels of Canadian use for more than (say) 50 years (%)
Disaggregation:	None suggested

OTHER POSSIBLE INDICATORS:

1. For Indicator 5.1: Use physical quantities of the energy commodities rather that GJ
2. Variants on the "Other Possible Indicators" presented in Exhibits 1 - 3.

SELECTED METHODOLOGICAL ISSUES:

1. Use of primary or secondary energy data.

SECTION 5. CONCLUSION

The ideas and indicators outlined above represent a point of departure for further discussion, elaboration, refinement and eventually testing. Throughout this development process, and particularly at the testing stage, the central question must be: do the indicators serve the central purposes they were designed for? Above all, do they have the ultimate effect of influencing energy policy in the direction of sustainability?

The answer to this will depend on many factors, of course. Are the indicators sufficiently compelling to trigger action? Are they ambiguous or are their implications readily understood (particularly given that all of the indicators will not always move in the same direction)? Are the conclusions suggested by the indicators consistent with "real world" experience? Is the scope of the indicators sufficiently broad, or should additional questions (such as global energy reserves) be addressed?

In fact, we believe that useful, high impact energy indicators can be developed. Combined with an effective delivery system, such indicators could undoubtedly play an important support role in the move towards sustainability.

General comments on the complete set of indicators follow.

a) Support for Preliminary Indicators

Workshop participants agreed that the preliminary set of indicators provided a useful basis for discussion and that work will be needed to develop a second generation set of indicators. Some indicators were better received than others, but improvements were suggested for many of the proposed indicators. Some were considered more useful at the sectoral or corporate level than at the national or macro level.

The two indicators receiving the highest level of support were those of sectoral energy efficiency (energy used per unit of product or service provided), and air emissions and waste (by category). Indicators of total energy use and diversity of the energy mix received moderate support. Participants felt it useful to know this information, but stated that these data by themselves were not indicators of sustainable development. Efficiency of energy conversion for the full fuel cycle also received moderate support as an indicator although it was cautioned that there may be difficult definitional and double counting problems.

There was a mixed reaction to proposed national indicators of energy intensity (energy use per capita) and energy productivity (GDP per unit of energy used). Some participants, particularly in the policy group, thought these two indicators could be useful within Canada to track economic reliance on energy. However, most participants, including energy suppliers and users, agreed these two indicators were inappropriate for international comparisons because they inaccurately portray Canada's performance regarding energy efficiency. This is because a large part of Canada's economy, particularly our export market, is tied to energy-intensive development of natural resources.

However, if these two indicators were used to evaluate trends and rates of change, they would be acceptable. The participants only disagreed with these indicators being used for direct comparisons among nations which could portray Canada as a profligate energy user when the cause of the disparity flows from different national economic bases. In the aggregate Canada could look bad, since forestry, agriculture, mining, and petroleum production and processing form the base of the economy. Less energy intensive economies based on manufacturing, services, and production for the domestic market would appear "better" because different activities are in fact being measured for energy use without examining the efficiency with which that energy is applied.

There was little support for an indicator based on the amount of land affected by energy development. There were questions raised about the usefulness of this indicator because of the variabilities regarding the degree, longevity, and risk of impacts. As well, there was little — if any — support for measuring the proportion of energy use met by less abundant resources because of high variability due to changing technology and market prices.

b) Energy Exports

There was moderate support for the preliminary indicators related to export proposed by Marbek. No agreement was reached on how to define and report energy export indicators.
Some participants argued that what is important is the overall level of energy production, efficiency of production and resulting environmental impact(s), whether energy is produced for export or not. They stated Canada did not need separate indicators for energy exports.

Others argued that because Canada provides energy and other natural resources to the rest of the world, Canada should explicitly state the amount of energy use, efficiency of production, and environmental impact(s) (e.g. greenhouse gas emissions) related to that export. Failure to do so could result in a distorted picture of Canada's performance regarding sustainable development.

