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## Measuring Eco-efficiency in Business:

## Feasibility of a Core Set of Indicators

Prepared for NRTEE by Glenna Ford and Alan Willis
(on behalf of the Canadian Institute of Chartered Accountants)

Third Draft, December 7, 1998

# NATIONAL ROUND TABLE ON THE ENVIRONMENT AND THE ECONOMY

## Measuring Eco-efficiency in Business: Feasibility of a Core Set of Indicators

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**To be inserted by NRTEE editors:**
Members of NRTEE
Members of Task Force
Acknowledgements

## PREFACE

Company managers and directors know that it is good business to reduce waste, minimize energy use and avoid the costs and liabilities of dealing with the dispersion of pollutants. Yet information about these three matters is almost never reported to them in a standardized manner that would allow useful dialogue and permit easy comparison between divisions, time periods, companies and business sectors.

The same applies to external audiences. Investors, customers, regulators and the public lack standards by which to compare company achievements regarding the above-mentioned goals. Since those goals constitute three tenets of the concept of "Eco-Efficiency" as formulated by the World Business Council on Sustainable Development (WBCSD), we at the National Round Table of the Environment and Economy (NRTEE) were glad to have the cooperation of the WBCSD as we set about to create standardized indicators for business reporting. Despite the fact that human patterns of consumption may be the planet's largest threat, it is still essential to encourage cleaner and more efficient production practices.

For the past two years, a number of volunteer companies have gone to considerable trouble and expense to work together in this project in order to hammer out the indicators and the decision rules that would make sense in the real world of competitive business. They have achieved some important successes but a lot remains to be done. As Chair of both the Eco-Efficiency Task Force and of the NRTEE itself, I express, on behalf of all our colleagues and staff, our sincere gratitude to the firms and individuals whose work in this project has advanced a worthwhile cause.

Finally, it is important that the crucial contributions of Alan Willis, Glenna Ford, Jim Fava, Kevin Brady and Elizabeth Atkinson be recognized. Without their efforts, the work could not have proceeded as smoothly and as effectively as it did.

Stuart L. Smith, M.D.
Chair, NRTEE and Eco-Efficiency Task Force

## EXECUTIVE SUMMARY

### Key results of feasibility study

Canada's National Round Table on the Environment and the Economy (NRTEE), with the cooperation of the World Business Council for Sustainable Development, and the active participation of eight companies,[1] has carried out a feasibility study on indicators for energy and materials intensity. This has yielded many practical lessons and insights of value to those who develop and implement eco-efficiency indicators. Indicators for energy efficiency - energy consumed per unit of output - have been found to be readily and widely applicable and meaningful. Indicators for materials intensity - materials consumed per unit of output - have also been found to be feasible, but are more relevant in some industry sectors than others. Practical issues concerning implementation and interpretation have been identified for both energy and material intensity indicators. The stage is set for broader testing and demonstration of these indicators.

In addition, options for pollutant dispersion indicators were evaluated at a pre-feasibility study stage. The companies made valuable progress towards the selection of a suite of issues-related pollutant dispersion indicators that would be meaningful, widely applicable and scientifically acceptable. Many practical considerations were identified as to the design, use and interpretation of such indicators. Feasibility testing of selected components from a set of pollutant dispersion indicators would be a useful next step.

### Eco-efficiency: context for the study

The NRTEE's goal for this study was to explore the feasibility of designing and implementing meaningful and robust indicators for three of the elements of eco-efficiency.[2] In setting this goal, the NRTEE recognized that eco-efficiency is a practical approach that businesses are adopting in setting and achieving their environmental performance objectives. The development of ways to measure and report eco-efficiency is therefore an important aspect of the evolution of this approach.

Eco-efficiency indicators should be reliable signposts and triggers for dialogue and further enquiry. They should not be expected to measure and communicate all aspects and details of environmental performance, whether at corporate, division, facility or product level. Other indicators and data such as absolute quantities or communication of the particular context may also be necessary. Eco-efficiency indicators when combined with other information should assist management of companies, their boards of directors and external stakeholders in tracking progress towards environmental performance targets. These indicators should facilitate meaningful comparison of performance between companies and across sectors. Care must be taken to avoid selecting indicators that are ambiguous or may lead to adverse results in other aspects of eco-efficiency.

The design of indicators to be tested allowed flexibility through the selection of a few minimum indicators and the inclusion of some complementary ones where more complete information is required. Testing and evaluation of the indicators focused on their technical feasibility, such as the required degree of precision and availability of data, the clarity of decision rules, definitions and compilation procedures, and on interpretation issues – the meaning that may be ascribed to the indicators by users.

### Energy intensity indicators

For energy intensity, the minimum indicator selected was energy consumed from all sources within the manufacturing or service delivery process (numerator, reported in joules) per unit of manufactured output or service delivery (denominator, reported in physical, operational or financial terms). Financial denominators tested included sales revenues and value-added formulas. Because of the fluctuations that occur in monetary values over time through inflation and exchange rates, the group concluded that indicators that use financial denominators should be accompanied by

[1] 3M Canada, Alcan Aluminium, Bell Canada, Monsanto, Noranda Mining and Exploration, Nortel Networks, Procter & Gamble, Pacific Northern Gas (representing WestCoast Energy).

[2] According to the definition developed by the World Business Council for Sustainable Development. See *Backgrounder: Measuring Eco-efficiency in Business*, NRTEE, 1997.

related indicators that use physical/operational denominators as well.

Numerators for the seven complementary indicators agreed upon were:

- energy delivered and consumed, including energy consumed in energy delivery;
- energy delivered and consumed, including energy consumed in energy delivery, plus fleet energy;
- energy consumed during the use phase of a product's life;
- energy inherent in materials used in manufacture or service delivery, and in acquiring and processing those materials;
- energy consumed in the end-of-life phase of a product's life cycle, i.e., in disposal;
- energy consumed or generated during the entire life cycle; and
- greenhouse gas emissions related to energy consumption as measured for one or more of these indicators.

