NATIONAL ROUND TABLE ON THE ENVIRONMENT AND THE ECONOMY

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ECE7

Measuring Eco-efficiency in Business: Developing and Implementing Energy and Material Intensity Indicators

National Round Table on the Environment and the Economy

Report of the Feasibility Study Workshop

Held November 12, 13, & 14, 1997
Toronto, Canada

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Preface

This document details the results of a workshop convened by the National Round Table on Environment and Economy on November 12-14, 1997, to develop material and energy eco-efficiency indicators. At the workshop representatives of eight companies came to agreement, in principle, on a set of indicators, a methodology framework, and plan of action for conducting a feasibility study to test material and energy indicators. The purpose of this document is to provide a record of these areas of agreement and to provide the workshop participants with a document that may be used to gain support and buy-in for the development of eco-efficiency indicators within their companies.

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1. Background

In the document Science and Technology for the New Century: A Federal Strategy, the federal government set out its policy response to the Science and Technology Review. With the aim of achieving sustainable development through innovation, the federal government sought the advice of the National Round Table on the Environment and the Economy (NRTEE) with regard to establishing specific targets to help industries and other sectors become significantly more eco-efficient. They also asked NRTEE to examine the implications of those targets for the development of new technologies. Reaffirming this objective, the Liberal Party in its 1997 plan, Securing Our Future Together, stated that the NRTEE would be asked to "expand its work with stakeholders and provincial governments to develop eco-efficiency indicators."

In response, the NRTEE's Eco-efficiency program is developing a system of performance indicators that will assist companies in developing and implementing a set of measurable eco-efficiency indicators.

On April 2, 1997, in Washington, D.C., by invitation of the NRTEE and World Business Council on Sustainable Development (WBCSD), leading representatives from industry, non-government organizations (NGOs) and government met to discuss their experiences in measuring eco-efficiency within companies and to reach conclusions on the feasibility of developing and implementing a core set of eco-efficiency indicators. These individuals came from organizations in Canada, the US, Mexico, Colombia and Switzerland; many had also worked extensively in other countries or were involved in work concerning developing countries; all were practitioners and thinkers in the areas of eco-efficiency, performance measurement and business policy.

The workshop participants agreed that the development and testing of indicators for material and energy intensity held the greatest promise. These measures are particularly relevant to companies because they relate directly to costs. Companies in several countries have already designed and implemented indicators relating to these elements of eco-efficiency. At that workshop, candidate resource productivity indicators were also put forward for pilot testing with volunteer companies.

Detailed discussion on these indicators is contained in the NRTEE Backgrounder publication *Measuring Eco-efficiency in Business*. At the workshop the following process was agreed to:

- Examine existing applications by companies to determine whether such measures (or other similar measures) are being used. Consider/evaluate the results of their use to determine the applicability of the proposed indicators and who are the users and audiences of the information. Also, some companies may have developed software models for calculating material and energy intensity.
- Test the proposed indicators on a limited pilot basis with volunteer companies and organizations.
- Based on the results of the initial pilot project, extend to a broader group for further field-testing.

As a first step in testing the feasibility of the indicators the NRTEE held a workshop, on November 12-14, 1997, with eight volunteer companies, who agreed to consider testing the indicators within their organizations. This report summarizes the results of the workshop.

2. Purpose of the Project

The purpose of the pilot is to test the feasibility and value of indicators to support the goal of eco-efficiency. The criteria for evaluation include:

- **Robust, non-perverse.** Eco-efficiency indicators must be robust information sources for improvement i.e. clear, scientifically sound, unambiguous, and representative regardless of context. It is an essential corollary that the use of these indicators for decision-making not result in reduced eco-efficiency or increased environmental impacts, elsewhere in the system.

- **Rules for inclusion/exclusion.** Principles, rules and guidance are needed for the transparent inclusion and exclusion of the data, measurements and assumptions used to derive indicators.
- **Data collection cost-effectiveness.** The data and measurements for the indicators should either be available or obtainable in a cost-effective manner.
- **Usefulness as a management tool or a corporate reporting tool.** The indicators should be valuable at several levels within the company, including business unit, regional and corporate level.

Potential audiences for the indicators developed under the feasibility study are:

1. Internal to companies (e.g.,)

- Business sectors and product development groups
- Strategic management groups
- Other company organisations – e.g., environmental quality
- Employees

2. Potential Co-developers of eco-efficiency indicators where formal liaisons may be useful (e.g.,)

- World Business Council on Sustainable Development
- Industrial Pollution Prevention Council
- Center for Waste Reduction Technologies
- International Center for Environment Management
- World Environment Center

3. Stakeholders (e.g.)

- Customers
- Financial institutions
- Competitors
- Governments
- Non-governmental organizations (NGOs)

An ultimate goal of the use of eco-efficiency indicators is to establish an accurate, measurable baseline to assist in assessing a company's progress toward certain aspects of eco-efficiency (e.g., material and energy intensity - and, as noted at the workshop, potentially including energy related greenhouse gas emissions).

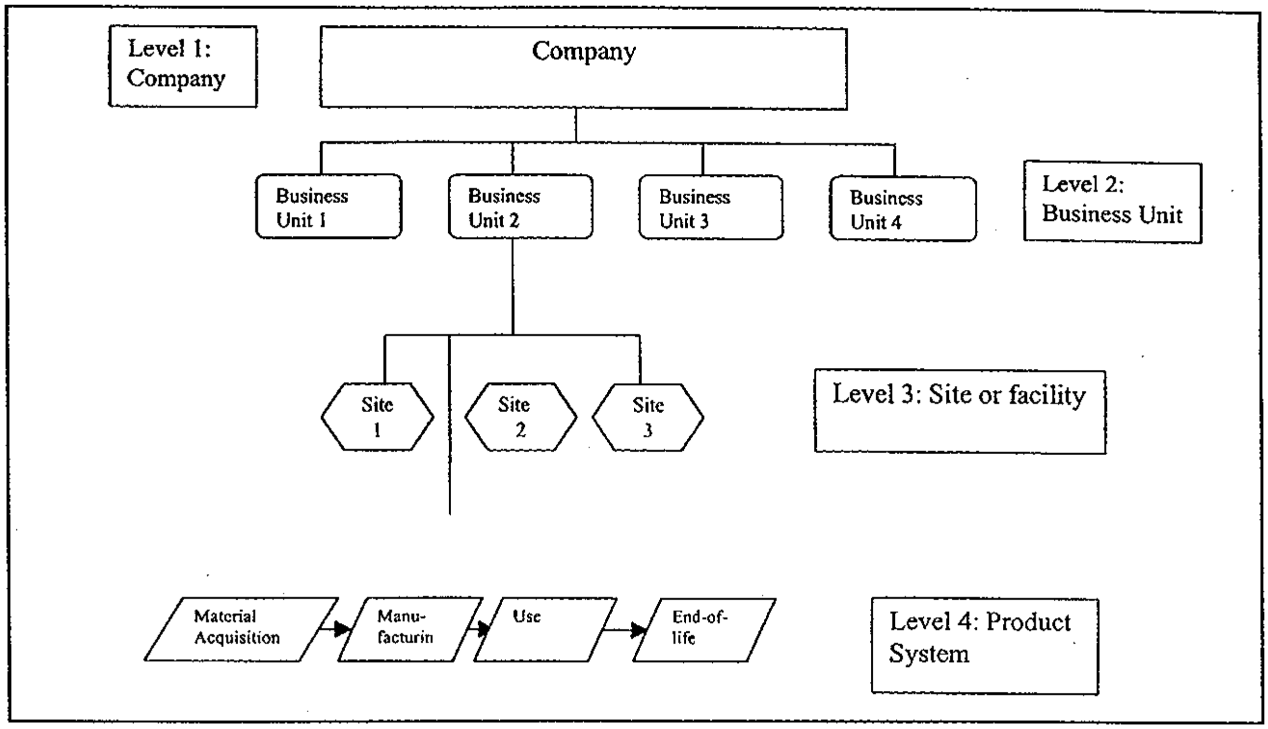
3. Scope of the Project

The purpose of this section is to describe the scope in sufficient detail to ensure that the breadth, depth, and detail of the study are compatible and sufficient to address the purpose stated in section 1. The scope is based upon several broad areas of agreement reached during the workshop:

- Two types of resource efficiency indicators will be evaluated: Material Intensity Index and Energy Intensity Index. These indices are expressed in terms of materials (or energy) consumed per unit of output for a product or service and can be expressed in either practical (e.g., per kg or per 1000 uses) or economic (per $ value) terms.
- Material Intensity Index and Energy Intensity Index are primarily measures of efficiency not surrogates for management effectiveness or land productivity. They are measures of the efficiency of converting materials to products or services, or efficiency of energy use to generate products or services either for a business and its operations or for a larger and broader life cycle.
- A well-defined set of indicators must be tailored to meet the needs of internal and external audiences identified in section 2. For example a plant manager is interested in the energy consumed by his/her plant in manufacturing a product(s). Alternatively, a product designer may be interested in not only the manufacturing energy but also the inherent energy of the materials, energy consumed throughout the life cycle of the product(s), and the energy that can be recovered at the end of the useful life of the product(s).
- With respect to the energy indicator, there should be consistency in the definition of the numerator, but there can be flexibility in the definition of the denominator.
- Due to the particular nature of the "mining" sector the material intensity indicator may have limited application and would need to be carefully qualified. In the mining industry, a large amount of earth is utilized in the processing of ore. The objective is to separate the valuable minerals and metals from the ore. The efficiency of this process can vary depending on the grade of the ore and whether multiple minerals and metals are being extracted. Although a material efficiency indicator is important for individual operations, the application of such an indicator between operations using different grades of ore, and extracting different minerals and metals, may not be meaningful. Similar circumstances may apply to other sectors as the indicators are examined, e.g., different types of wood and water use in the forestry and paper industry.
- All participants in the feasibility study will measure the minimum set of indicators. However, for the purposes of this feasibility study, the mining companies may choose to use the energy indicator(s) only.
- The use of complementary indicators is optional and the choice of those used will be dependent upon the particular needs of the participating companies. These complementary indicators are intended to provide additional information and perspective on complex product and service systems, so that the basic indicators are appropriately interpreted and used.
- Workshop participants recognize that this feasibility study addresses only two aspects of eco-efficiency, namely, energy and material intensity. Multiple assessments are needed to provide complete information on full eco-efficiency and environmental impacts of products, operations, or services.
- The indicators developed and used should be demonstrated to be scientifically sound.
- Every effort will be made to ensure that the application of the indicators and the methodology by the companies is complementary to current company practice, so that implementation costs are minimized.

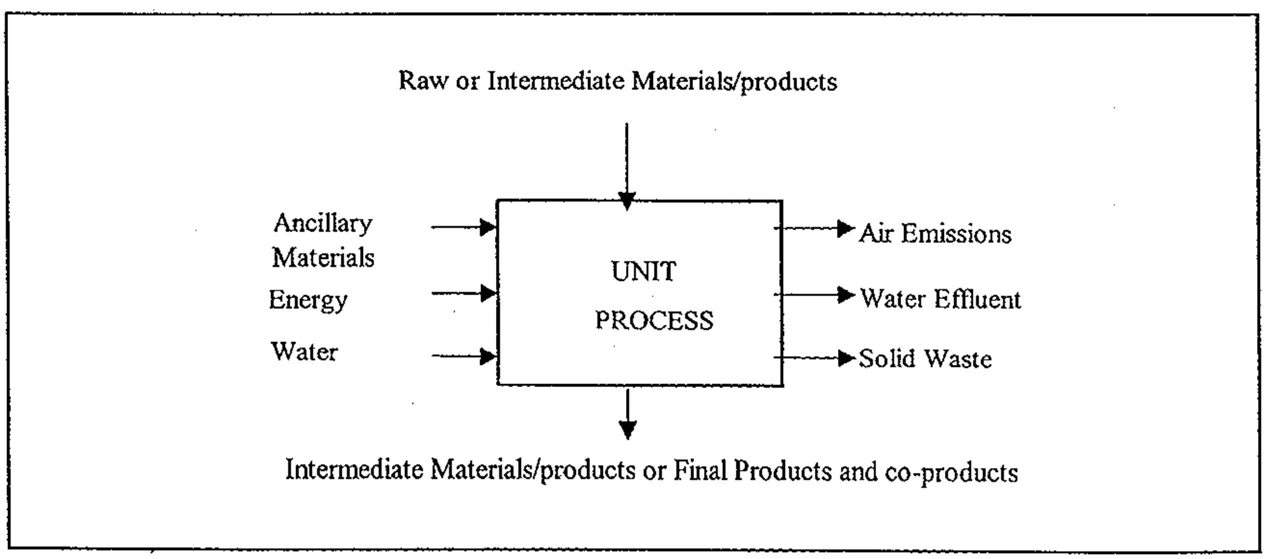
Building from these basic areas of agreement the workshop participants refined and agreed upon the indicators described below in section 3.1. These indicators can be applied at multiple levels within a company (company, business unit, site or product) as illustrated in the following figure.

Figure 1: Levels Within a Company at which Indicators Can be Applied



As a frame of reference, every manufacturing process is often characterized and documented by a list of raw or intermediate material inputs, ancillary materials, energy and water consumed, environmental releases and output intermediate material(s), or final product and/or co-products. A conceptual template that illustrates the information of interest within a manufacturing unit is provided in Figure 2. For the energy indicators, one would be interested in energy entering the manufacturing unit, energy generated within the manufacturing unit, and intermediate products, final products or co-products leaving the unit. For energy related greenhouse gases, relevant emissions within the air emissions category are also of interest. For the material indicators one would be interested in raw or intermediate materials (including in product water) and intermediate products, final products and co-products.

Figure 2: Template for Unit Process



3.1 Energy Intensity Indicator:

For energy intensity, a minimum set of indicators for a facility or company[1] are proposed, as well as a complementary set to provide perspective on additional stages in a product or service life cycle.

3.1.1 Minimum set

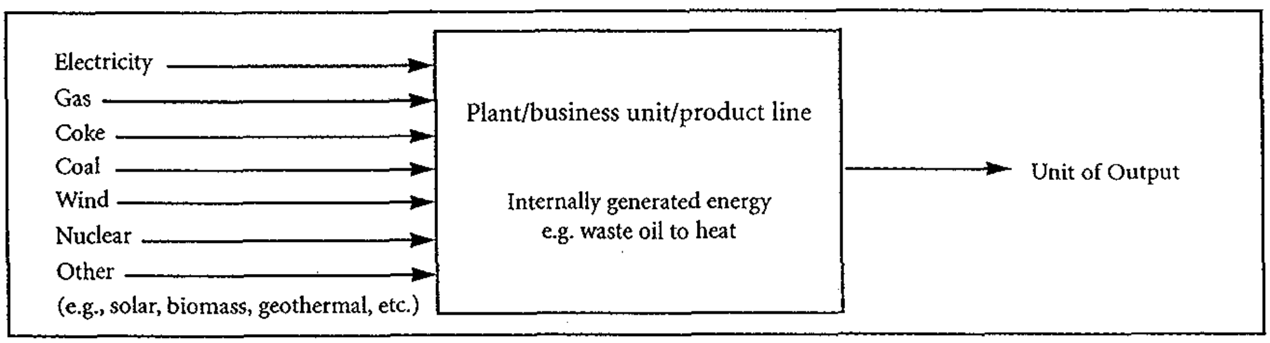
- Energy consumed by the company/unit of output

Where energy is defined as the total amount of energy[2] measured in joules, used to manufacture a defined unit of output or deliver a defined service.

Unit of output is a measure of the products and co-products[3] that leave the defined manufacturing process, or deliver a defined service. A unit of output can be represented as 1) a unit of measurement of output or 2) a unit of revenue.

The minimum energy indicator is shown schematically in Figure 3. Energy includes electricity, as well as, energy derived from fuels such as gas, oil, coal, coke, and other sources. The fuels are converted to joules by use of conversion factors (Appendix A presents typical fuel conversion factors and an example illustrating how these conversion factors are used to calculate joules from various fuels sources).

Figure 3: Schematic of Minimium Energy Indicator. All energy used by the manufacturing plant or service entity, including internally generated energy, consumed per unit of output.



3.1.2. Complementary Indicator Set

Six complementary energy indicators were developed (Figures 4 and 5). The intent behind these complementary indicators is to allow a company to build on the minimum set of indicators in order to provide a more complete picture related to the company's energy performance.

- C1 – "Expanded energy" consumed by the company/unit of output: defined as the total amount of energy including energy delivered to, or generated within, the plant or service entity, plus the energy consumed by energy delivery (losses during production/generation and distribution)[4].

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1 Although in this section, the term manufacturing is used, it should be interpolated as an example of one level of organization that the indicator could be applied. It also can be applied at product, business unit and/or company basis. See Figure 1.

2 Includes energy generated within the manufacturing process(es).

3 The group agreed that co-products would be defined as any of the two or more products coming from the same manufacturing process, waste is defined as any output that is disposed of to the environment. This clarification was important because it established clear guidance on what is a co-product and what is waste.