Still others argued that if energy embodied in products destined for export had separate indicators, the energy embodied in imports should also be identified and net energy imported or exported used as the basis for these export indicators.

c) Additional Indicators

Several participants stated that the proposed set of indicators is based on available data and is not a complete list. The need for a more comprehensive list and supporting data was identified. Two additional areas where suggested:

- Water Quality and Use — e.g. water contaminants, water consumption, efficiency of water use, amount of water recycled;

- Socio-Economic Factors — e.g. jobs and other spin-off benefits provided by energy production and environmental clean-up, cost of environmental clean-up, economic health

of industry (e.g. cash flow, return on investment), intellectual capital, technology availability, quality of life considerations, human health considerations.

It was not clear from the discussion whether participants considered these indicators important at the national (macro) level or at the corporate/organization (micro) level or both.

d) Linking Micro Indicators with Macro Indicators

Participants identified about 50 micro indicators currently in use or being considered by corporations or organizations. The majority of these indicators could be linked to the proposed macro indicators. These obvious linkages confirm that there is a "real world" foundation for many of the preliminary macro indicators (Table 3). Those corporate/organizational level indicators which could not be linked to a proposed national indicator suggested a need for additional macro indicators (see sections on Additional Indicators and Contributing Factors). There were no indicators identified at the corporate/organization level that could be linked to national indicators dealing with energy export (Indicators 5.1-5.3).

It was suggested by several participants that attempts to systematically aggregate micro indicators from individual companies or organizations into macro indicators would pose unrealistic accounting problems. Micro indicators currently are in their very early formative stages and they are not yet standardized nor widely adopted within industry sectors. As well, many organizations are currently focusing on the actions required to integrate environmental considerations into business planning rather than on actual outcomes, which is the focus of the proposed macro indicators. Nevertheless, participants agreed that macro indicators should be sensitive to general changes measured through micro indicators and act as a national gauge of actions towards sustainable development at the corporate or organization level. The question was raised as to how to measure efficiency nationally, by product or sector. A private sector energy user participant in the government-industry program called Canadian Industry Program for Energy Conservation (CIPEC) suggested that CIPEC might be an existing avenue for accomplishing this.

e) Indicators of Contributing Factors

Many participants over the course of the two-day workshop identified a need to measure factors contributing to sustainable development outcomes rather than only the outcomes themselves, particularly at the micro level. Contributing factors were defined as the actions or policies required to achieve sustainable development. It was argued that indicators of contributing factors are more likely to motivate changes in behaviour at the micro level than are indicators of outcomes. Examples of contributing factors provided by workshop participants include:

- market penetration of energy efficient products
- market penetration of emission reducing technologies
- acceptance and implementation of procurement policies, such as energy efficiency and waste reduction
- acceptance and implementation of energy efficiency audits
- acceptance and implementation of environmental audits
- acceptance and implementation of demand side management programs by electric utilities
- investments in research and development
- acceptance and implementation of full cost and full cycle accounting methodologies

5.0 NEXT STEPS AND FUTURE DIRECTIONS

Workshop participants were asked to identify and discuss future directions in developing indicators of sustainable development in energy production and use. Key suggestions arising from these discussions follow.

5.1 Set National Framework

All small groups identified a need to develop a coherent national policy framework to help determine indicators of sustainable development. This would apply to all levels of indicators — national, regional, sectoral, corporate/organizational and individual. As part of this recommendation, participants recognized the importance of developing sustainability criteria which could be used to determine appropriateness and adequacy of indicators. This work could build on the sustainability criteria proposed by the policy group at the workshop and on other related work currently being done by the NRT.

The need to develop clearly defined goals or targets for sustainable development also was identified by workshop participants. Indicators could then be used to assess progress towards these goals. Noteworthy, however, is the widespread concern expressed about the process for defining criteria and goals. Participants stressed that definition of criteria and goals should not occur unilaterally or through bilateral negotiation but rather **through a consultative process involving all affected sectors.**

5.2 Continue to Develop National Indicators

There was solid support for having a set of national indicators of sustainable development related to energy production and use. All groups identified a need to more clearly define the preliminary set of energy indicators as discussed at the workshop. This would include reassessing and revising the indicators of energy intensity and productivity to place more emphasis on indicators of energy efficiency. Participants strongly suggested there is some urgency for accomplishing this so that it could be included as part of Canada's position for the United Nations Conference in Brazil in June, 1992. There was general agreement that indicators of water quality and socio-economic indicators needed to be factored into developing a comprehensive set of indicators.