The level of testing for these indicators (e.g., site, product, business unit, total company) varied between participating companies.

Several practical considerations came to light in compiling and testing both the minimum and complementary indicators. Two particular issues are allocation of data between products and data availability. Allocation issues were sometimes encountered at lower levels of aggregation such as by-product, where, for instance, several products are manufactured at a particular site or facility. Adequate data about electricity grid supply were difficult to obtain in some locations for carrying out conversions to joules, especially for the complementary indicators. Energy generated during production (including co-generation of electricity), and as a by-product, was another topic requiring further consideration in indicator design.

Greenhouse gas emissions attributable to energy use may not be the full measure of a company's greenhouse gas emissions (which may also be measured and reported under the pollutant dispersion indicator set). Further, the usefulness of a company calculating and reporting "upstream" greenhouse gas emissions, if these are also being measured and reported by energy and raw materials suppliers, may be limited to performing product comparisons and evaluating product design decisions.

**Material intensity indicators**

The companies tested two basic or minimum indicators for material intensity, and one complementary indicator. The first minimum indicator compares total mass (weight) of materials used directly in the product and co-product with the total output of product and co-product (measured in physical, operational or financial terms, as for the energy efficiency indicator). The second minimum indicator includes total indirect material in the numerator (indirect being materials used in production but not included in final product). Packaging material included with product and co-product is regarded as a material for these indicators.

Ideally, the material intensity indicator should measure material consumed per unit of function or service, but such a measurement appears to be too difficult at this time. Instead, material consumed per unit of output was used as the basis for indicator design. The two minimum indicators are therefore intended to focus on reducing material requirements to deliver physical products for consumption. The indicators address "gate-to-gate" materials consumption, not that of upstream or downstream life cycle stages. The indicators are relevant to waste minimization (and therefore to cost savings) as well as to resource conservation objectives.

The complementary indicator tested by two companies compared total mass (weight) of materials and packaging recovered, recycled and reused to the total output of product and co-product. This indicator addresses further aspects of waste minimization and resource productivity.

Four particular insights resulted from the companies' work. First, a material intensity indicator is not really relevant or meaningful for extractive industries such as mining, or for service industries such as telecommunications carriers. The companies also concluded that primary and secondary manufacturing industries are likely to find more use for material intensity indicators than assembly and packaging industries.

Secondly, changes in product mix can result in a company's material intensity indicator not reflecting improvements in materials efficiency at the plant or overall company level.

Thirdly, caution needs to be exercised in industries where the use of large masses or volumes of one particular substance, such as a gas or a solvent, may overwhelm the indicator.

Fourthly, related to the previous issue, is the effect of water (which may be transformed to another state but rarely destroyed). Where water is included in the product, it should not normally be included in the calculation of the indicator, either as input or as output. Where water is used for non-contact cooling or heating purposes, then it should be omitted as a material (although its condition or quality after use may need to be addressed, perhaps under pollutant dispersion indicators). A separate water consumption indicator may be needed; however, when water is included in products or used in production, if that water is taken from and not returned to a location where water scarcity is a concern, e.g., a particular aquifer, an arid country, etc.

**Pollutant dispersion indicators**

Aggregation of data about different substances with different characteristics and effects is the primary problem in designing indicators for dispersion of toxic and other non-product outputs classified as pollutants.

Pre-feasibility study work on the pollutant dispersion indicators concluded that these must address a wide range of public concerns that cannot be reduced to a single indicator. The most useful and workable approach was seen as the selection and design of indicators relative to issues or categories of common concern. These categories may, for example, be smog precursors or atmospheric ozone depletors, greenhouse gas emissions, or dispersion of "priority toxics" in water.

Where the science is sufficiently advanced to allow meaningful weightings to be applied, aggregation of substances within specific issues (such as for greenhouse gases or ozone depletion) may be appropriate. A useful next step would therefore be for a cross-section of companies to design and test indicators for three issues, such as greenhouse gas emissions (for which data are generally readily available), smog precursors and atmospheric ozone depletion.

Earlier in the study, attempts were made to design a single indicator for toxic dispersion. This would be based on aggregating specific toxic substances included in recognized lists such as for the Toxic Release Inventory (TRI) in the USA, and the National Pollutant Release Inventory (NPRI) in Canada, for which companies already measure and report data about releases to the environment. For this approach, consideration was given to weighting methods, such as the categories in Canada's Accelerated Reduction/ Elimination of Toxics (ARET) program, for substances to be included in overall and complementary indicators. The study concluded that such an approach would only be workable and acceptable when there is sufficient international consensus on substances to be monitored and on weightings that reflect relative hazard and toxicity, which might then permit meaningful aggregation into a small number of indicators.

Three important issues for pollutant dispersion indicators were identified. First is the need for them to be both scientifically acceptable and meaningful to users. Secondly, while an eco-efficiency type of indicator will relate pollutant dispersion to product output or value added, absolute measurement data about environmental releases is also likely to be desired by many users, regardless of improvements in release per unit output. Thirdly, indicator design and decision rules need to distinguish clearly between non-product outputs that are released directly to the environment as pollutants, and those that may or may not eventually result in releases, depending on management and disposal practices.

**Future directions**

The key to progress for eco-efficiency indicators is active, phased experimentation and shared learning among companies to discover which eco-efficiency indicators are the most appropriate, meaningful and cost-effective to produce.

To move forward and build upon the valuable lessons learned from this project, the NRTEE encourages continued evaluation by the participating companies, and testing by a wider group of companies, particularly in the manufacturing sector. More research is needed regarding pollution dispersion indicators. Industry associations may be able to play a useful role in promoting testing and research.