4 Use National Energy Reliability Council conversion data (provided in Annex B).

- C1 (a) – Expanded energy (including fleet energy) consumed by the company/unit of output: defined as the total amount of energy including energy delivered to, or generated within, the plant or service entity, plus the energy consumed by energy delivery (losses during production/generation and distribution), plus energy consumed by fleets transporting products or services to their intended markets.
- C2 – Energy consumed during the use phase of the product.
- C3 – Energy inherent in the materials used in manufacturing the product, and energy consumed in the acquisition and processing of materials entering the manufacturing process or service entity.
- C4 – Energy consumed and/or generated in the end-of-life phase of the product (e.g., via waste-to-energy incineration).
- C5 – Life cycle energy (i.e., the sum of all of the above)
- C6 – Energy Related Greenhouse Gas (GHG) Emissions – In this indicator, greenhouse gas emissions, measured in CO_2 equivalents, will be included with the measures of energy in one or more of the above energy indicators. A list of GHG equivalency factors will be provided including guidance on the use of the factors and how to estimate different fuel sources.

Transportation energy is assumed to be included in each indicator, as appropriate.

Figure 4: Schematic of Complementary Indicator (C1) and Complementary Indicator C1 (a)

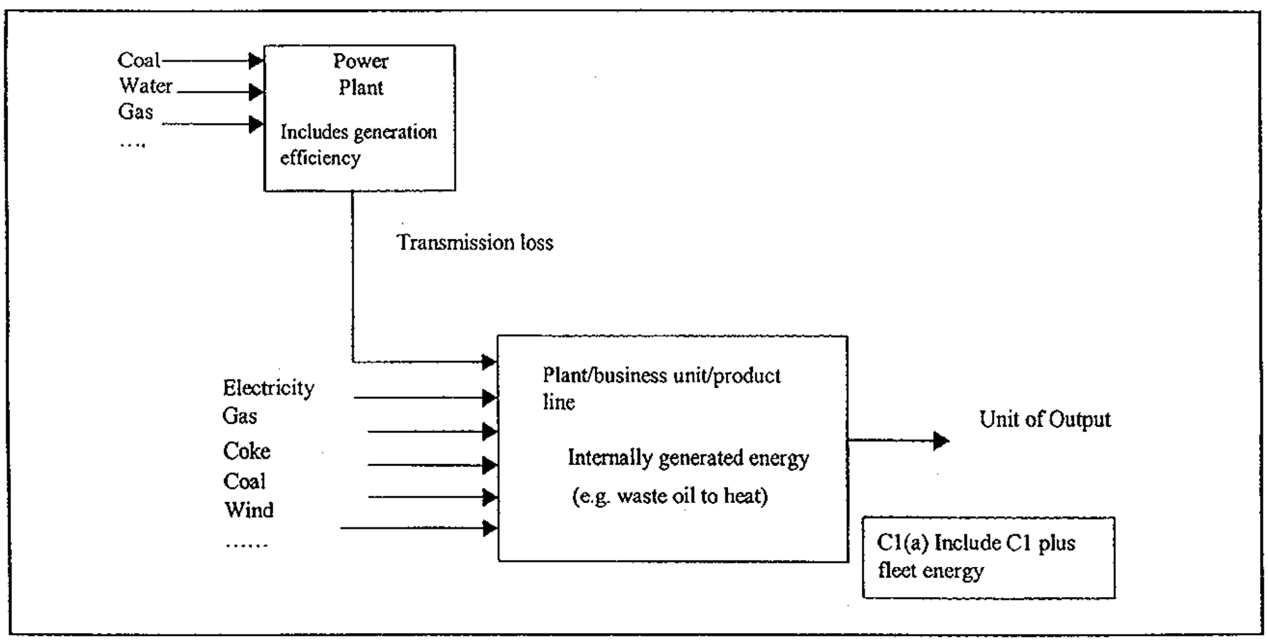
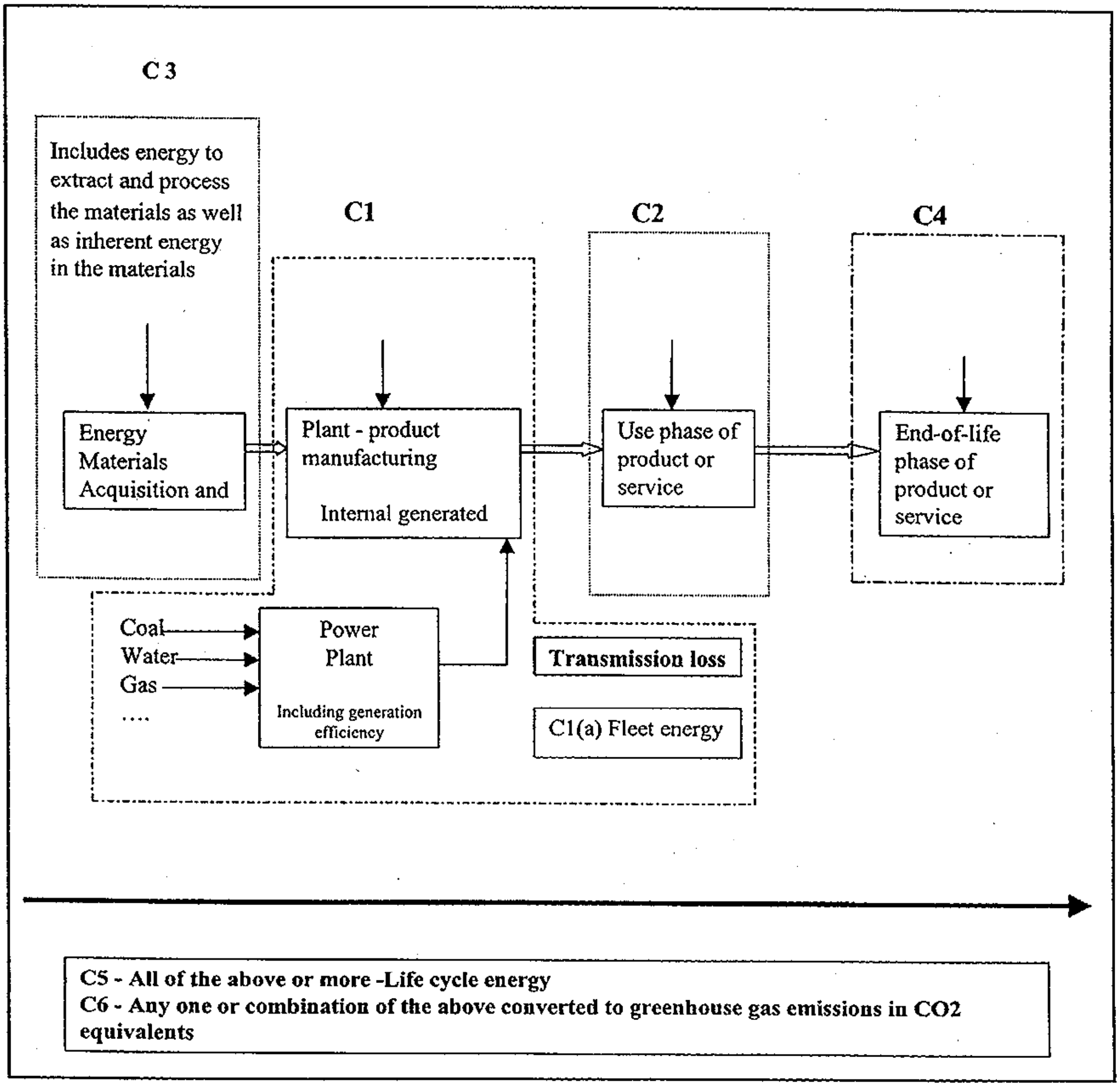


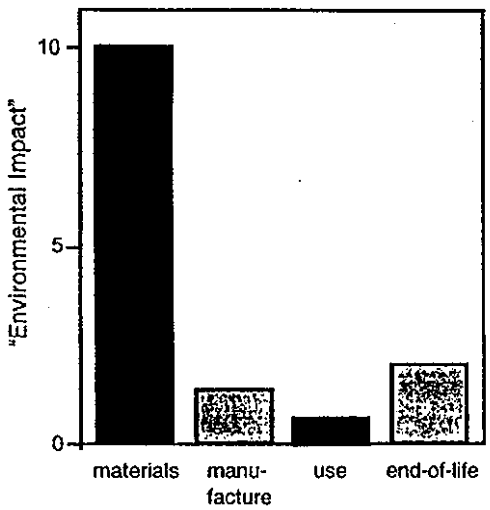
Figure 5: Schematic of Full Complementary Indicator Set for Energy Intensity



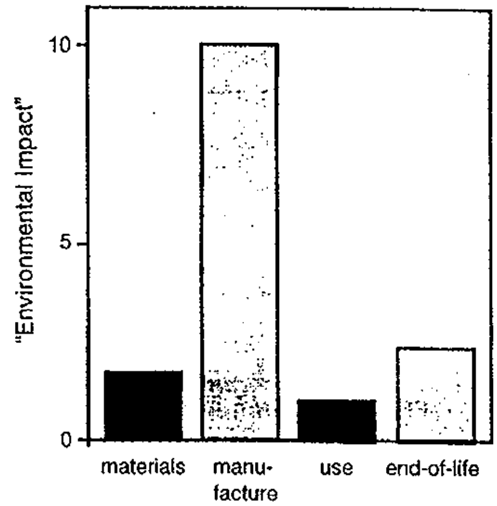
3.1.3 Selecting Complementary Indicators

The choice of which complementary indicators, if any, will depend on a number of factors. Of particular relevance is the environmental profile of the product or service the company provides, especially the relative contribution of different stages of the product's life cycle to the overall energy picture. An additional factor is the purpose of the energy indicator for the company. For example, some companies may choose to focus only on manufacturing energy for improving their eco-efficiency in specific areas. For external reporting in other cases, a company may want a more holistic picture. Examples of different product profiles are provided in Figure 6.

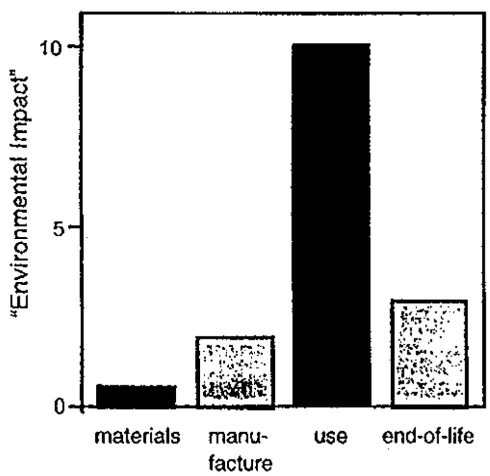
Figure 6: Different Product Profiles



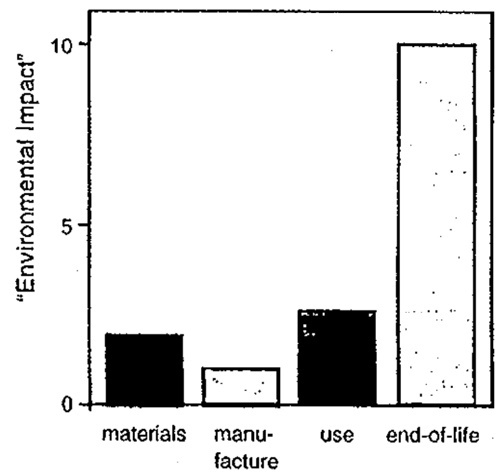
Type a: short-lived material-intensive product. e.g. single-use packaging.



Type b: manufacturing-intensive product. e.g. lap-top computer, paper-products.



Type c: long-lived, energy and resource consuming products. e.g. automobiles, appliances, buildings.



Type d: product with special end-of-life or disposal characteristics. e.g. single-use diapers.

Note: the "environmental impact" axis is a generic metric that could be defined by a number of different environmental impact indicators.

Source: S.B. Young, "Materials in LCA", in Environmental Life-Cycle Assessment, M.A. Curran, ed., (McGraw-Hill: New York), Chapter 10, p. 10.9, 1996.

3.2 Material Intensity Indicator

3.2.1 Minimum set

$$\frac{\text{Total material used directly in the product and co-product}}{\text{Total output of product and co-product}}$$

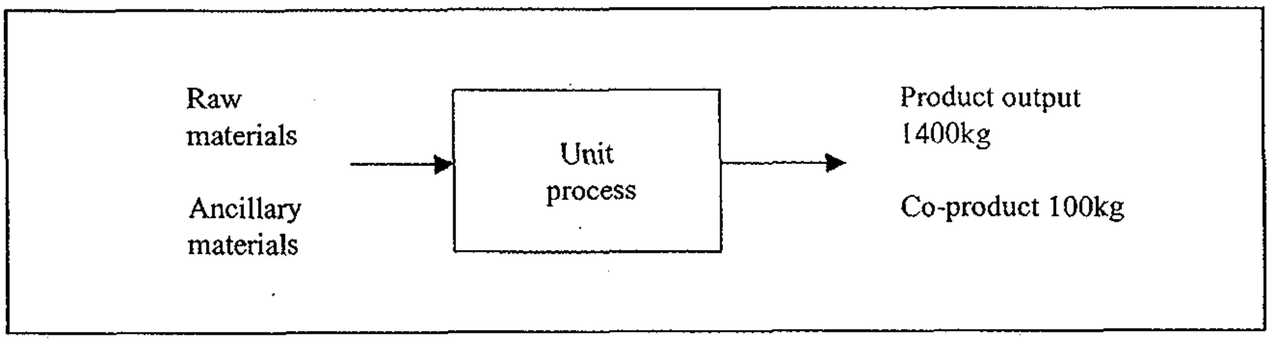
$$\frac{\text{Total material used directly in product and co-product + total indirect material}}{\text{Total output of product and co-product}}$$

Where input includes materials directly incorporated in the product and co-product, and indirect (ancillary) materials used in the manufacturing process to produce the product and/or co-products. Materials include raw materials, packaging, and water (excluding non-contact water).[6]

All materials considered relevant to either the product and/or process will be included. Two examples of decision rules to determine relevancy of materials are outlined here:

1. All material which make up greater than 1% by mass of the products or co-products leaving the manufacturing site will be identified. From this list, the materials that have a cumulative mass contribution of up to 90 % of the total weight of products or co-products would be included. Figure 7 and Table 1 illustrate an example of how this decision rule may be applied to determine materials to be included.

Figure 7: Material Calculations. In this case all raw and ancillary materials representing greater than 1% of 1500kg (i.e. 15 kg or greater) entering the system would be identified. The total mass of these materials would be added together.



6 This refers to cooling or heating water that is not modified by the manufacturing process (i.e., not contacting the direct material flows).

Table 1. Sample Material Calculation Table

Material	Weight in kg	Included in calculation >1%
Raw material 1	700	✓
Raw material 2	400	✓
Raw material 3	500	✓
Ancillary material 1	30	✓
Ancillary material 2	10	✗
Ancillary material 3	25	✓
Ancillary material 4	12	✗
Ancillary material 5	16	✓
Total of inputs greater than 15kg		**1671**

In this example all raw and ancillary inputs 1% or greater of the mass of the product would be added together. This would be raw materials 1, 2, and 3 and ancillary materials 1, 3, and 5. The total in this case is 1671 kg. Applying the 90% rule will require that at a minimum, 90% of 1671 kg or 1503.9 kg of material should be included in the calculation of total material. For this example raw materials 1, 2 and 3 contribute greater than 90% of 1671kg and therefore be included in the final calculation.

2. The 17 most significant materials. In this decision rule, the materials are ranked by mass, and the top 17 materials are included in the analysis.

3.2.2 Complementary Set

The amount of materials and packaging recovered, recycled and reused per total output of product and co-product.

4. Data Collection and Calculation Procedures

For all indicators used, each company will describe and document the data collection and calculation procedures, and the verification procedures used.

Each company is responsible for data collection and handling. An example of a generic data input sheet is presented in Appendix C. For the minimum set of indicators, the following rules apply:

- Units: Joules for energy; and Kg for materials.
- Allocation: If the indicators are normalised to a product or service, allocations based on mass will be used if multiple products are produced from the same facilities (e.g., different grades of paper from a mill).
- Time period coverage: The relevant time period (e.g., the year the data were based) will be reported for each indicator. Relevant timeframe (the period of time ~ 1 month, 1 year, etc.) for the feasibility study will be decided on a case-by-case basis, and reported by each company.

For the complimentary set of indicators, each company will document and report to the steering committee, the calculation procedures, assumptions, and decision rules used to include and/or exclude materials, and/or energy.

5. Data Quality

This section specifies the general data quality requirements needed to meet the project goals. Data quality may be defined as — the degree of confidence one has in the data. Every effort should be made by participants to collect high-quality primary data. Where primary data are not available, secondary or surrogate data may be employed.[5]

For each indicator, information regarding the source, nature, and quality of the data shall be reported by the respondent. Where possible, estimates of variability associated with the indicators should be considered and included. Data used in the feasibility study will also be characterised as to whether measured, calculated, or estimated values have been used. These latter indicators are defined as follows:

Measured: Primary data reflect actual measurements (direct sampling) performed during the subject time period.