5.3 Encourage Development of Micro Indicators

All small groups recognized the importance of developing micro indicators, particularly within corporations and organizations. It was suggested that these are the indicators most likely to motivate changes in individual and corporate behaviour and ensure accountability. Although workshop participants proposed few specific pilot projects on micro indicators, most of the energy suppliers and users represented at the workshop indicated they are beginning to define and develop performance indicators related to environment and sustainable development. Another suggestion to assist the development of micro indicators was for an ongoing exchange of information on indicators among the national, provincial and territorial round tables, government agencies (federal, provincial, municipal), industry and public interest organizations, such as consumer and environmental groups. One specific recommendation was to provide NRT's report on this workshop to the parties mentioned above and another was to set up a centralized information base on sustainable development indicators. Several participants stated that the workshop helped provide a context for their work on indicators and stimulated their thinking on the matter. The workshop also set the stage for future consultation.

5.4 NRT Role in Development of Sustainable Development Indicators

The National Round Table on the Environment and the Economy (NRT) was identified by all small groups as the body which should help provide the policy framework for indicators, promote the development and use of indicators and collaborate with other groups better suited to do the technical work. NRT is structured to draw on the expertise of several federal government departments, including the Departments of Environment, Finance, and Energy, Mines and Resources. Moreover, NRT is structured to include representatives of industry and environmental organizations, whose advice and support is essential. Also, NRT has ties to provincial and territorial round tables which provide avenues for public consultation. Finally, NRT advises the Prime Minister. Political support for the concepts of sustainable development is essential in setting the policy framework for national indicators.

APPENDIX 1

MEASURING SUSTAINABLE DEVELOPMENT: ENERGY PRODUCTION AND USE IN CANADA

Workshop Participants

Name/Nom	*Organization/Organisme*	*Location/Lieu*
Ed Bain	*Nova Scotia Department of Energy*	*Halifax, Nova Scotia*
Jay Barclay	*Energy, Mines and Resources*	*Ottawa, Ontario*
Grant Billing	*North Canadian Oils Ltd.*	*Calgary, Alberta*
Cheryl Bradley	*Western Environmental and Social Trends Inc.*	*Calgary, Alberta*
Liza Campbell	*NRT Secretariat*	*Ottawa, Ontario*
Don Dabbs	*Calgary Chamber of Commerce c/o Concord Environmental*	*Calgary, Alberta*
Len Delicaet	*Ernst and Young*	*Toronto, Ontario*
Ron Edwards	*Department of Finance*	*Ottawa, Ontario*
Jason Edworthy	*Nowester Energy Systems Ltd.*	*Calgary, Alberta*
Dawn Farrell	*TransAlta Utilities Corporation*	*Calgary, Alberta*
Charlie Ferguson	*Inco Ltd.*	*Toronto, Ontario*
Jane Hawkrigg	*Jane Hawkrigg Enterprises Ltd.*	*Bale D'Urfe, Quebec*
Tony Hodge	*University of McGill*	*Montreal, Quebec*
Helen Howes	*Ontario Hydro*	*Toronto, Ontario*
Pierre Marc Johnson	*NRT*	*Montreal, Quebec*
Jim Johnston	*Canadian Renewable Fuels Assoc.*	*Guelph, Ontario*
Diane Keefe	*Canadian Utilities Ltd.*	*Edmonton, Alberta*
Mike Kelly	*NRT Secretariat*	*Ottawa, Ontario*
Mel Kliman	*McMaster University*	*Hamilton, Ontario*
Jean Etienne Klimpt	*Hydro Quebec*	*Montreal, Quebec*
Linton Kulak	*Shell Canada*	*Calgary, Alberta*
Gordon Lambert	*Esso Resources Canada*	*Calgary, Alberta*
David Lightfoot	*Petromont*	*Montreal, Quebec*
Jim MacNeill	*NRT*	*Ottawa, Ontario*
George Matheson	*Marbek Resource Consultants*	*Ottawa, Ontario*
Kerry Mattila	*Canadian Petroleum Products Institute*	*Ottawa, Ontario*