# 1. INTRODUCTION

## 1.1 Key accomplishments

The Task Force on Eco-efficiency (the Task Force) of Canada's National Round Table on the Environment and the Economy (NRTEE) has reached important conclusions about the feasibility of eco-efficiency indicators that companies can use to measure energy and material intensity, and about possible future directions for development of eco-efficiency indicators regarding pollutant dispersion.

Specifically, the design and testing of core indicators (i.e., a small number of cross-cutting indicators) for energy and materials intensity by eight companies[3] under the auspices of the Task Force has shown the extent to which these are currently feasible, and has yielded many practical lessons and insights of value to those who are developing and implementing eco-efficiency indicators. Indicators for energy efficiency - energy consumed per unit of output - have been found to be readily and widely applicable and meaningful. Indicators for materials intensity - materials consumed per unit of output - have also been found to be feasible, but are more applicable and relevant in some industry sectors than others.

Options for pollutant dispersion indicators were evaluated at a pre-feasibility study stage. The companies made valuable progress towards the selection of a suite of issues-related pollutant dispersion indicators that would, after further research, design and testing, be meaningful, widely applicable and scientifically acceptable. Many practical considerations were identified as to the technical feasibility, use and interpretation of such a suite of indicators. Consensus was reached that no single, aggregate indicator would be adequate to measure and report all aspects of pollutant dispersion in any meaningful way, and that focusing only on toxic releases is too narrow to address the wider range of pollutant dispersion issues related to non-product outputs.

Ultimately, companies will discover, through systematic processes of practical testing and evaluation, which indicators are most useful to them, what data and resources are needed to compile them, how to interpret and apply them at different levels within the company, how and where to report them, and how to assess their benefits compared to the costs of producing them. The process agreed upon for conducting the feasibility study of the energy and materials intensity indicators was found to be a useful model for future work in evaluating proposed indicators, and to have beneficial side effects for the participating companies.

*Structure of report*

The remainder of this introduction summarizes the process leading to this study, and criteria used as guidance in conducting it. Chapters 2 and 3 of this report set out the results of the feasibility testing process for energy intensity and material intensity indicators respectively. Chapter 4 outlines the results of considering indicators for pollutant dispersion. The final chapter summarizes the overall conclusions, the lessons learned and proposed future directions arising from the work completed on the three indicators.

Appendix A provides a tabular overview of the companies that volunteered for the exploratory work described in this report, and highlights of their experiences in carrying it out. Appendix B describes the original proposals for toxic release indicators and what was learned in considering them for possible feasibility testing. Appendix C presents a chronology of the workshops held during the study and identifies the related workshop reports available from the NRTEE and on its website. *(Ed. note: check)*

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[3] 3M Canada, Alcan Aluminium, Bell Canada, Monsanto, Noranda, Nortel Networks, Procter & Gamble, Pacific Northern Gas (representing WestCoast Energy).

## 1.2 Proposed eco-efficiency indicators

In 1996, the NRTEE established its Task Force on Eco-efficiency to explore, in cooperation with the World Business Council for Sustainable Development (WBCSD), the possibility of developing a core set of indicators for companies to use in measuring eco-efficiency. These would be designed to encourage and help companies to set measurable eco-efficiency targets, assist in assessing their progress and performance against these targets, and facilitate comparisons and benchmarking of environmental performance between companies of all sizes and types, as well as within sectors.[4]

In deciding to proceed with this work, the NRTEE recognized eco-efficiency indicators as a practical tool that is useful to:

- businesses engaged in setting and achieving environmental performance objectives; and
- both businesses and external audiences in the development of ways to measure and report eco-efficiency.

Such indicators are thus an important element in the evolution and implementation of eco-efficiency.

The NRTEE Task Force adopted the definition and elements of eco-efficiency as developed under the auspices of the WBCSD:

*Eco-efficiency is reached by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the earth's estimated carrying capacity.*[5]

The WBCSD went on to expand this definition, setting out seven elements of eco-efficiency:

*Reducing the material requirements for goods and services*

*Reducing the energy intensity of goods and services*

*Reducing toxic dispersion*

*Enhancing material recyclability*

*Maximizing sustainable use of renewable resources*

*Extending product durability*

*Increasing the service intensity of goods and services.*

Regarding "Value Generation," the WBCSD noted:

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[4] The NRTEE's proposals for indicators are discussed more fully in *Backgrounder: Measuring Eco-efficiency in Business*, NRTEE, 1997.

[5] World Business Council for Sustainable Development, *Eco-Efficient Leadership for Improved Economic and Environmental Performance* (Geneva, WBCSD, 1996), p. 4.

*A key feature of eco-efficiency is that it harnesses the business concept of creating value and links it with environmental concerns. The goal is to create value for society, and for the company, by doing more with less over a life cycle.*

From the outset, the NRTEE goal was to devise a "core" set – a few robust, widely accepted and understood, quantifiable and verifiable indicators that all companies could use – both for internal purposes, and for external performance reporting (the intent was not, however, to bring about new, mandatory external disclosure requirements). Eco-efficiency indicators should therefore be reliable signposts and triggers for dialogue and further enquiry.

They should not be expected to measure and communicate all aspects and details of environmental performance, whether at the corporate, division, facility or product level. Other indicators and data such as absolute quantities may also be necessary. Reporting any single eco-efficiency indicator alone is unlikely to be useful and could in fact be misleading. Explanatory notes about the content and meaning of indicators may also be necessary to ensure they are fully and clearly understood, similar in purpose to the notes to financial statements.

The credibility of eco-efficiency indicators in general for communicating with external audiences was recognized as an important issue, relating to needs for third party verification and transparency in reporting, as well as indicator design. In this regard, the scope and boundaries of an indicator and the level of aggregation are important considerations, as high levels of aggregation may mask important trends or provide less meaningful information. Similarly, life cycle data may include too many assumptions or estimates at a product level.

The three eco-efficiency indicators originally put forward by the NRTEE as a starting point for informed, focused discussion, hopefully leading to exploration and testing were as follows.