Calculated: Measured values that have been modified to reflect calculations by the process engineer based on process design and operation (report rationale especially where professional judgements and estimates are used).

Estimated: Any secondary data, design-based extrapolations to other facilities or processes or other theoretical calculation (report data source, any allocations, and rationale).

Additionally, qualitative and quantitative data quality indicators (DQIs) may be used. The following section outlines DQIs.

5.1 Qualitative Data Quality Indicators

5.1.1 Consistency

Consistency describes how uniformly the methodology is applied not only across different processes and stages within a life cycle, but to other products, systems, and services. Documentation of the assumptions, protocols, and transparency of the process is needed to ensure that the results can be reproduced.

Consistency is assessed by reviewing how tools or procedures (including such things as process flow diagrams, boundary descriptions, templates, normalization and/or aggregation methods, calculations and computer procedures) are applied.

It should be noted that while consistent techniques may be used, diverse results may still be obtained for reasons including the use of different raw materials or different processes. It is easy to misplace or misinterpret the position of process boundaries, which directly affect perceived quality.

5.1.2 Representativeness

Representativeness refers to the degree to which data values and results truly reflect the processes relevant to the indicator included in the study. The degree of representativeness may be judged by comparing data sets for similar processes within the study, and perhaps with sets of published data.

Where published studies are not readily available, an examination of the technological mix of the processes in the study is conducted to ensure that the production-weighted inputs of the various technologies are fairly represented.

5 "Primary" refers to data collected directly from single facilities; "secondary" refers to data acquired from reference materials or published studies. "Surrogate" data may be used where some information is initially missing or ill defined.

5.1.3 Anomalies and Missing Data

Anomalies are extreme data values within a data set. Where a data value is suspect, more information should be obtained, if possible, to determine if the datum is within the expected range of the average value.

Missing data or data gaps are absent data values that are considered important. Where important data are missing, efforts should be made to fill these gaps with measurements or calculations, if possible. Otherwise, explicit and documented estimates may be used to fill the data gaps.

5.2 Quantitative Data quality indicators

5.2.1 Completeness

Completeness evaluates the sets of primary data obtained relative to the number of data sets that might possibly be obtained. A measure of the completeness of a primary data category for each manufacturing unit is performed by dividing the number of reporting locations providing data by the number of locations which were solicited for data.

5.2.2 Precision

Precision is a measure of the spread or variability within a data set, expressed as a statistical mean and variance. Where more than three data points exist, a mean and an estimate of variability may be obtained. Such calculations are performed for each primary data category.

Depending upon whether the minimum set or complementary set of indicators is used, the following data will be collected.

1. Energy	Fossil Non-fossil Process Transportation Feedstock Total
2. Materials Consumed	All significant materials as defined by the indicator(s)

The various types of energy that should be considered in the study are outlined here.

- **Fossil Energy**: those derived from any fossil source of carbonaceous material, including oil, coal and natural gas.
- **Non-Fossil Energy**: those derived from any non-fossil carbonaceous source, including hydroelectric, geothermal, nuclear, wood, and others.
- **Process Energy (Electric and Non-Electric)**: The national grid for the various sites will be used to reflect electricity production. The conversion of the electrical power mix into primary energy units (joules) has to take into account the combustion efficiencies of the various fuels and the conversion efficiencies of the generating facilities. In addition, the pre-combustion energies for the various fuel types and line losses from the transmission of electricity must be added.
- **Feedstock Energy**: Feedstock energy, also known as fuel-related inherent energy, or the energy content of material resources, is calculated as the gross calorific value (high heat) of the energy resources removed from the earth's

energy reserves. It is the calorific value of the inputs to the system as opposed to the calorific value of the output. Feedstock energies should be calculated separately for all material inputs that may be considered as an energy source.

- **Total Energy**: the summation of process, transport, and feedstock energy flows as well as any related pre-combustion energy. Pre-combustion energy is defined as the energy expended to extract, process/refine, and deliver a usable fuel for combustion. Pre-combustion energy values should be included for all fuels used within the scope of the indicator.

6. Results Verification

Verification of the feasibility study process will be carried out through distribution of the workshop report to the NRTEE Eco-efficiency Task Force and representatives of the stakeholders identified in section 2 of this report.

Although not part of this feasibility study it is recognized that verification of the procedures used by the companies may be required in the future, as appropriate. Additionally the results of the feasibility study may also be verified by application to other companies prior to full-scale implementation.

7. Communications Plan

There are three elements to the communications plan for the project. Ongoing communications of the feasibility project, internal communications between the participants, and communication of the final results.

For ongoing communications, a package will be produced for each participant, which includes:

- A overhead presentation describing the project, indicators, method, expected outcomes and business benefits of participating in the project;
- A one page communication note on the project, including who to contact for additional information; and
- Copy of this report from the November workshop.

For internal communications, a schedule for regular information exchange between participating companies will be developed. Whenever possible, electronic forms of communications will be used. When appropriate, follow-up meetings will be scheduled and project updates will be produced.

The third element of the communication plan for this feasibility study will be a strategy (agreed to by all participants) to communicate the final results.

8. Other Issues for Consideration

8.1 Costs

The feasibility project will endeavor to design the most cost effective approach possible. Participants are encouraged to complement existing measurement and management systems, and capitalize on opportunities to share information and costs. Where possible participants will document costs and business benefits associated with conducting the feasibility study.

8.2 Confidentiality

The federal *Access to Information Act* ("the Act") applies to the NRTEE by virtue of section 24 of the *National Round Table on the Environment and the Economy Act*, S.C. 1993, c. 31 which adds the NRTEE to the list of government institutions subject to the *Access to Information Act*. The *Access to Information Act* provides a right of access to individuals and corporations or other entities in Canada to all records under the control of the NRTEE, subject to the exemptions from disclosure the Act sets out.

Paragraph 20(1)(b) of the Act is a mandatory exemption requiring the government institution to refuse to disclose information which meets the following four criteria:

1. the information must be financial, commercial, scientific or technical information;

2. it must be confidential in nature;

3. the information must be supplied to a government institution by a third party; and

4. the information must be treated consistently in a confidential manner by the third party.

The NRTEE will take all the measures outlined in the legal opinion obtained for this project to maintain any documentation in a confidential manner. When submitting information for this study, participating companies are asked to clearly mark the material "confidential". However, participants are urged not to communicate information that is confidential to their companies.

9. Plan of Action

The Steering Committee (SC) is made up from representatives of each of the participating companies, as well as members of the NRTEE Eco-efficiency Task Force. It is essential to have one primary and one or more secondary contacts for each company. This will ensure that participation by the company continues, even when there is a conflict in scheduling interactions among the Steering Committee. The Steering Committee has agreed to make decisions regarding this project on a consensus basis.

The role of the Steering Committee is to:

- Oversee the implementation of the feasibility study
- Be available to discuss and resolve issues brought up by the individual companies
- Results of individual company efforts are presented to Steering Committee for final agreement and resolution of outstanding issues
- Be available to resolve issues raised by the individual companies
- Direct the preparation of outlines and divide up tasks related to the completion of the feasibility study
- Direct the preparation of the final report

The role of the individual companies is as follows:

- Take the results of the November workshop (indicators, methodology framework and plan of action) and obtain appropriate approval and buy-in from the company
- Be primarily responsible for data collection

- Participate in the regular information exchange between participating companies and provide representatives to the necessary follow-up meetings
- Be available to describe data collection efforts, and to follow-up and answer questions raised by Steering Committee
- Finalize all data collection efforts
- Assist in preparing draft sections of final report
- Approve final report

Table 2 sets out the schedule for the feasibility study.

Table 2: Proposed Timetable

Email Word 6.0 version of document + communications piece to NRTEE	Nov 28
Forward document to participating companies	
Comments from companies back to NRTEE + Go no go decision by companies	Dec 8
Forward document to potential co-developers – let them know feasibility study is going forward and check significant concerns	Dec 8-12
Response back from potential co-developers	Jan 19
Initial data collection	Dec-March
Tele-conference or other communication mechanism to prepare for March session	
Reality Check SC meeting – communication session if appropriate, firm up path forward, liaison with potential co-developers if appropriate	March 17 Globe 98 Vancouver
Input from companies, outline final report	June 23-24
Draft Final Report	September 15, 1998....
Final Report	December 15, 1998....

Glossary

Ancillary material: input that is used by the unit process producing the product or service, but is not incorporated in any of the product outputs of the unit process.

Co-product: any two or more products coming from the same unit process.

Waste: any output that is disposed of to the environment

Life cycle: consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to the final disposal.

Final product: product which requires no additional transformation prior to its use

Intermediate product: input or output from a unit process which requires further transformation.

Energy: input to or output from a unit process, measured in units of energy

Raw material: primary or secondary material that is used to produce a product or service

Annex A: Fuel Conversion Factors and Sample Calculations

Fuel Conversion Factors:

		HHV (MJ)	Pre-comb (MJ)	Total (MJ)
Fuel Oil (medium)	kg	44.18	4.61	48.79
Diesel	lit	38.66	4.03	42.69
Gasoline	lit	34.86	3.64	38.50
Natural Gas	Cu. M	38.29	5.03	43.32
Propane	lit	25.45	3.35	28.79
Bituminous/Sub	kg	23.84	0.84	24.68
Anthracite	kg	24.17	0.86	25.03

The Table below shows sample calculations for converting different fuels units to MJ:

	Quantity (a)	Units	Conversion Factors (b)	Converted Data (MJ) = (a) x (b)
Fuel Oil (medium)	191.14	kg	48.79	9,326.44
Diesel	28.45	lit	42.69	1,214.54
Gasoline	4.02	lit	38.50	154.82
Natural Gas	669.56	Cu. M	43.32	29,005.08
Propane	4.06	lit	28.79	117.02
Bituminous/Sub	16.88	kg	24.68	416.69
Anthracite	0.17	kg	25.03	4.36

Annex B: National Energy Reliability Council Conversion Data

	From Coal	From Nuclear	From Hydro	From Geothermal	From Oil - Total	From Natural Gas - Total	From Other Utility Fuels	From Non-Utility Generators	TOTAL	Generation Efficiency	Transmission Losses
ECAR	87.58%	9.39%	0.65%	0.00%	0.06%	0.27%	0.00%	2.04%	100.00%	38%	
ERCOT	42.36%	11.58%	0.69%	0.00%	0.13%	34.63%	0.00%	10.60%	100.00%	24%	
MAAC	47.08%	38.00%	1.88%	0.00%	3.16%	1.72%	0.00%	8.16%	100.00%	39%	
MAIN	50.75%	47.34%	1.49%	0.00%	0.20%	0.18%	0.02%	0.02%	100.00%	32%	
MAPP U.S.	73.36%	18.81%	6.94%	0.00%	0.06%	0.37%	0.34%	0.13%	100.00%	26%	
NPCC U.S.	20.07%	26.53%	13.00%	0.00%	16.20%	9.97%	0.02%	14.22%	100.00%	36%	
SERC	56.44%	28.21%	5.05%	0.00%	4.61%	3.29%	0.00%	2.39%	100.00%	39%	
SPP	55.91%	14.63%	3.01%	0.00%	0.02%	24.56%	0.11%	1.75%	100.00%	29%	
WSCC U.S.	37.05%	12.73%	25.69%	1.71%	0.11%	11.89%	0.13%	10.69%	100.00%	31%	
Total U.S.	53.65%	21.14%	8.00%	0.32%	2.60%	8.68%	0.05%	5.55%	100.00%	33%	6.7%
MAPP Canada	26.15%	0.00%	72.05%	0.00%	0.02%	1.78%	0.00%	0.00%	100.00%	18%	
NPCC Canada	12.04%	26.52%	56.56%	0.00%	3.76%	0.00%	0.00%	1.12%	100.00%	42%	
WSCC Canada	38.51%	0.00%	54.98%	0.00%	0.00%	5.19%	0.00%	1.32%	100.00%	24%	
Total Canada	19.55%	17.86%	57.61%	0.00%	2.54%	1.38%	0.00%	1.06%	100.00%	29%	

Annex C: Generic Data Input Sheet

Material Group:	
Product System:	
Unit Process:	
Company:	
Location:	

#	MATERIAL OUTPUTS	DQI	Raw Data		Kg/1000 Kg	Comments
		(1 thru 5)	Units	Data		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

#	ENERGY OUTPUTS	DQI	Raw Data		MJ/1000 Kg	Comments
		(1 thru 5)	Units	Data		
1	Process Steam				0	
2	Electricity				0	
3					0	
4					0	
5					0	
6					0	
7					0	
8					0	
9					0	
10					0	

#	MATERIAL INPUTS	DQI	Raw Data		Kg/1000 Kg	Energy Value	Comments
		(1 thru 5)	Units	Data		MJ/Kg	
1					0	0	
2					0	0	
3					0	0	
4					0	0	
5					0	0	
6					0	0	
7					0	0	
8					0	0	
9					0	0	
10					0	0	
11					0	0	
12					0	0	
13					0	0	
14					0	0	
15					0	0	
16					0	0	
17					0	0	
18					0	0	
19					0	0	
20					0	0	

	ENERGY INPUTS		DQI	Raw Data		If Emissions Included	Kg/1000 Kg	Heating Value	Default HV	MJ/1000 Kg	Comments
			(1 thru 5)	Units	Data	Emissions Indicate	-	MJ/Kg	MJ/Kg	-	
	Petroleum										
1	Medium Fuel Oil						0	0	0	0	
2	Light Fuel Oil						0	0	0	0	
3	Diesel						0	0	0	0	
4	Kerosene						0	0	0	0	
5	Gasoline						0	0	0	0	
6	Petroleum Coke						0	0	0	0	
7							0	0	0	0	
8							0	0	0	0	
9							0	0	0	0	
	Natural Gas										
1	Natural Gas						0	0	0	0	
2	LNG						0	0	0	0	
3	Methane						0	0	0	0	
4	Propane						0	0	0	0	
5	Butane						0	0	0	0	
6							0	0	0	0	
7							0	0	0	0	
8							0	0	0	0	
	Coal										
1	Anthracite						0	0	0	0	
2	Bituminous/Sub						0	0	0	0	
3	Lignite						0	0	0	0	
4	Coke						0	0	0	0	
5							0	0	0	0	
6							0	0	0	0	
7							0	0	0	0	
	Biomass										
1	Wood						0	0	0	0	
2	Hog Fuel						0	0	0	0	
3	Black Liquor						0	0	0	0	
4	Peat						0	0	0	0	
5							0	0	0	0	
6							0	0	0	0	
7							0	0	0	0	
	Other										
1	Hydropower						0	0	0	0	
2	Solar - Thermal						0	0	0	0	
3	Solar - Photovoltaic						0	0	0	0	
4	Wind						0	0	0	0	
5	Geothermal						0	0	0	0	
6							0	0	0	0	
7							0	0	0	0	
8							0	0	0	0	
	Other: (Specify)										
	Energy X						0	0	0	0	
	Energy X						0	0	0	0	
	Energy X						0	0	0	0	
	Energy X						0	0	0	0	
	Energy X						0	0	0	0	

ELECTRICITY INPUTS Grid Electricity Only			DQI (1 thru 5)	Raw Data Units	 Data	kWh/1000 Kg -	Comments
1	National Canadian Grid					0	
2	ERCOT (Electric Reliability Council of Texas)					0	
3	NPCC (Northeast Power Coordinating Council)					0	
4	WSCC (Western Systems Coordinating Council)					0	
5	MAPP (Mid-Continent Area Power Pool)					0	
6	MAIN (Mid America Inter-connected Network)					0	
7	ECAR (East Central Area Reliability Coordination Agreement)					0	
8	MAAC (Mid Atlantic Area Council)					0	
9	SERC (South Eastern Reliability Council)					0	
10	SPP (South-west Power Pool)					0	
11	Other: (Specify)					0	
12						0	
13						0	
14						0	
15						0	

AIR EMISSIONS		DQI (1 thru 5)	Raw Data Units	 Data	Kg/1000 Kg -	Comments
Particulate Matter					0	
CO					0	
CO_2					0	
SOx					0	
H_2S					0	
Mercaptan					0	
NOx					0	
NH_3					0	
Cl_2					0	
HCl					0	
F					0	
HF					0	
Non-Methane Hydrocarbons					0	
Aldehydes (CHO)					0	
Organics					0	
Lead					0	
Mercury					0	
Metals					0	
Sulphric Acid (H_2SO_4)					0	
Nitrogen Dioxide (N_2O)					0	
Hydrogen					0	
Dichloroethane (DCE)					0	
Vinylchloride monomer (VCM)					0	
CFC/HCFC					0	
HCN					0	
Methane					0	
Enzyme					0	
PAH					0	
					0	
					0	
					0	
					0	

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Annex B: National Energy Reliability Council Conversion Data