Neil McIlveen	*Energy, Mines and Resources*	*Ottawa, Ontario*
Lynn Morrow	*Municipality of Toronto*	*Toronto, Ontario*
Ken Ogilvie	*Canadian Environmental Advisory Committee*	*Ottawa, Ontario*
John Peacey	*Noranda Minerals Inc.*	*Point Claire, Quebec*
Juri Pill	*Toronto Transit Commission*	*Toronto, Ontario*
Wayne Pushka	*Canada Mortgage and Housing Corporation*	*Ottawa, Ontario*
Tony Reinsch	*Canadian Energy Research Institute*	*Calgary, Alberta*
Mike Robertson	*PetroCanada*	*Calgary, Alberta*
Hans Rode	*National Energy Administration*	*Sweden*
Kenneth Rossi	*Ford Motor Company of Canada*	*Oakville, Ontario*
David Runnalls	*Institute for Research on Public Policy*	*Ottawa, Ontario*
Krishna Sahay	*Department of Finance*	*Ottawa, Ontario*
Robin Sinha	*Canada Mortgage and Housing Corporation*	*Ottawa, Ontario*
Tim Taylor	*PetroCanada*	*Calgary, Alberta*
Steve Thompson	*NRT Secretariat*	*Ottawa, Ontario*
Thorn Walden	*Energy Resources Conservation Board*	*Calgary, Alberta*
Alain Webster	*University of Quebec*	*Montreal, Quebec*
Leslie Whitby	*Environment Canada*	*Hull, Quebec*
Fraser Wilson	*Ernst and Young*	*Toronto, Ontario*
John Woodruffe	*Shell Canada*	*Calgary, Alberta*
Barry Worbets	*Husky Oil Limited*	*Calgary, Alberta*
Cynthia Praul Wright	*California Energy Commission*	*Sacramento, California U.S.A.*

APPENDIX 2

Measuring Sustainable Development:
Energy Production and Use in Canada

February 28 - March 1, 1991 Montreal, Quebec
Delta Montreal, 475 avenue President Kennedy

SUMMARY AGENDA

Thursday February 28th

7:30 a.m.	Registration and Continental Breakfast
8:30 a.m.	Introduction
9:30 a.m.	National Energy Indicators Overview of Discussion Paper Panel Discussion Plenary Discussion and Questions Small Group Discussions and Working Lunch Plenary Discussion and Synthesis
3:15 p.m.	Practical Links Between Macro and Micro Indicators Concurrent Workshops Plenary Progress Report
7:30 p.m.	Reception and Dinner

Friday March 1st

7:30 a.m.	Continental Breakfast
8:30 a.m.	Summary of Key Issues and of Progress
	Next Steps Concurrent Workshops Plenary Discussion and Concluding Remarks
1:00 p.m.	Lunch

Detailed Agenda

Thursday February 28th

7:30 a.m. — ***Registration and Continental Breakfast***

INTRODUCTION

8:30 a.m.

Workshop Chair: *Pierre Marc Johnson, Vice - Chair, NRT*

Opening Remarks: *Jim MacNeill, Senior Fellow, Environment and Sustainable Development Programme, Institute for Research on Public Policy, Ottawa*

Workshop Goals and Outcomes: *Fraser Wilson, Partner, Environmental Management, Ernst & Young*

NATIONAL ENERGY INDICATORS

9:30 a.m.

Overview of Discussion Paper: *George Matheson, Marbek Resource Consultants, Ottawa*

Panel Discussion:
Moderator: Pierre Marc Johnson

Panel: *Tony Reinsch, Canadian Energy Research Institute*

Mike Robertson, PetroCanada

Charlie Ferguson, INCO

Cynthia Praul Wright, California Energy Commission, U.S.A.

David Runnalls, Institute for Research on Public Policy

George Matheson, Marbek Resource Consultants

Break for Refreshments

Detailed Agenda

Thursday February 28th cont'd.