*Resource productivity index*

This indicator was designed to express as a percentage the material and energy contained in a company's products, by-products and usable wastes compared with the materials and energy consumed in their production.

*Product and disposal cost to durability ratio*

This indicator, intended to address life cycle product stewardship and recyclability, was designed to divide the cost of a producing a product (expressed in terms of purchase price) plus the cost of its ultimate disposal, by the number of years of its useful lifetime.

*Toxic release index*

This indicator was designed to express as a single number the amount of toxic materials released during a period (or in manufacturing a particular product), calculated as the sum of the masses of each toxic substance released adjusted by their respective toxicity weighting factors, compared with the product output during the period.

Key issues included the technical feasibility of a given indicator, its usefulness and meaning to various users, and the cost-effectiveness for a company in producing it.

## 1.3 Washington workshop

These proposals were discussed in detail at an international workshop organized by the NRTEE in conjunction with the World Business Council for Sustainable Development in Washington, DC, in April 1997.[6] The wide cross-section of expert participants from business and other stakeholder groups at the Washington workshop reached the following conclusions:

*Resource Productivity Index*: It would be not only more useful and meaningful, but also more practical and feasible to develop and test separate indicators to address materials intensity and energy intensity, first on a pilot basis with a few volunteer companies, then later (based on the pilot results) with a larger cross-section of companies.

*Product and Disposal Cost to Durability Ratio*: Such an indicator would be difficult to design and apply because it attempts to combine too many concepts, which themselves are difficult to define and measure, both physically and in financial terms, and would be of questionable relevance and understandability. The proposed indicator was considered unworkable, but the group acknowledged there might be merit at some point in considering and then perhaps developing one or more indicators to address matters such as product durability, or material recyclability, or lifetime cost compared to years of life.

*Toxic Release Index*: As proposed, this would be difficult to implement because of lack of consensus as to the substances to include in the measurement and lack of scientific consensus as to their relative toxicity for meaningful aggregation of data about different substances. Participants agreed, however, on the widespread importance of addressing the need for an indicator regarding toxic (later broadened to pollutant) dispersion, and noted that requirements for toxic release reporting to regulators are already in place in some countries. An appropriate indicator would facilitate assessment of performance improvement over time and comparison between companies. The group therefore recommended that work continue to define indicator scope and substances for inclusion, to consider alternative approaches for dealing with relative toxicity, and to consider how best to build off existing reporting schemes for which companies are already tracking and recording data. This might then provide a basis for useful field trials by companies.

***Other conclusions***

Workshop participants agreed on a number of characteristics and criteria for useful, acceptable eco-efficiency indicators. The indicators should:

- provide a concise, aggregated view of performance;
- be capable of integration with other measures;
- link with financial measures and be relevant in capital markets;
- be relevant to business strategy;
- be widely applicable across industry sectors;
- be relevant to and implementable by small and medium-sized enterprises (SMEs);
- be relevant and implementable in other countries;
- support decisions, lead to action;
- be relevant for periodic environmental reports;
- be applicable to non-renewable resource sector industries;
- be scientifically acceptable and credible;
- focus initially on internal, not external users' needs;
- recognize the public policy and social implications of reporting on performance; and
- be independently verifiable, if necessary.

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[6] The Washington workshop proceedings and conclusions are detailed in the *Backgrounder* (see footnote 2).

Work on indicator design and testing should recognize that:

- development and implementation of eco-efficiency indicators would necessarily be a voluntary and evolutionary process;
- eco-efficiency is a subset of sustainable development, and that linkages with socio-economic issues must therefore always be appreciated;
- there have to be trade-offs between simplicity and completeness, and that it is important to move ahead even with imperfect measures, since they can be refined over time;
- eco-efficiency indicators are tools for evaluation of progress and for decision making, not targets or goals for improvement; and
- development of indicators for all measurable elements of eco-efficiency would be desirable, but perverse results should be avoided in doing so, even if this means not having indicators for certain elements.

Specific technical challenges for indicator design were noted:

- product-related indicators – what aspects of total life cycle of product to address in indicators, and what level of aggregation is suitable – product, product line, division or company;
- aggregation – how to avoid masking important information that may be lost or submerged in aggregation, and how to avoid distortions through applying subjective weighting schemes to aggregate data;
- weighting, normalization and indices – when and how to normalize indicators versus when and how to create indices, and how to avoid subjectivity in weighting schemes; and
- financial as well as physical measures – whether financial measures as well as physical ones can be useful in indicator design, recognizing the inherent limitations of financial accounting and reporting practices.

### 1.4 Feasibility study – the process

Following the Washington workshop, the NRTEE identified eight companies (see footnote 1) willing to design and carry out feasibility tests of materials and energy intensity indicators, and to explore further the issues and possibilities for a toxic dispersion indicator. In addition, Stelco Inc. and Dow Chemical Co. participated in discussions about toxic and pollution dispersion indicators.

Initial planning meetings in November 1997 (for the material and energy indicators) and January 1998 (for the pollutant dispersion indicator) were followed by an interim progress review meeting of the participating companies and the NRTEE in March 1998, a workshop in June 1998 to share and summarize experiences, findings and issues arising from the work on all three types of indicators, and a meeting in October, 1998 to give input on a draft report about the study. Detailed technical reports from the various planning meetings and workshops were important to the continuity of the process.[7]

[7] Available upon request from the NRTEE. Refer to Appendix C for a chronology of the workshops.