	From Coal	From Nuclear	From Hydro	From Geothermal	From Oil - Total	From Natural Gas - Total	From Other Utility Fuels	From Non-Utility Generators	TOTAL	Generation Efficiency	Transmission Losses
ECAR	87.58%	9.39%	0.65%	0.00%	0.06%	0.27%	0.00%	2.04%	100.00%	38%	
ERCOT	42.36%	11.58%	0.69%	0.00%	0.13%	34.63%	0.00%	10.60%	100.00%	24%	
MAAC	47.08%	38.00%	1.88%	0.00%	3.16%	1.72%	0.00%	8.16%	100.00%	39%	
MAIN	50.75%	47.34%	1.49%	0.00%	0.20%	0.18%	0.02%	0.02%	100.00%	32%	
MAPP U.S.	73.36%	18.81%	6.94%	0.00%	0.06%	0.37%	0.34%	0.13%	100.00%	26%	
NPCC U.S.	20.07%	26.53%	13.00%	0.00%	16.20%	9.97%	0.02%	14.22%	100.00%	36%	
SERC	56.44%	28.21%	5.05%	0.00%	4.61%	3.29%	0.00%	2.39%	100.00%	39%	
SPP	55.91%	14.63%	3.01%	0.00%	0.02%	24.56%	0.11%	1.75%	100.00%	29%	
WSCC U.S.	37.05%	12.73%	25.69%	1.71%	0.11%	11.89%	0.13%	10.69%	100.00%	31%	
Total U.S.	53.65%	21.14%	8.00%	0.32%	2.60%	8.68%	0.05%	5.55%	100.00%	33%	6.7%
MAPP Canada	26.15%	0.00%	72.05%	0.00%	0.02%	1.78%	0.00%	0.00%	100.00%	18%	
NPCC Canada	12.04%	26.52%	56.56%	0.00%	3.76%	0.00%	0.00%	1.12%	100.00%	42%	
WSCC Canada	38.51%	0.00%	54.98%	0.00%	0.00%	5.19%	0.00%	1.32%	100.00%	24%	
Total Canada	19.55%	17.86%	57.61%	0.00%	2.54%	1.38%	0.00%	1.06%	100.00%	29%	

Annex C: Generic Data Input Sheet

Material Group:	
Product System:	
Unit Process:	
Company:	
Location:	

MATERIAL OUTPUTS		DQI	Raw Data		Kg/1000 Kg	Comments
		(1 thru 5)	Units	Data		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

ENERGY OUTPUTS		DQI	Raw Data		MJ/1000 Kg	Comments
		(1 thru 5)	Units	Data		
1	Process Steam				0	
2	Electricity				0	
3					0	
4					0	
5					0	
6					0	
7					0	
8					0	
9					0	
10					0	

MATERIAL INPUTS		DQI	Raw Data		Kg/1000 Kg	Energy Value	Comments
		(1 thru 5)	Units	Data		MJ/Kg	
1					0	0	
2					0	0	
3					0	0	
4					0	0	
5					0	0	
6					0	0	
7					0	0	
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10					0	0	
11					0	0	
12					0	0	
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20					0	0	

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	0	0	0	0				
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	0	0	0	0				
	0	0	0	0				

ELECTRICITY INPUTS Grid Electricity Only			DQI (1 thru 5)	Raw Data Units	Raw Data Data	kWh/1000 Kg	Comments
1	National Canadian Grid					0	
2	ERCOT (Electric Reliability Council of Texas)					0	
3	NPCC (North East Power Coordinating Council)					0	
4	WSCC (Western Systems Coordinating Council)					0	
5	MAPP (Mid-continent Area Power Pool)					0	
6	MAIN (Mid America Inter-connected Network)					0	
7	ECAR (East Central Area Reliability Coordination Agreement)					0	
8	MAAC (Mid-Atlantic Area Council)					0	
9	SERC (South Eastern Reliability Council)					0	
10	SPP (South-west Power Pool)					0	
11	Other: (Specify)					0	
12						0	
13						0	
14						0	
15						0	

AIR EMISSIONS			DQI (1 thru 5)	Raw Data Units	Raw Data Data	Kg/1000 Kg	Comments
	Particulate Matter					0	
	CO					0	
	CO_2					0	
	SOx					0	
	H_2S					0	
	Mercaptan					0	
	NOx					0	
	NH_3					0	
	Cl_2					0	
	HCl					0	
	F					0	
	HF					0	
	Non-Methane Hydrocarbons					0	
	Aldehydes (CHO)					0	
	Organics					0	
	Lead					0	
	Mercury					0	
	Metals					0	
	Sulphric Acid (H_2SO_4)					0	
	Nitrogen Dioxide (N_2O)					0	
	Hydrogen					0	
	Dichloroethane (DCE)					0	
	Vinylchloride monomer (VCM)					0	
	CFC/HCFC					0	
	HCN					0	
	Methane					0	
	Enzyme					0	
	PAH					0	
						0	
						0	
						0	
						0	
						0	

Measuring Eco-efficiency in Business:
Developing and Implementing
Pollutant Dispersion Indicators

Results of the Feasibility Study Workshop
January 26 & 27, 1998

Toronto, Canada

Prepared for

National Round Table on the Environment and the Economy

Prepared by

DEMETER GROUP
AND
ROY F. WESTON, INC.

PREFACE

This document summarises the results of a workshop convened by the National Round Table on Environment and Economy on January 26 and 27, 1998, to develop a pollutant dispersion indicator (PDI) that can be used to help corporations track progress toward eco-efficiency. At the workshop, representatives of several companies and a number of invited experts discussed the feasibility of developing and pilot testing such an indicator. There was agreement on the purpose of a feasibility study, the general characteristics of a PDI, and the criteria a useful indicator should meet. Building on the results of previous NRTEE workshops and background papers, the participants developed the draft PDI presented in this document. The purpose of this document is to provide a record of these areas of agreement, describe the PDI, and to provide the workshop participants with a document that may be used as a starting point to evaluate the feasibility of a PDI.

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1. BACKGROUND

In the document *Science and Technology for the New Century: A Federal Strategy*, the Canadian government set out its policy response to the Science and Technology Review. With the aim of achieving sustainable development through innovation, the federal government sought the advice of the National Round Table on the Environment and the Economy (NRTEE) with regard to establishing specific targets to help industries and other sectors become significantly more eco-efficient. They also asked NRTEE to examine the implications of those targets for the development of new technologies. Reaffirming this objective, the Liberal Party in its 1997 plan, *Securing Our Future Together*, stated that the NRTEE would be asked to "expand its work with stakeholders and provincial governments to develop eco-efficiency indicators."

In response, the NRTEE's Eco-efficiency program is developing a system of performance indicators that will assist companies in developing and implementing a set of measurable eco-efficiency indicators.

On April 2, 1997, in Washington, D.C., by invitation of the NRTEE and World Business Council on Sustainable Development (WBCSD), leading representatives from industry, non-government organizations (NGOs) and government met to discuss their experiences in measuring eco-efficiency and to reach conclusions on the feasibility of developing and implementing a core set of eco-efficiency indicators. These individuals came from organizations in Canada, the US, Mexico, Colombia and Switzerland; many had also worked extensively in other countries or were involved in work concerning developing countries; all were practitioners and thinkers in the areas of eco-efficiency, performance measurement and business policy.

The Washington workshop participants agreed that the development and testing of indicators for material and energy intensity held the greatest promise[1]. The workshop participants also discussed the feasibility of developing a toxic release index. They agreed that developing such an index would be problematic due its dependence on value based weighting factors and data limitations. However, they did agree that relevant indicators for toxic releases could be devised using currently available data. The workshop report concluded that:

> *Development of one or more indicators for toxic dispersion or releases was also considered to be both highly desirable and relatively feasible, since it is likely that toxic release data pertaining to specified substances is already routinely tracked and recorded by companies under existing domestic laws (in some countries) and international treaties (in many countries).*

[1] As a first step in testing the feasibility of these indicators the NRTEE held a workshop on November 12-14, 1997, with eight volunteer companies. At this workshop material and energy intensity indicators were designed and subsequently all eight companies are testing the indicators within their organizations.

Detailed discussion on the toxic release index is contained in the NRTEE Backgrounder publication *Measuring Eco-efficiency in Business*[2]. The workshop participants recommended a number of follow-up actions such as, better defining the scope of the indicator, developing a list of specific chemicals, reviewing models/methodologies for measuring toxicity and for reporting toxic emissions and conducting field trials.

As a first step in carrying out these recommendations the NRTEE commissioned a discussion paper entitled *International Performance Indicators for Dispersion of Toxic Chemicals into the Environment*[3]. The paper reviewed possible means to develop pollutant dispersion indicators. It examined current pollutant release and transfer registers and it made the following observations:

- the essential element of a pollutant dispersion indicator is the annual quantity of toxic substances released by an organisation per unit of production or business activity;
- the approach used by the Canadian Accelerated Reduction/Elimination of Toxics (ARET) program provides the most applicable model for classifying toxic chemical substances;
- although there are models for weighting or ranking toxicity of chemical substances these schemes are somewhat arbitrary in their allocation of weighting factors; and
- the quality and reliability of quantitative release data can vary, therefore the methodology for calculating releases will require careful attention.

To further explore the development of a pollutant dispersion indicator the NRTEE held a workshop on January 27 and 28, 1998, with several volunteer companies and a number of invited experts. The companies agreed upon the design of a pollution dispersion indicator and they also agreed to review the results of the workshop and consider the possibility of a feasibility study going forward. This report summarises the results of that workshop.

2. PURPOSE OF THE PROPOSED FEASIBILITY STUDY

The overall purpose of the study is to test the feasibility and value of indicators to support the goal of eco-efficiency. Workshop participants agreed to the following statements in regard to the development of pollutant dispersion indicators.

- The indictors developed should help companies engage in an intelligent dialogue both within the company and with outside stakeholders.

---

[2] NRTEE, *Measuring Eco-efficiency in Business* (Ottawa: Renouf. 1997)

[3] G. Peter Robson *Discussion Paper on International Performance Indicators for Dispersion of Toxic Chemicals into the Environment,* prepared for the National Round Table on Environment and Economy, October 1997.

- The indicator(s) developed will assess the release of pollutants to the environment not the reduction of chemical use.

- The list of pollutants used in the feasibility study will follow the decision rules agreed to by the participating companies.

- The list of pollutants for the feasibility study will be created from existing credible lists of pollutants as agreed to by the participating companies.

- For the feasibility study, the list will recognize different levels of concerns for pollutants as outlined in ARET.

- The intention of the feasibility study is to take a proactive approach to the development of an eco-efficiency indicator(s) for pollutants.

These statements were used by the participants as a guide in the development of the information and approaches outlined in this report.

3. CRITERIA FOR PDI INDICATOR

Before the participants attempted to define the indicator, considerable effort was made to ensure that there was a common understanding of the criteria to be used in its development. The participants agreed that the PDI must embody the following criteria:

- Useful as an analytical tool and easy to reproduce from year to year.
- Adaptable – capable of being modified over time (that is, it is capable of accommodating new substances provided they have met established criteria for inclusion or have been scientifically evaluated in an open and transparent process and capable of dropping substances that are no longer of concern).
- Credible to stakeholders, users and respond to external concerns.
- Allow for sector-specific indicators and be applicable to different countries and regions.
- Auditable.
- Relevant to both organic substances and inorganic substances.
- Complement existing energy and material indicators and other eco-efficiency tools.
- Simple to use and easy to understand by audiences representing broad technical and non-technical backgrounds.
- A robust information source for improvement (i.e., clear, relevant, accurate, scientifically sound, unambiguous, and representative regardless of context). It is an

essential corollary that the use of these indicators for decision-making not result in reduced eco-efficiency or increased environmental impacts, elsewhere in the system[4].

- Valuable at several levels within the company, including the business unit, and the regional and corporate level for applications such as, goal setting, progress assessment and continual improvement (see Figure 1).

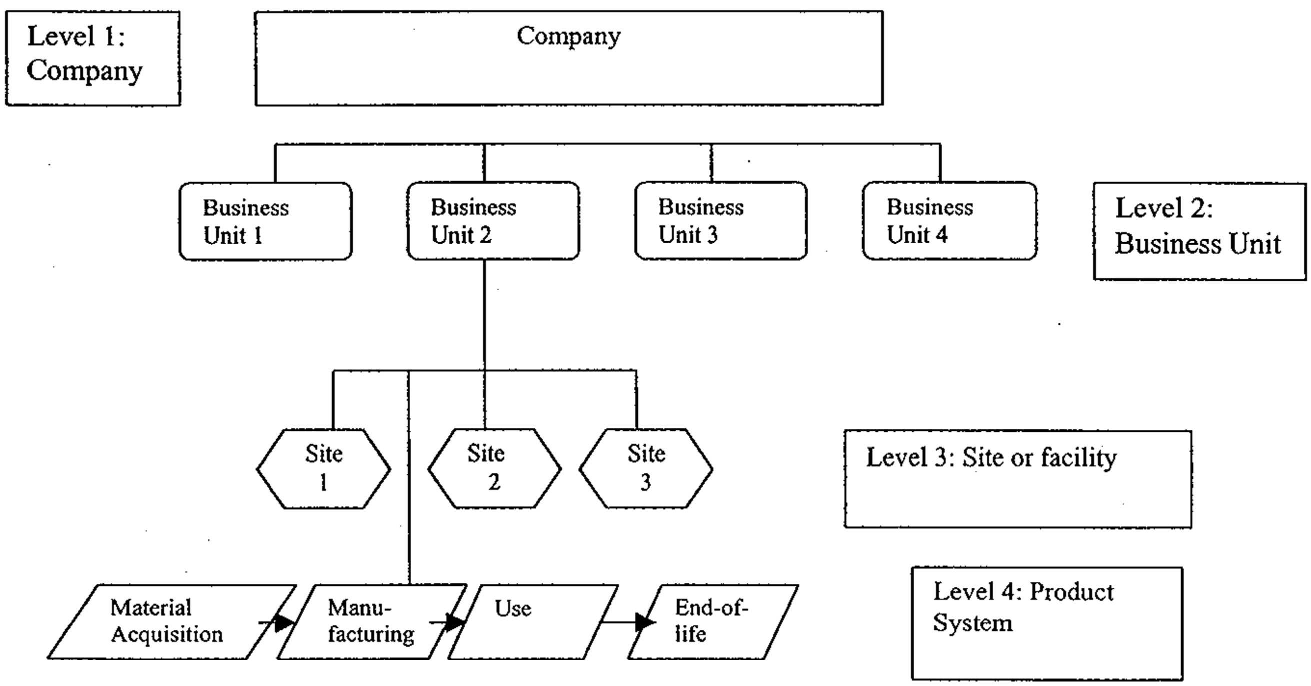


Figure 1: Levels within a company at which indicators can be applied.

- The methodology for developing the indicator(s) should provide principles, rules and guidance for the transparent inclusion and exclusion of the data, measurements and assumptions used to derive indicators.

- The data and measurements for the indicators should either be available or obtainable in a cost-effective manner.

[4] There may be cases when a company must make a trade-off, where, for example, reducing an emission will result in increased energy consumption elsewhere in the system. Companies must strive for the most eco-efficient option but it is recognized that in some cases trade-offs will have to be evaluated.