NATIONAL ENERGY INDICATORS cont'd.

Plenary Discussion: *Questions from the Floor*
Moderators: Pierre Marc Johnson

11:30 a.m. ***Small Group Discussions,*** *including,*
12:30 p.m. ***Buffet Style Working Lunch***
Facilitators: Jay Barclay, Cheryl Bradley, Kevin Brady, Jane Hawkrigg, Mike Kelly, Ken Ogilvie, Steve Thompson

1:30 p.m. ***Plenary Discussion & Synthesis:***
Moderators: Pierre Marc Johnson and Fraser Wilson

Break

PRACTICAL LINKS BETWEEN MACRO AND MICRO INDICATORS

3:15 p.m. ***Concurrent Workshops***
Facilitators: Jay Barclay, Cheryl Bradley, Jane Hawkrigg, Mike Kelly

1. *Energy Suppliers*
2. *Energy Users*
3. *Policy Issues*

5:15 p.m. ***Plenary Progress Report***

6:00 p.m. ***Adjournment***

7:30 p.m. ***Reception and Dinner***
Guest Speaker: Hans Rode,
National Energy Administration, Sweden

Detailed Agenda

Friday, March 1st

7:30 a.m.	*Continental Breakfast*

NEXT STEPS

8:30 a.m.	***Plenary session:*** *General Discussion of Key Issues and Direction for Concurrent Workshops on Next Steps* *Moderators: Pierre Marc Johnson and Fraser Wilson*
	Break
9:45 a.m.	***Concurrent Workshops*** *Facilitators*
11:45 a.m.	***Plenary Report and Concluding Remarks*** *Moderators: Jim MacNeill and Fraser Wilson*
1:00 p.m.	***Lunch***

APPENDIX 3

This paper was prepared for the National Round Table on the Environment and the Economy's Workshop on ***Measuring Sustainable Development: Energy Production and Use In Canada.***

The views expressed in this discussion document are not necessarily endorsed by the National Round Table on the Environment and the Economy.

APPENDIX 4

MEMBERS OF THE NRT

Dr. George Connell, Chair
National Round Table on the Environment and the Economy

R.C. (Reg) Basken
President
Energy and Chemical Workers Union

Françoise Bertrand
Présidente-directrice générale
Société de radio-télévision du Québec (Radio-Québec)

The Honourable Jean Charest
Minister of Environment
Government of Canada

The Honourable J. Glen Cummings
Minister of Environment
Government of Manitoba

Pat Delbridge
President
Pat Delbridge Associates Inc.

The Honourable Jake Epp
Minister of Energy, Mines, and Resources
Government of Canada

Josefina Gonzalez
Research Scientist
Forintek Canada Corp.

Diane Griffin
Executive Director
Island Nature Trust

Tony Hodge
University of McGill

Susan Holtz
Senior Researcher
Ecology Action Centre

John E. Houghton
Chairman
Québec and Ontario Paper Company Ltd.

David L. Johnston
Principal and Vice-Chancellor
McGill University

Pierre Marc Johnson
Directeur
Centre de médecine, d'éthique et de droit de l'Université McGill
a/s Guy & Gilbert

Dr. Geraldine A. Kenny-Wallace
President and Vice-chancellor
McMaster University

Margaret G. Kerr
Vice-President
Environment, Health and Safety
Northern Telecom Limited

Lester Lafond
President
Lafond Enterprises Ltd.

The Honourable John Leefe
Chair, Canadian Council of Ministers of the Environment (CCME)

Jack M. MacLeod
President and Chief Executive Officer
Shell Canada Ltd.

Jim MacNeill
Senior Fellow, Sustainable Development Program
Institute for Research on Public Policy

The Honourable Donald Mazankowski
Minister of Finance
Government of Canada

David Morton
Chair and Chief Executive Officer
Alcan Aluminium

Leone Pippard
President and Executive Director
Canadian Ecology Advocates

His Honour Judge Barry D. Stuart
Territorial Court of Yukon

The Honourable Michael Wilson
Minister of Industry, Science and Technology and Minister for International Trade
Government of Canada