The companies are continuing to implement, evaluate and modify the indicators used in the study, and to build on the learning and benefits they had experienced during the feasibility study. The study and the process were found by the companies to:

- be reproducible in terms of definitions, boundaries and general decision rules and study approach;
- provide methodological guidance that will be required in the future;
- be grounded in practical trial efforts and progressing rapidly;
- have reduced the complexity of the concept of eco-efficiency for some of the participants;
- be moving along a continuum from data to indicators that could serve various audiences;
- provide simplified, reasonably uniform measures of how production is being managed;
- facilitate informed dialogue with audiences by providing indicators that show direction;
- have led to major companies arriving at a consistent, uniform approach;
- be practical in moving towards a manageable number, not a laundry list, of eco-efficiency indicators
- be leading to additional contacts both within the study and through external interests; and
- introduce the participants to broader international perspectives on indicator development and use.

At the outset, the companies and the Task Force established the following four criteria to guide the process of selecting and evaluating indicators for the feasibility study:

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

2. **Rules for inclusion/exclusion** – principles, rules and guidance are needed for the transparent inclusion and exclusion of data, measurements and assumptions used to derive indicators.

3. **Data-collection cost-effectiveness** – the data and measurements for the indicators should either be available or obtainable in a cost-effective manner.

4. **Usefulness as a management or corporate reporting tool** – the indicators should be applicable and useful at several levels within the company, including business unit, regional and corporate level.

Experience in carrying out the work on all three indicators, and the conclusions reached for each confirmed the importance and soundness of these criteria. The energy and materials intensity indicators substantially satisfy these criteria; for the pollutant dispersion indicators, the criteria will continue to serve as important guidelines to success in a longer developmental process.

## 2. ENERGY INTENSITY INDICATORS



### 2.1 Indicator set, lessons learned

The energy intensity indicator is an eco-efficiency indicator that has broad applicability, and is technically feasible and meaningful to audiences both within and outside companies. Unlike materials, which vary widely, energy is like a common "currency" unit in all businesses and countries. The development and implementation of indicators to measure the energy intensity of a company's products and services therefore proved to be both a realistic and worthwhile endeavour, although further theoretical and practical work is needed to address in full emissions of greenhouse gases (GHGs) as part of a set of indicators for energy intensity.

***The energy intensity indicator set***

The eight participating companies agreed on a minimum energy indicator that all would test, and on a suite of seven other energy indicators from which companies might choose to test one or more in order to provide a more complete picture of their energy use. These indicators are shown schematically in Figure 1.

*(Insert Figure 5 from page 7 of November workshop report)*

*The minimum energy intensity indicator:*

$$\frac{\text{Energy consumed by the company}}{\text{Unit of output (product or service)}}$$

Energy was defined as total energy consumed, measured in joules, to manufacture a defined unit of output or deliver a defined service. Energy included all forms of energy, from all sources within the manufacturing or service delivery process, including energy generated internally (e.g., waste oil to heat) during manufacture of product or delivery of service. Fuels were converted from mass to joules through the use of accepted conversion factors.

Unit of output is a measure, in either physical/operational terms (e.g., mass, units of product or service) or financial terms (e.g., sales revenues, value added), of manufactured output (products and co-products, whether sold or inventoried) or service delivered. Financial denominators tested included sales revenues and value-added formulas. Because of the fluctuations that occur in monetary values over time through inflation and exchange rates, the group concluded that indicators that use financial denominators should be accompanied by indicators that use physical or operational denominators.

*The complementary energy intensity indicator set:*

- C1: "expanded energy" consumed by the company per 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). Conversion data from the National Energy Reliability Council would be used to calculate energy consumed by energy delivery.

- C1a: "expanded energy" as in C1, plus fleet energy, namely the energy consumed by fleets transporting products or services to their intended markets.
- C2: energy consumed during the use phase of a product's life cycle.
- C3: energy inherent in the materials used in manufacturing a 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 a product's life cycle, i.e., in disposal.
- C5: life-cycle energy, that is, the energy consumed during the entire life cycle of a product.
- C6: energy-related greenhouse gas (GHG) emissions – the greenhouse gas emissions associated with each of the energy types and sources measured under any of the above complementary indicators or the minimum indicator above.[8]

Companies' selections of complementary indicators for the purposes of the feasibility study took into account various factors. These included relevance to their eco-efficiency improvement objectives (that might focus on, for example, manufacturing process energy), the life cycle energy use profile of products (that may be more energy intensive in the use phase than during the manufacturing phase), and the users of the indicator within the company or outside it.

***Lessons learned***

Several practical considerations came to light in testing both the minimum and complementary indicators.[9] Adequate data about the electricity grid supply were difficult to obtain in some locations for carrying out conversions to joules, especially for the complementary indicators. Allocation issues were sometimes encountered at lower levels of aggregation, such as by product, where, for example, several products were manufactured at a particular site or facility. Other topics requiring further consideration in indicator design were the effect of changes in product mix, and the treatment of energy generated during production, including co-generation.

With respect to greenhouse gas emissions, such emissions attributable to energy use may not be the full measure of a company's greenhouse gas emissions (that also may be measured and reported under the pollutant dispersion indicator set described in Section 4 of this report). The value of calculating and reporting "upstream" greenhouse gas emissions may be limited to performing product comparisons and evaluating design decisions, as these emissions may be reported by upstream companies.

## 2.2 Decision rules and definitions[10]

***Decision/accounting rules for the indicators***

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[8] Participants were referred to the Intergovernmental Panel on Climate Change report *(Ed. Reference?)* for information on the global warming potential of GHG emissions and to the National Action Plans for GHG Reduction *(Ed. Reference?)* for emissions factors related to the various energy carriers.
[9] These are discussed further in "Technical feasibility issues," Section 2.3.
[10] Additional background and technical detail for the study may be found in the four workshop reports prepared during the course of the study and available on request from the NRTEE.

Decision/accounting rules were agreed upon by the participants for the minimum indicator, with greater flexibility being given to companies to develop the complementary set. For the minimum energy indicator, energy units were to be joules, allocations (if needed for normalization to a product) were to be based on output masses, and time periods covered were to be selected (and reported) by each company. For any complementary indicators selected, companies were to document and report their decision rules as to the types of energy included/excluded, assumptions and conversion factors used, and calculation procedures.