4. AUDIENCE (S) FOR ECO-EFFICIENCY INDICATORS

Potential audiences for the indicators developed under the feasibility study are:

1. Internal to companies
   - Business units and product development groups
   - Strategic management groups
   - Product design –material selection
   - Other company organisations – e.g., environmental quality
   - Employees

2. External - other stakeholders
   - Customers
   - Financial institutions
   - Competitors
   - Suppliers (material/parts – influenced by customers and product designers)
   - Governments
   - Non-governmental organizations (NGOs)
   - Communities and the general public

In addition, there are a number of potential co-developers of eco-efficiency indicators where formal liaisons may be useful (e.g.,)

- World Business Council on Sustainable Development
- Industrial Pollution Prevention Council
- Center for Waste Reduction Technologies
- World Environment Center

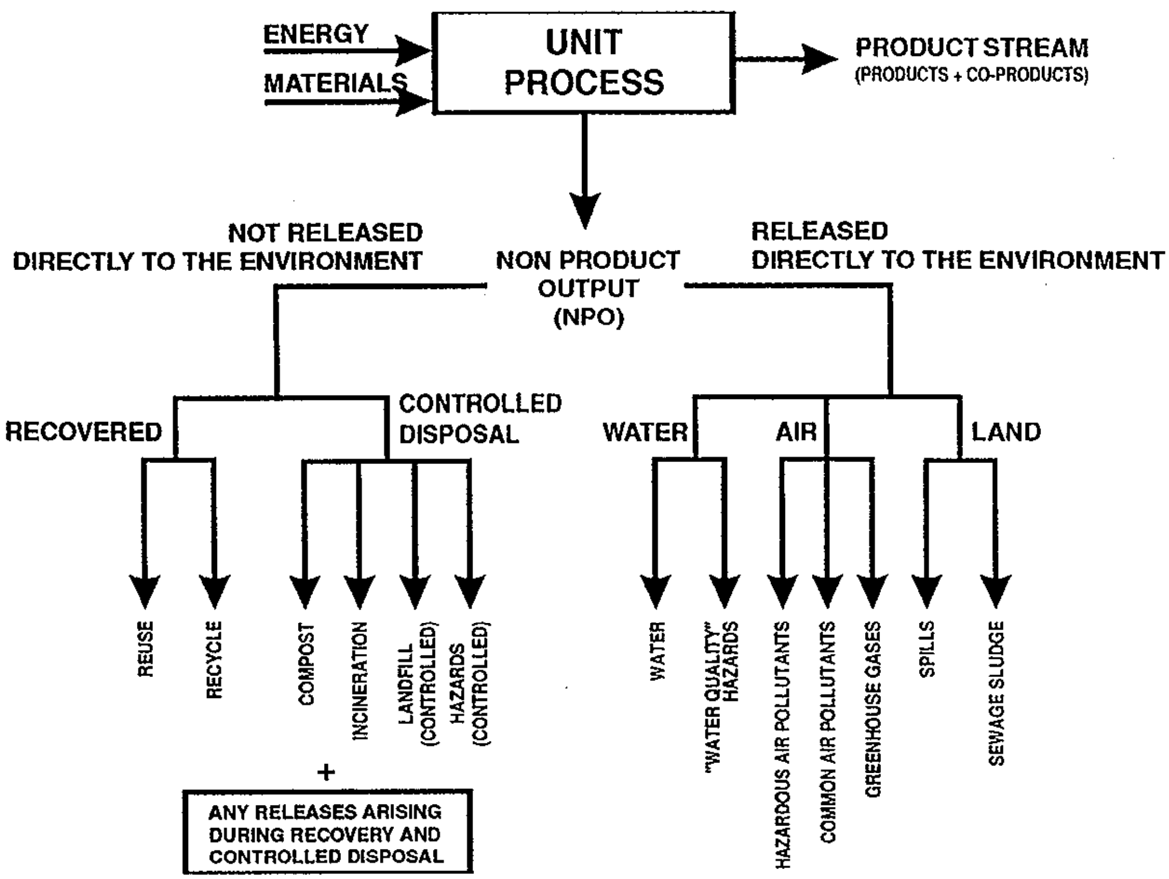
5. INDICATOR SET

Figure 2 below illustrates the broad range of releases, or non-product output, that can occur from a unit process. For the purposes of this feasibility study, a unit process can be assumed to be the starting point for which data are collected from the product or service system. For a manufacturing company, this is often the manufacturing site. For a service company, this may be a processing facility (e.g., a switching station).

Non-product output encompasses substances that are released directly to the environment, substances that are recovered, and substances that are transferred to various controlled disposal options such as a hazardous waste facility or an incinerator. This feasibility study is primarily concerned with pollutants released directly to the environment. Additional complementary indicators are suggested for participants who may also wish to identify and measure pollutant "transfers" to controlled disposal. As with the material and energy intensity indicators, this will provide the users, if appropriate, with an opportunity to provide a more complete picture of their activities.

A further consideration for pollutants released directly to the environment are pollutant releases that occur during the handling and treatment of substances that are reused, recycled or sent for controlled disposal. This can be viewed as indirect releases, which are attributed to the original companies' generation of the non-product output. Where such information is available it should be considered in the calculation of the indicator.

Figure 2: Non-Product Output of a Unit Process



Minimum Indicator Set

Each of the participating companies will test the feasibility of the following indicators:

1. Mass of pollutant releases per unit of output
2. Mass of pollutants common to TRI and ARET (placed in the ARET classification scheme) per unit of output.

Where unit of output is defined as a unit of production measure or a unit of revenue. All participating companies shall report the indicator using a unit of production as the denominator. If appropriate a denominator based on a unit of revenue (e.g., value added), should also be reported[5].

Pollutant releases (the mass of pollutants released for the defined manufacturing process or service) for the minimum indicator are selected substances from the following lists:

- Toxics Release Inventory (TRI);
- National Pollutant Release Inventory (NPRI); and
- Accelerated Reduction /Elimination of Toxics (ARET)

The intersection of these lists is illustrated in Figure 3. For the first minimum indicator, the substances occurring in sections A, B and C of Figure 3 are to be included as part of the indicator. A list of these substances is provided in Appendix B. A total of 195 substances are included in this minimum indicator.

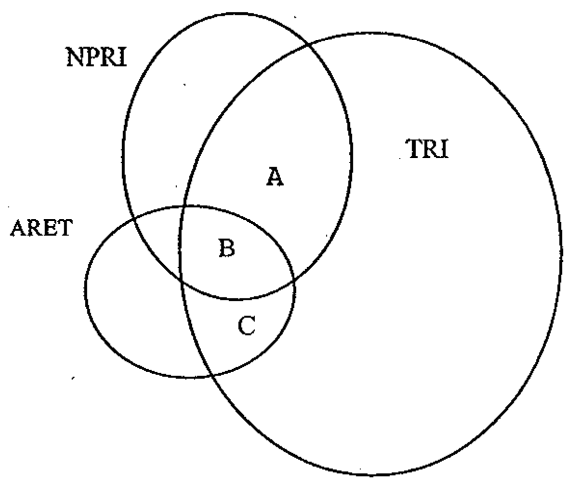


Figure 3. Illustration of pollutants to be reported in the minimum indicator set.

The second minimum indicator was developed to allow participating companies to differentiate pollutant releases based on a classification system that categorises pollutants based on their environmental relevance. The indicator comprises pollutants in section B and C of Figure 3 grouped into the ARET classification system.

A list of these pollutants grouped into the ARET classification scheme is provided in Appendix B. The ARET classes (A1, A2, B1, B2, and B3) are a ranking of the pollutants based on their intrinsic properties.

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[5] Although the information contained in the numerator is publicly available data it is important to note that issues of confidentiality may arise in the selection of the numerator. Participating companies are not obligated to provide any information which is confidential in nature or which might provide information useful to competitors.

To minimise the number of indicators a number of alternative groupings of the ARET classes were discussed at the workshop. The recommended approach is to add A1 and A2 substances together, leaving B1 as a class by itself and to adding classes B2 and B3 together. This aggregation step will result in three measures for the second indicator in the minimum set.

Note 1: For the purpose of the feasibility study the total mass for each of the groupings will be reported. With this basic data the participating companies can test and evaluate other approaches. For example, total mass of all groupings assuming an equal weight among all groupings or total mass using alternative weighting factors for each grouping.

Note 2: A reality check will be conducted by each company to determine whether other significant chemicals of concern are not captured. For example, a manufacturing site may be checked to ensure that it is not releasing large quantities of a chemical that is of environmental concern but not included in the minimum set.

Companies should look at the ease of collecting additional data on significant releases not included above; where this data is readily available companies are encouraged to evaluate the effect of this data on the indicator.

Note 3: Workshop participants also noted that prior to conducting the feasibility study it would be desirable to determine the relationship of the above lists to European priority substance lists.

About ARET

ARET is a multi-stakeholder initiative dedicated to decreasing the adverse effects of toxic substances on human health and the environment. These effects are mitigated by accelerating the reduction or elimination of emissions of selected toxic substances.

ARET especially targets toxic substances that persist in the environment and bioaccumulate in living organisms. Through voluntary action, organizations that use, generate or release toxic substances strive to reduce or eliminate their emissions of these substances.

The ARET process screened two thousand substances to develop the ARET list of 117 toxic substances.

Source: *Environmental Leaders 2 Accelerated Reduction / Elimination of Toxics Progress Report*

6. COMPLEMENTARY INDICATORS

In addition, to the pollutants identified in the minimum set, companies may wish to develop complimentary indicators in any of the following ways:

- expand their pollutant list (i.e., add additional classes) to include, for example such items as common air pollutants or greenhouse gas emissions;
- for companies testing the indicator within Canadian operations, add to the minimum indicator releases of other ARET and NPRI substances; and
- for companies testing the indicator within American operations, add to the minimum indicator releases of other TRI substances.

Moreover any of the indictors developed can be measured at other life cycle stages including material acquisition and processing, transportation, use, and disposition (see Level 4 in Figure 1).

For these complementary indicators the selection of the unit of output is identical to the minimum set.

7. RELATIONSHIP TO THE MATERIAL INTENSITY INDICATOR

In the NRTEE energy and material intensity feasibility study the material intensity indicator is defined as follows:

$$\frac{\text{Total material used directly in the product and co-product}}{\text{Total output of product and co-product}}$$

$$\frac{\text{Total material used directly in product and co-product + total indirect material}}{\text{Total output of product and co-product}}$$

Where input includes materials directly incorporated in the product and co-product, and indirect (ancillary) materials used in the manufacturing process to produce the product and/or co-products, but do not end up in the product or co-product. Materials include raw materials, packaging, and water (excluding non-contact water).

The pollutant dispersion indicator tracks a portion of the material flows that are not included in this measure - the non-product output (see Figure 2). For the material intensity indictor the following decision rule applies:

> All materials, which make up greater than 1% by mass of the products or co-products leaving the manufacturing site, will be identified. From this list, the materials that have a cumulative mass contribution of up to 90 % of the total weight of products or co-products would be included.

Companies who are testing both the PDI and the material intensity indicator will also wish to ensure that they are tracking the PDI pollutants regardless of whether they meet this decision rule. This will help streamline data collection, facilitate the measurement of the PDI, and will help link the material intensity and pollutant dispersion indicators.

8. DATA COLLECTION AND CALCULATION PROCEDURES

For all indicators used, each company will describe and document the data collection and calculation procedures, and the verification procedures used.

Each company is responsible for data collection and handling and will report according to the following:

- Units: Pollutants will be reported in metric units (e.g. kg or tonnes)

- Allocation: If the indicators are normalised to a product or service, allocations based on mass will be used if multiple products are produced from the same facilities (e.g., different grades of paper from a mill).

- Time period coverage: Time period used for all indicators will be 1996 data. To the extent that is available earlier years (95, 94, 93...) may also be used. This information over several years will help the users evaluate the usefulness of the PDI to assist decision making.

- Thresholds: The reporting thresholds for both indicators in the minimum set will be those currently used in NPRI and TRI. Appendix D provides current thresholds.

For the complimentary set of indicators, each company will document and report to the steering committee, the calculation procedures, assumptions, and decision rules used to include and/or exclude pollutants. Information on generic data quality concerns is contained in Appendix E.

9. RESULTS VERIFICATION

Verification of the feasibility study process will be carried out through distribution of the workshop report to the NRTEE Eco-efficiency Task Force and representatives of the stakeholders identified in Section 4.

Although not part of this feasibility study, it is recognised that verification of the procedures used by the companies may be required in the future, as appropriate. Additionally the results of the feasibility study may also be verified by application to other companies prior to full-scale implementation.

10. COMMUNICATIONS PLAN

There are three proposed elements to a communications plan for the project. Ongoing communications of the feasibility project, internal communications between the participants, and communication of the final results.

For ongoing communications, a package will be produced for each participant, which includes:

- An overhead presentation describing the project, indicators, method, expected outcomes and business benefits of participating in the project;
- A one page communication note on the project, including who to contact for additional information; and
- Copy of the report from the January workshop.

For internal communications, a schedule for regular information exchange between participating companies will be developed. Whenever possible, electronic forms of communications will be used. When appropriate, follow-up meetings will be scheduled and project updates will be produced.

The third element of the communications plan for this feasibility study will be a strategy (agreed to by all participants) to communicate the final results.

11. COSTS

The feasibility study team will endeavour to design the most cost effective approach possible. Participants are encouraged to complement existing measurement and management systems, and capitalise on opportunities to share information and costs. Where possible participants will document costs and business benefits associated with conducting the feasibility study. Considerations in determining the costs are labour hours, direct expenses, travel, and any consultancy (if used).

12. PLAN OF ACTION

The Steering Committee (SC) is comprised of representatives of each of the participating companies, as well as members of the NRTEE Eco-efficiency Task Force. It is essential to have one primary and one or more secondary contacts for each company. This will ensure that participation by the company continues, even when there is a conflict in scheduling interactions among the Steering Committee. It is proposed that the Steering Committee make decisions regarding this project on a consensus basis.

The proposed role of the Steering Committee is to:

- Oversee the implementation of the feasibility study.
- Be available to discuss and resolve issues brought up by the individual companies.
- Results of individual company efforts are presented to Steering Committee for final agreement and resolution of outstanding issues.
- Direct the preparation of outlines and divide up tasks related to the completion of the feasibility study.
- Direct the preparation of the final report.

The proposed role of the individual companies is as follows:

- Take the results of the January workshop (indicators, methodology framework and plan of action) and obtain appropriate approval and buy-in from the company.
- Be primarily responsible for data collection.
- Participate in the regular information exchange between participating companies and provide representatives to the necessary follow-up meetings.
- Be available to describe data collection efforts, and to follow-up and answer questions raised by Steering Committee.
- Finalise all data collection efforts.
- Assist in preparing draft sections of final report.
- Approve final report.

Table 1 sets out the schedule for the feasibility study.

Table 1: Proposed Schedule

Email Word 6.0 version of document + lists + communications piece to NRTEE	Feb. 6
Forward document to participating companies	Feb. 10
Comments from companies back to NRTEE + Go no go decision by companies	Feb. 13
Forward document to reviewers – let them know feasibility study is going forward and check significant concerns	Feb. 27
Response back from reviewers	March 13
Initial data collection	March - May
Reality Check SC meeting – firm up path forward, liaison with reviewers if appropriate	March 16
NRTEE Eco-efficiency program communication session	March 17 Globe 98 Vancouver
PDI SC meeting – evaluate progress, map out next steps	June 25
Draft Final Report	1998....
Final Report	1998....

APPENDIX A: Notes regarding the chemical lists.

The following should be noted with respect to the chemical lists in Appendix B and C:

These comparison lists were compiled from the complete lists of TRI, NPRI and ARET substances obtained directly from the government agencies responsible for these lists. They were the valid lists as of the January 1998. Matches for chemicals were based on CAS number to ensure accuracy. Hence the lists are ordered by CAS number except for the metals, which are handled differently. TRI lists elemental metals with associated CAS numbers; NPRI lists metals "and their compounds", with no CAS numbers; ARET lists inorganic soluble forms for metals generally, again with no CAS numbers. It was assumed that if copper is on one list, for example, it means essentially the same thing as copper listed on the other two lists.

The TRI list refers to PCBs as CAS# 1336-36-3, while the corresponding Canadian entry (only on ARET) has no CAS number. The CAS identification cell block for these substances have been left blank. The individual lists contained the following total number of chemicals:

TRI = 581
NPRI = 178
ARET = 121 (116 individual chemicals + 5 group categories)

The ARET list contains several group categories of chemicals. These groups are the following:

Non-CAS ID	Chemical name	Group
PAH-A1	PAHs A-1 (not speciated)	A-1
PAH-B1	PAHs B-1 (not speciated)	B-1
PAH-B2	PAHs B-2 (not speciated)	B-2
TCDF/TCDD	2,3,7,8-TCDF/TCDD	A-1
NA12	PCBs	A-1

Only the PCB grouping is treated as a "substance" in compiling the lists in Appendix A and B.

In figure 2 - the Venn diagram, a + b + c = 195 substances

NPRI and TRI (or a + b):	165 substances
ARET and TRI (or b + c):	78 substances
ARET and NPRI and TRI (b only):	48 substances

One interesting fact to note is that although each list contains unique chemicals, the intersection of ARET + NPRI is the same as ARET + NPRI + TRI. In other words, there are no chemicals that are on both ARET and NPRI which are not also on TRI.