***Definitions***

For the purposes of applying the decision/accounting rules and for precision and consistency in data collection for the feasibility study, the various types of energy to be considered were defined as follows:

*Fossil energy*: that derived from any fossil source of carbonaceous material, including oil, coal and natural gas.

*Non-fossil energy*: that derived from any non-fossil source, including hydroelectric, geothermal, nuclear, wood, and others.

*Process energy* (electric and non-electric): energy input required to operate process or equipment. With regard to electricity production, information pertinent to the (national) grids for the various operating sites of a company was to be used regarding electricity production. The conversion of electrical power mix into joules needs to take into account the combustion efficiencies of the various fuels consumed in energy production, the conversion efficiencies of the generating facilities and transmission efficiencies related to line losses.

*Feedstock energy*: that which is fuel-related inherent energy or energy content of material resources; to be calculated as the gross calorific value (high heat) of the energy resources removed from the earth's energy reserves and used in producing input materials consumed in the company's operating processes. Feedstock energies were to be calculated separately for each material input.

*Transport energy*: energy required to transport intermediate or final products to the next point of use, as well as the energy required to transport waste materials for final disposition.

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

***Data collection and quality rules***

Each company was responsible for its own data collection and handling, and for describing and documenting the data collection and calculation procedures used. Participating companies were each to decide, for the purposes of the feasibility study, on the scope of the indicator, e.g., company, facility, product, product line. The level of testing for the indicators (e.g., site, product, business unit, company) therefore varied between participating companies, based on their individual circumstances and requirements.

Companies would report on the source, nature and quality of their data, as well as provide estimates of variability. In this regard, they would indicate whether their data was primary, secondary or surrogate and whether it was measured, calculated or estimated. Both qualitative (consistency, representativeness and anomalies and missing data) and quantitative (completeness and precision) data quality indicators could be used. Participants also were encouraged to document their costs and the identified business benefits of conducting the pilot test. In this regard, the study was intended to complement existing measurement and management systems, rather than to require the creation of new ones.

### 2.3 Technical feasibility issues

Technical feasibility issues for the energy intensity indicator set identified by participants related to three main areas: availability of data (including information about electricity supply), allocation procedures, and changing product mix. Through conducting this study, Procter & Gamble also identified the need to look at energy accounting rules for co-generation, life-cycle stages and transportation data. Some participants encountered as well practical difficulties in advancing the feasibility study due, for example, to unforeseen changes in business priorities, corporate re-structuring, plant expansion, etc.

*Availability of data*: difficulties were noted in obtaining energy supply data (profiles) for the various types of energy. Some participants believed that determining the actual source of electrical energy obtained from grids might be difficult in some countries and regions, but participants noted that this type of data is becoming increasingly available.

*Allocation procedures*: choice of allocation procedures could be problematic, where, for example, different metals are being extracted from ore. In some cases, a mass-based allocation might be appropriate; in others, an economic-based allocation might be more appropriate. For instance, a pilot study at a site or product level could cause allocation problems that would not occur at higher levels of aggregation, such as when developing an indicator at the business unit or company-wide levels. In this regard, Noranda, for which energy is a fairly significant operating cost, had difficulty allocating energy to different streams in its site processes.

*Changing product mix*: new and discontinued products and product lines posed a challenge for developing consistent, comparable indicators. Both Procter & Gamble and 3M experienced misleading results when their product mixes were altered, in that environmental improvements were in some cases masked by the changes.

Table 1 summarizes the decisions made by the participating companies as to energy intensity indicators for the purposes of the feasibility study.

***Table 1: Energy intensity indicator selection and results summary***

| Company | Minimum indicator – denominator chosen | Complementary indicator(s) | Level/scope | Time frame; data quality indicators |
|---|---|---|---|---|
| **3M** | Unit of output | C1a – expanded energy plus fleet energy per unit of output<br>C5 – life-cycle energy per unit of output<br>C6 – energy-related GHG emissions | Manufacturing site | One year; not chosen |
| **Alcan** | Unit of output | C5 – life-cycle energy per unit of output<br>C6 energy-related GHG emissions | Site and possibly products | One year/completeness & representativeness |
| **Bell** | Indicator chosen: kWh/m² | Not tested | Building | One year; not chosen |
| **Monsanto** | Unit of revenue – value added, e.g., sales revenue less cost of raw material | Not chosen | Company for minimum set, product line for complementary | One year; expert review |
| **Noranda** | Unit of output | Likely C1 – expanded energy consumed by the company per unit o output | Site (changed from product) | Not chosen; not chosen |
| **Nortel Networks** | Unit of revenue - cost of sales | C6 – energy-related GHGs | Company | One year; not chosen |
| **Procter & Gamble** | Unit of output (internal measure called statistical case) | C1 – expanded energy consumed by the company per unit of output<br>C1a – expanded energy plus fleet energy per unit of output<br>C2 energy consumed during product use phase | Various levels – company, business unit and product line | Varies; completeness & representativeness |
| **West Coast Energy/ Pacific Northern Gas** | Unit of output | Data not available | Data not available | One year; not chosen |

***Energy intensity and greenhouse gas emissions***

One technical issue of particular relevance for the participants related to greenhouse gas emissions. The proposal for complementary indicator C6 for energy-related greenhouse gas emissions (through the use of conversion factors for different types of energy source) linked energy consumption and intensity with the broader issue of global climate change. Greenhouse gas emissions may arise as well from production processes and delivery of services, and at different stages in product life cycles. The pollutant dispersion indicator suite also may include indicators related to atmospheric releases of greenhouse gases.

The eco-efficiency definition and components do not directly address climate change due to greenhouse gas emissions, but energy intensity is clearly relevant to this issue, where energy is consumed from sources that cause greenhouse gas emissions. Consideration therefore appears to be necessary of the question of how energy intensity indicators can be designed to communicate meaningfully about greenhouse gases associated with a company's products and services, whether on a "gate-to-gate" basis or from a life cycle perspective. Also needed is consideration of how such indicators would fit within a suite of pollutant dispersion indicators to give a complete and clear picture of a company's contribution to greenhouse gases.

### 2.4 Use and interpretation issues

A third area of focus for the pilot study in terms of developing an energy intensity indicator (or suite of indicators) that is robust, reliable, meaningful and cost-effective was the overall utility of the indicators and their interpretation by users. The indicators proved to be valuable at several levels within a company, including business unit, regional and corporate, as both a management and corporate reporting tool.

The group recognized the challenge to interpret the energy indicators meaningfully, as these indicators can be applied to many different situations (e.g., to reflect energy use at buildings that serve many different purposes and whose characteristics vary widely). The following issues relating to the interpretation of and the meaning to be ascribed to the indicators were identified.

*Highly aggregated indicators*: the group expressed concern about loss of meaning, at least for internal users and possibly for external users, where data is aggregated across product lines or sites. In some situations, highly aggregated indicators can lead to oversimplified results.

*Complementary indicators – the suite:* participants saw the need for more than one single energy intensity indicator, whether that is just the minimum as proposed, or C1, expanded energy. In addition, C6 (energy-related GHG emissions) was favoured, although, as noted above, it may not provide the full GHG picture for a company and may not necessarily be formulated as an eco-efficiency indicator unless normalized by an appropriate denominator. Also, the use of energy indicators only in conjunction with materials and pollutant dispersion indicators needs further consideration in the interests of presenting a more complete picture and minimizing the possibility of wrong conclusions or perverse results.

*Standardization of numerator:* further work is required to reach consensus on selecting the numerator and defining the scope and boundaries for the numerator, and on how much flexibility to allow companies if comparability is to be achieved between companies and sectors. The availability of data for electricity grids and sources and general acceptability of conversion factors are important considerations in deciding what is reasonable to expect in numerators. This issue is closely related to the issue of how many energy intensity indicators are needed – just one or a suite?

*Standardization of denominator:* participants agreed that standardization of the numerator is important; however, they considered that greater flexibility is acceptable, even necessary, in selecting the denominator for the indicator. The group preferred financial or value-related denominators, especially at the company level, but both unit output and unit value denominators need further consideration as to their appropriateness in various sectors.

*Proprietary issues*: some participants expressed concern that the use of economic (i.e., financial) denominators in the indicators might disclose proprietary, confidential and/or competitive information.

# 3. MATERIAL INTENSITY INDICATORS



## 3.1 Indicator set, lessons learned

The group concluded that an indicator of material intensity is a reasonable and workable measure of eco-efficiency, although more applicable and relevant in some industry sectors than in others. Companies encountered greater challenges in developing and implementing the material intensity indicator set than they did with the energy indicators. One key difference in this regard was that, unlike the energy indicators that resemble a "currency" that can be converted to common units, the indicator set for material intensity necessarily encompasses a large number of different materials, each with its own physical attributes and purpose. For example, one kilogram of waste paper is vastly different from one kilogram of waste metal.

***The material intensity indicator set***

The group agreed to test the following three material intensity indicators – two as the minimum set for measurement, and the third as the complementary or optional indicator that would allow companies to build on the minimum set to provide a more complete picture of their performance.

Ideally, the material intensity indicator should measure material consumed per unit of function or service, but such a measurement appears to be too difficult at this time. Instead, material consumed per unit of output became the basis for indicator design. The two minimum indicators are therefore intended to focus on reducing material requirements to deliver physical products for consumption. The indicators address "gate-to-gate" materials consumption, not that in upstream or downstream life cycle stages. The indicators are relevant to waste minimization (and therefore to cost savings) as well as to resource conservation objectives. The complementary indicator was designed in order to reflect an expanded focus on waste minimization.

*Minimum indicator set:*

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

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

*Complementary indicator:*

$$\frac{\text{Total mass (weight) of materials and packaging recovered, recycled and reused}}{\text{Total output of product and co-product}}$$

In these formulas, inputs include materials directly incorporated in the product and co-product, and indirect (ancillary) materials used in the manufacturing process to produce the product and co-products.

Materials include raw materials, packaging and water (excluding non-contact water).[11] Indirect material is that used in production but not included in the final product. Packaging material included with product and co-product is regarded as a material for these indicators.

In terms of the denominator chosen, the materials consumed per unit of output for a product or service could be expressed in physical, operational (e.g., per kg or per number of uses) or in economic (e.g., per dollar value added or revenue) terms.

The companies acknowledged that the material intensity indicators may be used at different levels within a company (e.g., company, business unit, site or product). In order to provide a frame of reference, a unit process template was developed (i.e., raw or intermediate material inputs, ancillary materials, energy and water consumed, environmental releases and output intermediate materials, or final product and co-products). Figures 2 and 3 illustrate these levels and the unit process template respectively.

*(Insert Figures 1 and 2 from p. 4 of November workshop report)*

***Lessons learned***

Four key insights into material intensity indicators resulted from the companies' work:[12]

1. A materials intensity indicator is not particularly relevant or meaningful for extractive industries such as mining, or for service industries such as telecommunications carriers. The companies also concluded that primary and secondary manufacturing industries are likely to find more use for materials intensity indicators than are assembly and packaging industries.

2. Changes in product mix can result in a company's materials intensity indicator not reflecting improvements in materials efficiency at the plant or overall company level.

3. Caution needs to be exercised in industries where the use of large masses or volumes of one particular substance, such as a gas or a solvent, may overwhelm the indicator.