APPENDIX B: Chemical list for Indicator 1

TRI + (NPRI or ARET)

Substance	CAS Number
1,1,2,2-Tetrachloroethane	79-34-5
1,1,2-Trichloroethane	79-00-5
1,2,4-Trimethylbenzene	95-63-6
1,2-Butylene oxide	106-88-7
1,2-dibromo-3-chloropropane	96-12-8
1,2-Dichloropropane	78-87-5
1,2 dichloroethane	107-06-2
1,2 diphenylhydrazine	122-66-7
1,2,4-Trichlorobenzene	120-82-1
1,3 butadiene	106-99-0
1,3 dichloropropene	542-75-6
1,4 dioxane	123-91-1
2,4,6-trichlorophenol	88-06-2
2,4-Diaminotoluene (and its salts)	95-80-7
2,4-Dichlorophenol (and its salts)	120-83-2
2,4 dinitrotoluene	121-14-2
2,6 dimethylphenol	576-26-1
2,6 dinitrotoluene	606-20-2
2-Ethoxyethanol	110-80-5
2-Methoxyethanol	109-86-4
2-methylpyridine	109-06-8
2-naphthylamine	91-59-8
2-nitropropane	79-46-9
3,3' dichlorobenzidine	91-94-1
4,6 dinitro-o-cresol	534-52-1
4-aminoazobenzene	60-09-3
4-aminobiphenyl	92-67-1
4-nitrosomorpholine	59-89-2
Acetaldehyde	75-07-0
Acetamide	60-35-5
Acetonitrile	75-05-8
Acrolein	107-02-8
Acrylamide	79-06-1
Acrylic acid (and its salts)	79-10-7
Acrylonitrile	107-13-1
Allyl alcohol	107-18-6
Allyl chloride	107-05-1
alpha-hexachlorocyclohexane	319-84-6
Aluminum (fume or dust)	7429-90-5
Aluminum oxide (fibrous forms)	1344-28-1
Ammonia (Total)	
Aniline	62-53-3
Anthracene	120-12-7
Antimony (and its compounds)	
Arsenic (and its compounds)	
Asbestos	1332-21-4
Benzene	71-43-2

Benzidine	92-87-5
Benzoyl chloride	98-88-4
Benzoyl peroxide	94-36-0
Benzyl chloride	100-44-7
Beryllium	7440-41-7
Biphenyl	92-52-4
bis(2-chloroethyl)ether	111-44-4
bis(2-ethylhexyl)phthalate	117-81-7
bis(chloromethyl) ether	542-88-1
Bromodichloromethane	75-27-4
Bromomethane	74-83-9
Butyl acrylate	141-32-2
Butyraldehyde	123-72-8
C.I. Acid Green 3	4680-78-8
C.I. Basic Green 4	569-64-2
C.I. Basic Red 1	989-38-8
C.I. Disperse Yellow 3	2832-40-8
C.I. Food Red 15	81-88-9
C.I. Solvent Orange 7	3118-97-6
C.I. Solvent Yellow 14	842-07-9
Cadmium (and its compounds)	
Calcium cyanamide	156-62-7
Carbon disulphide	75-15-0
Carbon tetrachloride	56-23-5
Catechol	120-80-9
Chlorine	7782-50-5
Chlorine dioxide	10049-04-4
Chloroacetic acid (and its salts)	79-11-8
Chlorobenzene	108-90-7
Chloroethane	75-00-3
Chloroform	67-66-3
Chloromethane	74-87-3
Chromium (and its compounds)	
Cobalt (and its compounds)	
Copper (and its compounds)	
Cresol (mixed isomers and their salts)	1319-77-3
Cumene	98-82-8
Cumene hydroperoxide	80-15-9
Cyclohexane	110-82-7
Decabromodiphenyl oxide	1163-19-5
Dibutyl phthalate	84-74-2
Diethanolamine (and its salts)	111-42-2
Diethyl sulphate	64-67-5
Dimethyl phthalate	131-11-3
Dimethyl sulphate	77-78-1
Dinitrotoluene (mixed isomers)	25321-14-6
Epichlorohydrin	106-89-8
Ethyl acrylate	140-88-5
Ethyl benzene	100-41-4
Ethyl chloroformate	541-41-3
Ethylene	74-85-1
Ethylene dibromide	106-93-4
Ethylene glycol	107-21-1

Ethylene oxide	75-21-8
Ethylene thiourea	96-45-7
Formaldehyde	50-00-0
gamma-hexachlorocyclohexane	58-89-9
Hexachlorobenzene	118-74-1
Hexachlorocyclopentadiene	77-47-4
Hexachloroethane	67-72-1
Hydrazine (and its salts)	302-01-2
Hydrochloric acid	7647-01-0
Hydrogen cyanide	74-90-8
Hydrogen fluoride	7664-39-3
Hydrogen sulphide	7783-06-4
Hydroquinone (and its salts)	123-31-9
Isobutyraldehyde	78-84-2
Isopropyl alcohol	67-63-0
Isosafrole	120-58-1
Lead (and its compounds)	
m-Cresol (and its salts)	108-39-4
m-Xylene	108-38-3
Maleic anhydride	108-31-6
Manganese (and its compounds)	
Mercury (and its compounds)	
Methanol	67-56-1
Methyl acrylate	96-33-3
Methyl ethyl ketone	78-93-3
Methyl iodide	74-88-4
Methyl isobutyl ketone	108-10-1
Methyl methacrylate	80-62-6
Methyl tert-butyl ether	1634-04-4
Methylene chloride	75-09-2
Michler's ketone (and its salts)	90-94-8
Molybdenum trioxide	1313-27-5
n,n-Dimethylaniline (and its salts)	121-69-7
n-Butyl alcohol	71-36-3
N-nitroso-di-n-propylamine	621-64-7
N-nitrosodimethylamine	62-75-9
n-Nitrosodiphenylamine	86-30-6
Naphthalene	91-20-3
Nickel (and its compounds)	
Nitric acid	7697-37-2
Nitrilotriacetic acid (and its salts)	139-13-9
Nitrobenzene	98-95-3
Nitroglycerin	55-63-0
o-anisidine	90-04-0
o-Cresol (and its salts)	95-48-7
o-Dichlorobenzene	95-50-1
o-Phenylphenol (and its salts)	90-43-7
o-Xylene	95-47-6
p,p'-Isopropylidenediphenol	80-05-7
p,p'-Methylenebis(2-chloroaniline)	101-14-4
p,p'-Methylenedianiline	101-77-9
p-Cresol (and its salts)	106-44-5
p-Dichlorobenzene	106-46-7

p-Nitrophenol (and its salts)	100-02-7
p-Phenylenediamine (and its salts)	106-50-3
p-Quinone	106-51-4
p-Xylene	106-42-3
PCBs	
Pentachlorophenol	87-86-5
Peracetic acid (and its salts)	79-21-0
Phenanthrene	85-01-8
Phenol	108-95-2
Phosgene	75-44-5
Phosphoric acid	7664-38-2
Phosphorus (yellow or white)	7723-14-0
Phthalic anhydride	85-44-9
Propionaldehyde	123-38-6
Propylene	115-07-1
Propylene oxide	75-56-9
Pyridine (and its salts)	110-86-1
Quinoline	91-22-5
Safrole	94-59-7
sec-Butyl alcohol	78-92-2
Selenium (and its compounds)	
Silver (and its compounds)	
Styrene	100-42-5
Styrene oxide	96-09-3
Sulphuric acid	7664-93-9
tert-Butyl alcohol	75-65-0
Tetrachloroethylene	127-18-4
Tetramethylthiuram disulphide	137-26-8
Thiourea	62-56-6
Thorium dioxide	1314-20-1
Titanium tetrachloride	7550-45-0
Toluene	108-88-3
Toluene-2,4-diisocyanate	584-84-9
Toluene-2,6-diisocyanate	91-08-7
Toluenediisocyanate (mixed isomers)	26471-62-5
Trichloroethylene	79-01-6
Vanadium (fume or dust)	7440-62-2
Vinyl acetate	108-05-4
Vinyl bromide	593-60-2
Vinyl chloride	75-01-4
Vinylidene chloride	75-35-4
Xylene (mixed isomers)	1330-20-7
Zinc (and its compounds)	

APPENDIX C: Chemical list for Indicator 2.

ARET + TRI (by ARET category)

ARET -A1	CAS Number
4,4'-methylenebis(2-chloroaniline)	101-14-4
alpha-hexachlorocyclohexane	319-84-6
gamma-hexachlorocyclohexane	58-89-9
Hexachlorobenzene	118-74-1
PCBs	NA12
Pentachlorophenol	87-86-5
Phenanthrene	85-01-8

ARET A-2	Cas Number
1,4 dichlorobenzene	106-46-7
Cadmium (inhalable & soluble inorganic)	NA1

ARET B-1	CAS Number
2,4,6-trichlorophenol	88-06-2
3,3' dichlorobenzidine	91-94-1
Anthracene	120-12-7
bis(2-ethylhexyl)phthalate	117-81-7
Hexachlorocyclopentadiene	77-47-4

ARET B-2	CAS Number
1,1,2,2-tetrachloroethylene	127-18-4
1,2 dichloroethane	107-06-2
1,4 dioxane	123-91-1
2-naphthylamine	91-59-8
2-nitropropane	79-46-9
4,6 dinitro-o-cresol	534-52-1
alpha-chlorotoluene	100-44-7
Arsenic (inorganic)	NA2
Asbestos	1332-21-4
Beryllium	7440-41-7
bis(2-chloroethyl)ether	111-44-4
Bromodichloromethane	75-27-4
Carbon tetrachloride	56-23-5
Chloroform	67-66-3
Chromium (Cr6+)	NA3
Cobalt (inorganic, soluble)	NA4
Copper (inorganic salts)	NA5
Ethylene oxide	75-21-8
Lead (all forms except alkyl)	NA6
Mercury (elemental and inorganic)	NA7
Methylene chloride	75-09-2
Nickel (inorganic, inhalable, soluble)	NA8
o-anisidine	90-04-0
Silver (soluble inorganic salts)	NA9

Thiourea	62-56-6
Zinc (inorganic, inhalable, soluble)	NA11

ARET B-3	CAS Number
1,1,2-trichloroethylene	79-01-6
1,2-dibromo-3-chloropropane	96-12-8
1,2 diphenylhydrazine	122-66-7
1,3 butadiene	106-99-0
1,3 dichloropropene	542-75-6
2,4-dichlorophenol	120-83-2
2,4 dinitrotoluene	121-14-2
2,6 dimethylphenol	576-26-1
2,6 dinitrotoluene	606-20-2
2-methylpyridine	109-06-8
4-aminoazobenzene	60-09-3
4-aminobiphenyl	92-67-1
4-nitrosomorpholine	59-89-2
Acetaldehyde	75-07-0
Acetamide	60-35-5
Acrolein	107-02-8
Acrylamide	79-06-1
Acrylonitrile	107-13-1
Aniline	62-53-3
Benzene	71-43-2
Benzidine	92-87-5
bis(chloromethyl) ether	542-88-1
Chlorine dioxide	10049-04-4
Epichlorohydrin	106-89-8
Ethylene dibromide	106-93-4
Ethylene thiourea	96-45-7
Formaldehyde	50-00-0
Hydrazine	302-01-2
Hydrogen sulphide	7783-06-4
Methyl isobutyl ketone	108-10-1
N-nitroso-di-n-propylamine	621-64-7
N-nitrosodimethylamine	62-75-9
N-nitrosodiphenylamine	86-30-6
Phenol	108-95-2
Quinoline	91-22-5
Tetramethylthiuram disulphide	137-26-8
Toluene diisocyanates	26471-62-5
Vinyl bromide	593-60-2

APPENDIX D: Reporting thresholds for NPRI and TRI

	NPRI	TRI
Minimum concentration of substance	1.0% except for unintentional by-products where there is no concentration threshold	No threshold addressed
Minimum annual quantity	Manufactured, processes or used = 10 000tonnes	1. Manufactured or processed = 11.34 tonnes 2. Used = 4.54 tonnes
	Note: For NPRI both the concentration and quantity thresholds must be met.	

The difference in these thresholds will need further discussion if the feasibility study moves forward. For transparency purposes it may be important to identify where a participating company is not reporting a release because of concentration or quantity thresholds are not met. This could be important from a stakeholder perspective and, for example, in comparing performance of different companies in a similar business sector.

APPENDIX E: Data Quality

This appendix specifies the general data quality requirements needed to meet the project goals. Data quality may be defined as the degree of confidence one has in the data. Every effort should be made by participants to collect high-quality primary data. Where primary data are not available, secondary or surrogate data may be employed.[7]

For each indicator, information regarding the source, nature, and quality of the data shall be reported by the respondent. Where possible, estimates of variability associated with the indicators should be considered and included. Data used in the feasibility study will also be characterised as to whether measured, calculated, or estimated values have been used. These latter indicators are defined as follows:

> **Measured:** Primary data reflect actual measurements (direct sampling) performed during the subject time period.
>
> **Calculated:** Measured values have been modified to reflect calculations by the process engineer based on process design and operation (report rationale especially where professional judgements and estimates are used).
>
> **Estimated:** Any secondary data, design-based extrapolations to other facilities or processes or other theoretical calculation (report data source, any allocations, and rationale).

Additionally, qualitative and quantitative data quality indicators (DQIs) may be used. The following section outlines DQIs.

Qualitative data quality indicators

Consistency

Consistency describes how uniformly the methodology is applied not only across different processes and stages within a life cycle, but also to other products, systems, and services. Documentation of the assumptions, protocols, and transparency of the process is needed to ensure that the results can be reproduced.

Consistency is assessed by reviewing how tools or procedures (including such things as process flow diagrams, boundary descriptions, templates, normalisation and/or aggregation methods, calculations and computer procedures) are applied.

It should be noted that while consistent techniques may be used, diverse results may still be obtained for reasons including the use of different raw materials or different processes. It is

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[7] "Primary" refers to data collected directly from single facilities; "secondary" refers to data acquired from reference materials or published studies. "Surrogate" data may be used where some information is initially missing or ill defined.

easy to misplace or misinterpret the position of process boundaries, which directly affect perceived quality.

Representativeness

Representativeness refers to the degree to which data values and results truly reflect the processes relevant to the indicator included in the study. The degree of representativeness may be judged by comparing data sets for similar processes within the study, and perhaps with sets of published data.

Where published studies are not readily available, an examination of the technological mix of the processes in the study is conducted to ensure that the production-weighted inputs of the various technologies are fairly represented.

Anomalies and Missing Data

Anomalies are extreme data values within a data set. Where a data value is suspect, more information should be obtained, if possible, to determine if the datum is within the expected range of the average value.

Missing data or data gaps are absent data values that are considered important. Where important data are missing, efforts should be made to fill these gaps with measurements or calculations, if possible. Otherwise, explicit and documented estimates may be used to fill the data gaps.

Quantitative data quality indicators

Completeness

Completeness evaluates the sets of primary data obtained relative to the number of data sets that might possibly be obtained. A measure of the completeness of a primary data category for each manufacturing unit is performed by dividing the number of reporting locations providing data by the number of locations which were solicited for data.

Precision

Precision is a measure of the spread or variability within a data set, expressed as a statistical mean and variance. Where more than three data points exist, a mean and an estimate of variability may be obtained. Such calculations are performed for each primary data category.

APPENDIX F: Participants List

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Measuring Eco-efficiency in Business: Developing and Implementing Energy and Material Intensity Indicators

Report of the Mid-Feasibility Study Review Meeting March 16, 1998

Vancouver, Canada

Prepared for

National Round Table on the Environment and the Economy

Prepared by

DEMETER GROUP
AND
ROY F. WESTON, INC.

Introduction

The National Round Table on Environment and Economy (NRTEE) and a number of leading North American companies are undertaking two feasibility studies in cooperation with the World Business Council for Sustainable Development (WBCSD), to develop eco-efficiency indicators. The purpose of these studies is to test the feasibility and value of material and energy intensity indicators, and pollutant dispersion indicators, to support the goal of eco-efficiency.

This report provides a brief synopsis of the mid-course meeting held in Vancouver, British Columbia on March 16, 1998. The purpose of the meeting was to take stock of the progress companies had made in conducting the material and energy intensity indicators feasibility study and to discuss issues arising from the first few months of effort. The status of the pollutant dispersion indicator (PDI) work was also discussed.

With the exception of a Mosanto representative, all company representatives participating in the energy and material feasibility study were present. George Werezak from Dow Canada joined the discussions in the afternoon session. Rob Macintosh, a member of the NRTEE Eco-Efficiency Task Force, also participated in the meeting.

MATERIALS AND ENERGY INTENSITY INDICATORS

Reviewers' comments

The materials and energy intensity indicators feasibility study methodology requires that various stakeholder groups review the study process. Representatives of this group are identified in the design workshop report from November 1997.

Comments on the feasibility study workshop report were received from the following organizations: Environment Canada, the Canadian Institute for Chartered Accountants, the International Institute for Sustainable Development, the World Business Council for Sustainable Development, and Gulf Canada Resources Limited. Overall, the reviewers were very supportive of this project, and agreed with the scope of the study. The following issues were raised:

The need to further develop the material intensity indicator: It was noted that this indicator could be expanded to take into account other life cycle stages. This would be similar to the complementary set of indicators for the energy intensity indicator.

The importance of verifying results in developing credible indicators: It was noted that verification of data and related indicators by a third party will be required in the future and, therefore, extended verification procedures should be considered in the feasibility study.

The usefulness of linking this work to greenhouse gas tracking and climate change discussions; particularly the complementary energy intensity indicator C5 (life cycle energy) and C6 (energy-related greenhouse gas emissions).

The value of establishing clear, consistent boundaries for the indicators; i.e., ensure that the scope and boundary of the numerator are the same as those of the denominator. Reviewers also commented on the level at which the indicators should initially be measured. It was suggested that the feasibility study should concentrate at the level of the company or its manufacturing site. Conversely, one reviewer proposed that, given this is a feasibility study, it should advance indicator development and concentrate on indicators which reflect different life cycle stages.

Company Progress Reports

Company representatives provided an overview of their respective progress to date. They are proceeding with the implementation phase of the feasibility study. The following issues have arisen so far:

Availability of data - A number of participants noted that existing data systems were not sufficient to track the information required for the indicators. Problem areas included:

- Energy supply data, i.e., environmental profiles for the various types of energy;
- packaging data from upstream suppliers; and
- material input data (waste output data can often be tracked but, in many cases, material input cannot).

Quality of data - Participants noted variations in the quality of data available, particularly when searching for data outside their own operations.

Energy - The use of average grid numbers versus actual supply numbers was the subject of some discussion. Some participants believed that it would be difficult to determine the actual source of the energy they obtained from the grid. Even if this determination was made possible, it would be difficult to obtain the profile of the energy (for instance, energy, material and environmental releases for Ontario's nuclear power or Quebec's hydro power).

Allocation procedures - The choice of allocation procedures could sometimes be problematic, for example, the different metals that can be extracted from ore. In certain cases, allocation procedures could be applied on a mass basis, in other cases, an economic allocation would be applicable.

Timing of project - The phase of implementing the indicators can move relatively swiftly. Project teams and individuals in charge need time to adjust to new procedures and to the responsibility of collecting the necessary data.

Business priorities can sometimes interfere with the feasibility study. In one case, initiation of the project was delayed due to company restructuring and, in another case, data collection for one site was postponed due to expansion of the plant.

Proprietary issues related to the use of an economic denominator. Acquiring information on energy and material use while correlating these numbers to units of revenue might disclose competitive information.

Changing product mix affects indicators. New and discontinued product lines will present a challenge to the development of consistent, reproducible indicators.

Loss of meaning using highly aggregated indicators. Data aggregation across different product lines and manufacturing sites can create a loss in resolution and responsiveness. A suite of indicators was therefore suggested.

Using the indicator as a communication tool. Communication within the company and with external audiences becomes difficult with highly aggregated indicators.

Participants are prepared to discuss options and/or recommendations on how to address their respective concerns at the next meeting, which is scheduled for June 23-24, 1998.

<u>Major Issues</u>

Further discussion revolved around the following points:

Suite of Indicators – Rethinking the ability to reflect eco-efficiency in a small number of highly aggregated indicators may be required. There was some concern that such numbers may not be meaningful internally or useful in determining possible improvement opportunities. The notion of using a suite of indicators was raised as a possible solution.

Material intensity indicator - A number of problems were identified in relation to the material intensity indicator. For reasons stated in the November workshop report, Noranda and Alcan are not measuring the material intensity indicator. Both Nortel and Bell were unable at this time to track material inputs. It was acknowledged that this indicator needs to be further defined (i.e., the difference between the indirect and direct materials).

Water treatment - It was pointed out that for some products (paper towels, for example) the inclusion or exclusion of water in the indicator would make a considerable effect on the outcome. It was concluded that a separate indicator for water might be necessary.

Schedule and Communications Plan

Participants indicated that the schedule proposed in the November workshop report was still applicable. With respect to the communications plan, participants agreed to a low profile release of the November workshop report on the energy and materials indicators, given that it has already been circulated to reviewers.

POLLUTANT DISPERSION INDICATOR (PDI)

The status of the pollutant dispersion indicators as well as future direction were discussed.

Jean Bélanger stressed the importance of developing the means of measuring eco-efficiency in a PDI, otherwise, others will likely do so without a consultative process. Considering the NRTEE's past efforts, it is appropriate that options for the creation of a PDI be explored. A PDI would be an improvement over existing chemical lists, which are not indicative of eco-efficiency. Using a PDI would provide a common approach for application in corporate environmental reports, thereby clarifying the data for external audiences.

A discussion regarding a pollutant dispersion indicator ensued. The following issues were identified:

The familiarity to government policy makers of current inventories such as TRI, NPRI and ARET: these are well established inventories and, even though new indicators may be better measures of efficiency, they have to be clearly positioned as complements and/or improvements over existing inventories.

Will indicators that go beyond the TRI, NPRI and ARET lists add to the confusion of external audiences? Issues surrounding pollutants can become complex and gaining public acceptance for new indicators that surpass the simple quantitative measures of releases may be difficult. This could create confusion in the short term.

Recognition of the issue's high visibility and that opportunities exist to improve current measures and convey meaningful information about substances. The time may be ripe to take the next step toward second-generation pollutant indicators that surpass current release numbers. A well-designed indicator(s) can promote consistency, such as with corporate environmental reporting.

PDI indicator(s) might not only be limited to toxic substances but could also encompass common air pollutants and greenhouse gases.

A cautious approach should be adopted toward the creation of pollutant dispersion indicators. The choice of an appropriate denominator will require careful thought and planning.

Participants agreed that more discussion on the subject should take place. A few company representatives agreed to pursue implementation of the pollutant dispersion indicator using the workplan developed during the January PDI workshop, and report back their experiences to the meeting being held on June 25, 1998. Some of the other representatives indicated that they would not proceed with the PDI feasibility study at this time. A small sub-group of interested companies would be established to refine and further develop the indicator(s), investigate other initiatives and make recommendations back to the eco-efficiency Steering committee at the June 1998 meeting.

Note: Subsequent to the March 17 meeting a number of companies (i.e., GM, Dupont and Unilever) expressed interest in becoming part of the small sub-group to refine the PDI.

NEXT STEPS

The Steering Committee for feasibility studies will meet on June 23 – 25, 1998. The purpose of the meeting is to discuss the outcome of the materials and energy intensity indicators feasibility study and, as mentioned above, to further discuss developing the PDI.

A draft report on the material and energy intensity indicator study will be prepared by September. We expect the final report on this issue to be completed by December 1998. Work on the PDI will continue past this date. A revised schedule for this exercise will be available following the June meeting.

Measuring Eco-efficiency in Business: Indicators Workshop

Workshop Report
June 23-25, 1998
Montebello, Quebec

Prepared for

National Round Table on the Environment and the Economy

Prepared by

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and

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Preface

The National Round Table on the Environment and the Economy (NRTEE) and a number of leading North American companies are undertaking two feasibility studies to develop eco-efficiency indicators. The purpose of the studies is to test the feasibility and value of material and energy intensity indicators, and pollutant dispersion indicator(s), to support the goal of eco-efficiency. The energy and material intensity study was initiated in November 1997. Discussions on the pollutant dispersion indicator study began in January 1998. Readers are encouraged to refer to previous workshop and meeting reports to better understand the context and evolution of the feasibility studies. Previous reports can be obtained from the NRTEE. This document details the results of a workshop convened by the National Round Table on the Environment and the Economy on June 23-25, 1998, to evaluate progress with regard to both feasibility studies.

Table of contents

1. Overview

This report details the results of a meeting held by the National Round Table on the Environment and the Economy (NRTEE) in Montebello, Quebec on June 23-25, 1998. Two days of meetings were devoted to the discussion of the material and energy intensity indicators. The final day of the meeting dealt with the pollutant dispersion indicator.

The purpose of the meeting was to:

- receive progress reports from companies conducting the material and energy intensity feasibility study;
- document results achieved to date;
- analyse key issues arising during the implementation of the study;
- discuss the utility of the study for providing guidance on measuring eco-efficiency;
- continue the development of a pollutant dispersion indicator; and
- develop an outline for the final report.

With the exception of a representative from Westcoast Energy, all companies participating in the energy and material feasibility study were present. A number of companies interested in the pollutant dispersion indicator were unable to attend due to scheduling conflicts. Jean Bélanger and Rob Macintosh of the NRTEE Eco-efficiency Task Force also participated in the meeting. A participant list is provided in Appendix A.

2. The Material and Energy Intensity Indicators Study

Each of the seven companies in attendance provided an overview of progress to date with respect to the material and energy indicators feasibility study. All companies are proceeding with the study; although in the case of Noranda Inc., a corporate restructuring has caused difficulties in maintaining momentum on the implementation of the feasibility study. Company progress reports are provided as an electronic attachment to this report.

Having received presentations from each company, workshop participants identified the key issues and challenges that arose in the implementation of the feasibility study. These issues, elaborated below, mirrored the issues identified at the mid-course meeting in Vancouver and to a large extent they validated the initial directions set at the November workshop. Although the key issue discussion focused on the material and energy intensity indicators a number of references were made to the pollutant dispersion indicator (PDI). These references have been included and they are further elaborated in the PDI discussion in Section 7 of this report.

2.1 Key Issues and Energy Intensity Discussion

Participants identified a large list of key issues that either arose in conducting the feasibility study or were of general concern with respect to the development of eco-efficiency indicators. A number of these issues are elaborated below. A full list of issues along with a relative ranking provided by the participants is included in Appendix B.

The key issues discussion also considered in detail a number of points related to the development of the energy and material intensity indicator. Participants agreed that the energy intensity indicator was a reasonable measure of eco-efficiency, with the exception of the issues highlighted in this section. The discussions on the energy intensity indicator are therefore combined in this key issues section of the report. The material intensity indicator required greater discussion, which is detailed in Section 2.2.

2.1.1 External Credibility

The workshop participants noted that the manner in which the indicators are packaged and presented will affect the credibility of the indicators with various audiences. In particular, communicating the appropriate use of the indicators (e.g., for reporting a company's eco-efficiency progress) will be an important factor in ensuring credibility. Participants also noted that gaining wider acceptance for the use of the indicators will require support of a broader audience than the participating companies.

The energy intensity indicator was identified as having the broadest applicability for companies. This is because energy is in a sense a "currency" that can be converted to common units, whereas the material intensity indicator encompasses a large number of different materials each with their own physical attributes. For this reason the material intensity indicator is more complicated and perhaps less applicable (see Section 2.2).

To enhance the credibility of the study participants also recommended that the overall effort of developing eco-efficiency indicators be described as a "journey", which at present may be characterised as follows:

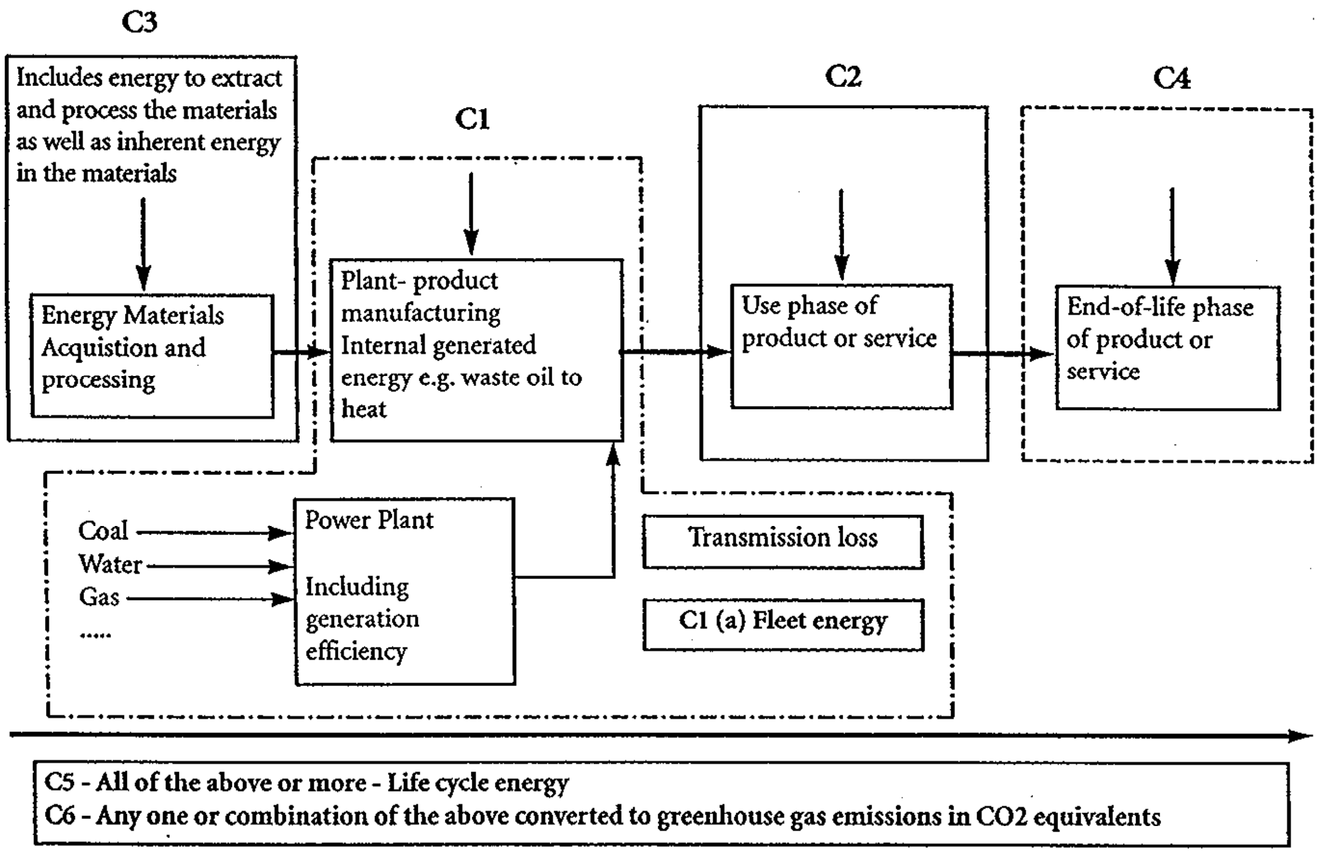
- energy intensity indicator - well along the road
- material intensity indicator - moving but a number of issues still need to be resolved
- pollutant dispersion indicator - just getting started

To further enhance the credibility of the indicators, participants recommended that a dialogue be maintained with stakeholders in which the rationale behind the indicators be clearly articulated. Internally, throughout the various business units and operations of the participating companies, it will be important to communicate the study results and the indicators to build awareness, understanding and credibility.

2.1.2 Standardization of the Numerator

A number of issues arose with respect to the selection of the numerator for the material and energy intensity indicators. Participants recognised that there is a trade-off between the desire of some audiences for comparability and the unique issues related to different industrial sectors. Participants further noted that the choice of numerator for complementary indicators might vary by sector, such as in choosing the boundary for the indicator. For example a raw material supplier might choose a complementary energy intensity indicator which would allow them to capture the power supply (C1) and energy associated with the acquisition and processing of materials entering the manufacturing process or service entity, including inherent energy of the materials (C6). A consumer product manufacturer on the other hand, may be more interested in energy consumed during the use phase of the product C2 and at the end of life C4.

Figure 1: Schematic of full complementary indicator set for energy intensity



A participant noted that care should be taken to ensure the suite of indicators does not have any redundant components that can lead to perverse results. For example, the selection of indicators should not lead to a situation in which a company would be measuring the mass of carbon entering a facility, the CO_2 being emitted when the carbon is oxidised, and also counting the energy that is generated from the combustion of the carbon. This measurement would be redundant and might lead to perverse results in terms of accounting for pollutants, carbon accounting or if the company sets goals related to individual indicators. In the latter situation a company could misinterpret the indicators if they did not identify the double or triple counting in a circumstance such as the one described above.

Participants discussed how to characterise the source of electricity. They agreed that wherever possible regional grids should be chosen over national averages. Data for regional grids can be obtained for most industrialised countries that will identify the location of the utility, the type of operation (hydro, nuclear, etc.) and the fuel purchased.

Participants also discussed how to treat net energy (purchased energy plus energy generated at the site minus energy exported) versus gross energy (total energy consumed). One viewpoint was that the energy purchased, generated and used at the site should be reduced by the amount of energy exported. The opposite view was that all energy used by the manufacturing plant or service entity, including internally generated energy should be included in the numerator. In this latter case, energy exported would be converted into mass, as equivalence of fuel used, and then added to the denominator. The question of how to treat feedstock inputs that become part of a product (e.g. natural gas) was also raised as an issue that will need clarification.

2.1.3 Denominator Issues

In the company presentations a financial denominator seemed preferred, particularly when the indicators are measured at a higher level in the organisation. Participants also noted that for product manufacturers and commodity producers a revenue-based measure might not be as meaningful. Both denominators, a revenue-based or unit of production measure, will be difficult to standardise as there can be a number of different approaches to selecting these types of measures.

Some participants suggested that a standardised denominator for different industrial sectors might be required. It was agreed that for the feasibility study companies should provide a rationale for the denominator they choose.

Participants were in fairly strong agreement that the numerator could be "standardised" but that flexibility is necessary with respect to the choice of reported denominator.

2.1.4 Complementary Indicators and Suite

Participants recognised that there is potentially high value for companies in looking at the C1 (capturing power supply) and C6 (GHG emissions) indicators.

Some participants felt that a selection of indicators from the full set (energy, material, and PDI) may be required to reduce redundant reporting and perverse results (see Section 2.1.2) Consequently a concern was expressed about reporting on the minimum material and energy indicators without a PDI or the complimentary energy indicator C6 (GHG). A number of the participants did not share this concern.

The majority of the participants indicated that a suite of eco-efficiency indicators is necessary to satisfy industry and the needs of a broader audience. It was felt that aggregating energy, material and pollutant data into overall indexes would undermine their usefulness for tracking eco-efficiency and guiding decision-making. This is particularly true for the PDI (see Section 7).

2.1.5 Timetable

With respect to the timetable of the feasibility study it was noted that significant input from the participating companies is required to make the December 1998 objective for publishing the results. Concern was expressed that the slower progress of the PDI feasibility study should not hold up the energy and material feasibility study. It was suggested that the primary focus of the

December report should be on energy, material, greenhouse gases, and perhaps water. The report however should explicitly address the PDI and describe progress to date on this study.

2.2 Material Intensity Indicator Discussion

The material intensity indicator presents a number of challenges. It was noted that the material intensity indicator is a good measure of waste minimisation, particularly if in the numerator the product is subtracted from the total materials used. However, the material intensity indicator does not provide information on the origin of the materials (e.g., renewable vs. non-renewable, from a sustainably managed resource or from a poorly managed resource). This absence of information on the origin of the materials can limit the usefulness of the material intensity indicator for tracking progress toward eco-efficiency.

It was further noted that while a material intensity indicator may be significant for some industries it is of limited applicability for industrial sectors such as metals and mining. This is offset to some extent in cases where life-cycle energy is being used as an indicator as this measure inherently includes information on material and wastes.

It was concluded that the material intensity indicator can be excellent for corporate management but is of less value for broad external reporting on eco-efficiency. To aid users in appropriate understanding and application of this measure it was suggested that a guideline for interpretation of a material intensity indicator would be useful.

Issues that require further clarification include:

- the treatment of water - for example, the geographic source of the water can be extremely important; and
- indirect materials such as recirculated/reused materials – How are these to be treated in the indicator? Would only losses be counted?

2.3 Greenhouse Gas Indicator Discussion

In the November workshop report the complementary indicator C6 dealt with greenhouse gas emissions. Under this indicator, greenhouse gas emissions measured in CO2 equivalents, would be included with the chosen energy indicator (minimum or minimum plus any combination of C1 to C5).

Participants noted that while most companies GHG emissions are energy related, some produce significant non-energy related GHG emissions. Given the importance of this issue for most companies it was decided to include all GHG emissions (energy related and non-energy related) in the complimentary indicator C6. See additional discussion in Section 7 below.

3. Utility of the Feasibility Study

Participants identified a number of positive results arising from their participation in the feasibility study. In particular they found that the study:

- **is reproducible** in terms of definitions, boundaries and general decision rules, and the study approach;
- provides **methodological guidance** that will be required in the future;
- **is not a one-company approach** - this enhances the credibility of the exercise and with eight companies participating a broader range of implementation issues are being addressed;
- is **grounded in practical trial efforts and is moving rapidly**;
- has **reduced the complexity** of the concept of eco-efficiency for some of the participating companies;
- has been **well received by outside audiences** such as the Vancouver Forum;
- is moving along a **continuum from data to reliable information to indicators** that could serve various audiences;
- provides **simplified, reasonably uniform** measures of how production is being managed;
- facilitates **informed dialogue with audiences by providing** indicators that show direction;
- has led to major companies arriving at a **consistent/uniform approach**;
- **is practical** in that it is moving toward the appropriate level of resolution for eco-efficiency indicators (i.e. a manageable number of indicators as opposed to a long laundry list);
- is leading to additional **contacts** both within the study and through external interests; and
- is exposing the participating companies to **alternative North American and international** perspectives.

4. Final Report

Appendix C presents a proposed outline for the final report. Participants suggested the following with respect to the final report:

- Add an executive summary.
- The report should discuss the context of the feasibility study and highlight the unique focus of this project.
- The issue of water should be highlighted in the report. This should be set in the context of the material intensity indicator and the discussions from the workshops should be elaborated.
- Company "profiles" could be added as appendix.

The process for finalising the report will involve reviews by the participating companies, the Eco-efficiency Task Force and NRTEE members.

5. Next Steps

The study participants briefly discussed options that should be pursued once the initial feasibility study is completed and the report is published. Ideas brought forward included:

- Recruiting more companies to further test the indicators.
- Solicit further comment and testing of the indicators from the Industrial Pollution Prevention Council and the Center for Waste Reduction Technologies.
- Further testing within current participating companies. For example, some companies expressed a desire to gather more data on the material intensity indicator.
- Evaluate the indicators in light of the WBCSD principles which are:
  - Eco-efficiency metrics will track the changing performance of a company over time.
  - The performance shall be compared against earlier set targets.
  - The metrics should strive to allow benchmarking within companies, between similar companies within the same sectors, and between different sectors.
- Discuss the results of the feasibility study with key industry associations and organisations and their associated advisory panels throughout North America. Some examples included the Chemical Manufacturers Association, Canadian Pulp and Paper Association, USAID, Canadian Chemical Producers Association, American Plastics Council, and the Friday Group.
- Discuss the results of the feasibility study with other "end users" of indicators (NGOs, institutional investors and the OECD Pollution Prevention and Control Group).
- Determine criteria for evaluating the success of the feasibility study and the resultant indicators.

6. Communications Strategy

A number of suggestions were made with respect to communicating the results of the feasibility study. One main point was that the study should continue to be described as joint NRTEE-WBCSD initiative. Ideas for communications vehicles included:

- Reconvening the participants of the initial Washington workshop.
- Hosting a larger information forum similar to the one held in Vancouver.
- Communicating the results of the feasibility study into the various GHG activities.
- Communicating the results of the study at the upcoming OECD Pollution Prevention and Control Group meeting on Implementing Eco-efficiency in Australia, February 1999.

- Combining the above suggestions with low-cost distribution of results (e-mail, website, and electronic links).
- Features/articles contributed to various targeted publications such as the Financial Post, BATE, CNN, Tomorrow, etc.

Whatever communications vehicles are chosen it is important to think about designing the communiqué such that structured feedback can be received on the studies. For example, individuals accessing a website can be asked to respond to a detailed questionnaire that solicits their view on the indicators, the results of the feasibility study and eco-efficiency in general.

7. Pollutant Dispersion Indicator Discussion

7.1 Company Presentations

Three presentations were made concerning the PDI. Two company presentations, one from Earl Beaver of Monsanto and one from Willie Owens of Proctor and Gamble, provided perspectives on developing a PDI. Rob Macintosh of the Pembina Institute for Appropriate Development provided an overview of impact categories the Institute uses with its industrial partners.

Earl Beaver noted that total toxics emitted by Monsanto were a relatively small proportion of the overall profile of pollutants released. He also noted that much of the current toxic emissions are not releases to the environment but transfers to various forms of treatment. For Monsanto this situation argues for a broader PDI indicator which includes other pollutants beyond toxic substances.

Willie Owens explained that Proctor and Gamble prefers to adopt a risk-based approach to the various categories of substances (Toxic Release Inventory (TRI) substances, high production volume (HPV) chemicals and persistent organic pollutants (POPs)). Therefore in considering TRI and HPV-type substances a distinction must be made between actual releases versus managed releases (which go to some form of treatment). For POPs-type substances the issue is where the criteria are set to ensure the "bad few" are dealt with appropriately.

Dr. Owens also pointed out that assessing risk for human toxicology is easier than it is for eco-toxicology because of the greater availability of data for human toxicology. This has implications for the development of safety factors such as predicted environmental concentration (PEC) and predicted no observable environmental concentration (PNEC). Traditional lists, such as the TRI, essentially weigh all chemicals equally and this is not in keeping with a risk-based approach. However, in determining risk or relative risk there are a number of technical issues that must be overcome.

Rob Macintosh of the Pembina Institute for Appropriate Development presented a list of impact categories that served as the basis for a general discussion of the types of environmental categories that could be included in a PDI indicator.

In this discussion the group agreed that PDI categories should use classifications or words that people generally recognise. A desire was also expressed to attempt to find a small number of categories that are in the general domain of public concern. These categories could form the basis of the PDI categories and other categories that are significant would be included on a company specific basis similar to the complementary indicators for energy intensity.

7.2 Proposed Categories for the PDI

Building on the impact categories identified by Mr. Macintosh, workshop participants discussed the potential categories for which pollutant dispersion indicators could be developed. A long list of potential categories was constructed. Participants prioritized the categories based on their experience and company perspective. Table 1 identifies those categories that have the most promise for inclusion in a PDI feasibility study. It is recognized that the proposed categories reflect only the experience of the companies present and that other companies might choose different categories.

Table 1: Proposed Categories for PDI Development

General Category	Pollutants considered
Water	• Dispersion of "priority" toxics • Other dispersed pollutants
Air	• Acid rain (acid deposition precursors) • Smog • Dispersion of "priority" toxics • Other dispersed pollutants
Global Issues	• Greenhouse gas emissions

"Priority" substances in the above Table refer to bio-accumulative, persistent and toxic compounds. A detailed list of these pollutants has yet to be decided for the feasibility study. A number of complimentary categories were identified. These complementary categories would be used by companies in a similar fashion to the complimentary energy intensity indicators. They are as follows:

- Oxygen depletors (BOD/COD)
- Micro-organisms
- Eutrophication
- Particulates
- Stratospheric ozone precursors
- Managed waste - hazardous and non-hazardous

7.3 Discussion of PDI and Proposed Categories

7.3.1 Reactions to Presentations and List

Relative to material and energy the development of an eco-efficiency type measure for pollutants is still in its infancy. Even established pollutant inventories such as the National Pollutant Release Inventory (NPRI) and TRI continue to evolve. The workshop participants believe that the PDI feasibility study has the opportunity to take a pragmatic and timely look at the pollutants aspect of eco-efficiency and develop a useful set of indicators.

There are two competing needs that must be addressed: 1) an intensive energy and material efficiency type approach to managing pollutants (risk management); and 2) reporting on the management of pollutants to external audiences. Most large companies are already taking action to meet the first requirement, the primary challenge is to determine a way to meet the second demand effectively.

Other observations regarding the PDI development are as follows:

- Regulations are a moving target. In many jurisdictions new programs are evolving and there is a trend toward developing a common international list based on current national pollutant lists.
- Generally, the PDI must be able to distinguish the "bad actors" (highly toxic, persistent and bio-accumulative substances) from a broad population of chemicals.
- Indicators, by definition, cannot deal with in-depth issues very well, but at the board of directors level broad indicators can be developed that will also be of interest to public. It was felt that indicators at this level will be highly aggregated but they can still provide directional information on the sound management of pollutants.
- Emission or impact categories for which indicators are developed must be dynamic, that is, they must be capable of changing over time. This is because some issues will be addressed in time and become of less importance (for example, many companies have addressed ozone depleting chemicals) and new issues will emerge.
- Looking at inputs and outputs in terms of "hazard" requires more detailed accounting of releases and where they end up. This is because hazard is often tied to exposure and therefore when and where a pollutant is released is of significance.

7.3.2 Aggregation

The majority of the participants felt that there should be disaggregation of pollutant dispersion indicators and in some cases more information or indicators should be added under each broad category (e.g. dispersion of priority toxics to water). The view was expressed that aggregation was not desired as it was as this could oversimplify complex environmental issues or concerns.

The alternative view was that the PDI issue should be considered in a context similar to energy and material in which case some aggregation is preferred, otherwise a pollutant dispersion indicator would overwhelm the other indicators.

As with the material and energy indicators consistency with respect to the methodology for data collection and handling is required for the PDI.

7.3.3 *Name for the PDI*

The appropriateness of the name "pollutant dispersion indicator" was discussed. Pollution indicator and pollution intensity indicator were suggested as possible alternative names. It was agreed that these names, along with the current pollutant dispersion indicator, would be informally tested with various internal and external audiences.

7.3.4 *Denominator*

The participants agreed that the denominators used for the energy and material intensity feasibility study (unit of production or unit of revenue) would be used for the PDI. In discussing the denominator, the primary issue of concern remained confidentiality, particularly within the chemical industry. It was noted that in the feasibility study companies are not being asked to disclose confidential information and that they can take whatever steps necessary to ensure confidentiality (e.g., rolling-up data or using a value-added type denominator).

7.3.5 *Next Steps for the PDI*

Initial consultations

It was agreed that participating companies would initially conduct an evaluation of the proposed PDI categories identified in Table 1 with a small group of individuals who have a particular interest in or perspective on eco-efficiency indicators. In this initial consultation some of the key questions will be:

- Are the proposed categories useful and meaningful to the company?
- Are there any important categories missing from the current list?
- Are there more "public friendly" names that can be given to the categories to facilitate communication?
- How should the indicators within each category be measured? What should it include? Is the data available?

Broader consultations

Concurrent to the initial consultation described above, it was suggested that a small group begin to flesh out the rationale, content and indicator associated with each of the categories identified in Table 1. Once this information takes shape participants agreed to discuss the proposed categories externally with other potential users of eco-efficiency indicators (e.g., companies, associations, and organizations) to get their feedback. They would gauge "top of mind reactions" to the following questions related to the development of a PDI.

- Are the issues covered in the proposed list of categories sufficient or too broad?

- What actions can be taken to ensure the credibility of a PDI? How can this be achieved? Who has to be involved?
- Is it helpful to place the disaggregated indicators under the broad media specific categories (air, water)?
- Is a suite of indicators such as those proposed preferred over a single indicator which rolls-up data from these categories?
- Who are the primary audiences for a PDI?
- What are the internal specific priorities for the company with respect to pollutants and indicators?
- Is there advice that can be given on how to communicate the categories? Are there other names for the categories that would be more useful?
- What is the general position on weighting (assigning relative quantitative values) within a category?
- Is there any preference in terms of choice of the denominator(s)?

7.3.6 Timing

It was agreed that by August 15, 1998, participants would conduct the initial consultation described in Section 7.3.5, with a select audience. The results of this effort will be discussed in a conference call on August 21, 1998. Based on the results of this initial effort a more detailed information package on PDI categories would be prepared for broader consultation and the results of this effort would be discussed at a conference call on September 30, 1998.

8. Schedule

Table 2 below provides the overall schedule of the feasibility study up to the submission of the final draft report in November 1998. Workshop participants noted that this is an ambitious schedule but it is in keeping with the original plan of action agreed to at the November 1997 workshop.

Table 2: Feasibility Study Schedule

Action(s)	Date
• Results of this meeting • Templates to companies • Summarised presentations from companies to NRTEE	July 10
PDI conference call	1 p.m. (Eastern), on Friday, August 21
Template provided by companies to NRTEE	August 31
Draft report circulated	September 15
Teleconference to discuss draft report and decide whether face-to-face meeting is required	11a.m. eastern September 30 - call will begin with energy and material discussion and followed by PDI
Energy and Material workshop (if required) Toronto	October 15
PDI workshop	October 16
Final draft report	October 30
Review and comment on final draft Report	Mid – November

In addition to the above tasks, company participants agreed that a detailed methodology and a set of decision rules are required for the proposed PDI categories in Table 1. The timing of the provision of this information is under consideration.

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Appendix B: Issues Identified in Round Table Discussion of Energy and Material Intensity Indicators

Issue	Numerical ranking
External credibility for the indicator	21
Standardisation of selected indicators	18
Apprehension of how the indicators will be used affected the selection of a denominator (confidentiality)	11
Value added of complimentary indicators – both internally and externally	11
Knowing customer needs to better understand data or indicators required – communications (in and out)	11
Timetable – dynamic of the need to move fast versus data collection challenges	11
Agreement on boundaries for numerator	9
Information needs by corporate decision-makers – choosing the scale	9
Choice of physical or economic denominator and which economic denominator	8
Eco-effectiveness – external judgement of social value or worth of the product	6
Limited applicability of material intensity indicator presented seems only suited to "real" manufacturers	5
Single versus sector specific denominators	4
Lack of an interim deliverable	4
Avoiding flavour of month	4
Certification/verification of data – given complexity	4
Additional guidance on treatment of water within material intensity indicator	4
Capacity of external audience to understand eco-efficiency	3
Accountability – verification of data	2
Numerator – how to express energy (source vs. average grid)	2
Transfer of information/indicators to SMEs	2
Alignment with existing internal indicator systems	1

Other unranked issues of concern:

- Changing priorities affect information flows
- Turbulence obtaining "steady state" data
- Commercially available, alternative indicators competing for managers' attention
- Fitting environmental and business aspects into one indicator

Appendix C: Final Report Outline

Introduction

The path to Washington meeting, April 1997
The workshop and conclusions reached at the Washington meeting
Actions and progress since the Washington meeting

Material Indicator(s)

The indicators that were (to be) tested and evaluated
What each company has done, and has learned to date and what each plans to do next
Summary of conclusions reached and key issues identified re: utility and evaluation
Suggestions for implementation and further development and evaluation

Energy Indicator (s)

The indicators that were (to be) tested and evaluated
What each company has done, and has learned to date and what each plans to do next
Summary of conclusions reached and key issues identified re: utility and evaluation
Suggestions for implementation and further development and evaluation

Pollutant Dispersion Indicator(s)

The indicator(s) proposed and the special challenges they represent
What each company has done, and has learned to date and what each plans to do next
Summary of conclusions reached and key issues identified re: utility and evaluation
Suggestions for further development work

Summary conclusions and issues resulting from NRTEE initiative

Summary of suggestions/recommendations for implementation and further development

Appendix

Company summaries – template to be prepared for consideration