4. Related to the previous issue is the effect of water (that may be transformed to another state but rarely destroyed).[13] Where water is included in product, it should not normally be included in the calculation of the indicator, either as input or as output. Where water is used for non-contact cooling or heating purposes, it should be omitted as a material (although its condition or quality after use may need to be addressed, perhaps under pollutant dispersion indicators). A separate water consumption indicator may be needed, however, when water is included in products or used in production, if that water is taken from and not returned to a location where water scarcity is a concern, e.g., a particular aquifer, an arid country, etc.

## 3.2 Decision rules and definitions[14]

***Decision/accounting rules for the indicators***

[11] This refers to cooling or heating water that is not chemically modified by the manufacturing process, i.e., that does not contact the direct material flows.
[12] These are described further in "Technical feasibility issues" below, Section 3.3.
[13] See further under "Material intensity and water use" below, Section 3.3.
[14] As for the energy intensity indicators, additional background information and technical detail is provided in the four workshop reports available from the NRTEE.

As for the energy intensity indicators, decision/accounting rules for use in the indicators relating to the materials that would be included in the calculations were agreed upon by study participants. The primary rule was that all relevant materials to the product and/or process would be included. Two rules for determining relevance were:

- all materials that make up more than 1% by mass of the products and co-products leaving the manufacturing site would be identified. From these, materials having a cumulative mass contribution of at least 90% of the total weight of products or co-products would be included.

- the 17 most significant materials, ranked by mass, would be included.[15]

***Definitions***

Participants in the pilot study agreed upon the following definitions for the material intensity indicators:

*Indirect/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 inter-linked stages of a product system, from raw material acquisition or generation of natural resources to final disposal.

*Final product*: product that requires no additional transformation prior to use.

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

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

***Data collection and quality rules***

As with the energy intensity indicators, each company was to be responsible for its own data collection and handling. In this regard, they would describe and document their data collection and calculation procedures, as well as their verification techniques.

Materials would be measured in kilograms. In terms of allocation, if an indicator were normalized to a product or service, allocation based on mass would be used where multiple products were produced from the same facilities (e.g., to reflect different grades of paper from a mill). The relevant time period for data measurement would be decided on a company-by-company basis. For the complementary indicators, companies were required to document their calculations, assumptions and decision rules for including and/or excluding materials.

Companies would report on the source, nature and quality of their data, and provide estimates of variability, in the same manner as for the energy indicators. They also would indicate whether their data was primary, secondary or surrogate and whether it was measured, calculated or estimated. Both qualitative and quantitative data quality indicators could be used. Participants were encouraged to document their costs and the identified business benefits of conducting the pilot test.

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[15] This number was selected as being sufficient in most cases.

### 3.3 Technical feasibility issues

In terms of the technical feasibility of developing and implementing the material intensity indicators, the companies encountered issues in the same three areas as in their energy intensity work.

*Availability of data:* in many cases, the availability of data for measuring the indicators was not sufficient, particularly for material inputs (although waste output often could be tracked). In this regard, both Nortel Networks and Bell Canada experienced difficulties in calculating their material inputs. For Bell Canada, although the company could control its waste and recycling activities, it could not control and measure what came into its offices. Furthermore, the quality of data varied, especially for external data (such as data coming from suppliers). For example, Nortel Networks has several thousand suppliers, both internal and external, and accurate information about incoming materials to an operation's "environmental prime" therefore is often not known. Procter & Gamble encountered similar data availability and accuracy difficulties, particularly when using external data.

*Allocation procedures*: problems were encountered by the companies with their allocation procedures, e.g., when allocating material inputs to the different metal concentrates that could be extracted from an ore. In some cases, allocation should be made on a mass basis, and in other cases an economic allocation should be used. Another allocation challenge arose when companies were dealing with numerous products. Procter & Gamble experienced this for data not collected at a sufficiently low level of specificity. Nortel Networks, which produces hundreds of manufactured products by multiple operations, had difficulty allocating and crediting materials to specific final products.

*Changing product mix:* changes in product mix can affect the calculation of indicators and produce results that do not reflect performance accurately. Furthermore, such changes (e.g., in new and discontinued product lines) present challenges for developing consistent and reproducible indicators over time. Both Procter & Gamble and 3M discovered that changes in product mix could produce results that did not properly reflect improvements in environmental performance.

Several technical issues unique to material intensity indicators were also identified.

*Extractive industries*: the two resource companies participating in the study, Alcan and Noranda, found the material indicators to be of limited applicability to their operations as a measure of eco-efficiency (i.e., the material intensity depended primarily upon the grade of ore and not upon the efficiency of the extraction process used), and therefore they did not attempt to measure it. Such companies could not meaningfully compare results beyond their individual operations. This may be an issue encountered by other extractive companies and sectors.

*Service companies*: as the two service companies participating in the study, Pacific Northern Gas and Bell Canada encountered special challenges in developing the indicator. Neither company manufactures product, although in their operations they both use materials that have environmental impacts. For example, as noted under "Availability of data" above, Bell Canada's attempt to measure material use in its main offices was problematic.

*Life cycle considerations*: the product life cycle should be considered as the use phase for some products can be more material intense than product manufacturing. For example, life cycle considerations are important for consumer goods packagers such as Procter & Gamble because most of the material consumption for such goods occurs upstream (raw materials production) and/or downstream (product use) in the life cycle. Overall material efficiency therefore should include the upstream supply of materials, consumer purchase and use habits and disposal. A life cycle perspective is also important internally for product design, and externally to assist stakeholders in understanding the overall environmental effects of products.

*Material intensity and water use*

Water use posed a particular technical challenge for some participants.[16] Including water use in the indirect indicator calculation could be problematic, as it strongly influenced the outcome for certain products and masked more meaningful information about other raw materials. For example, Procter & Gamble found that including water for tissues and towel products overwhelmed the indicator calculation. Separate water indicators should be considered, one dealing with consumption or movement of water where water scarcity is an issue (i.e., the geological source or geographic location of the water), and another that addresses water condition, in terms of quality of discharge.

Table 2 summarizes the material intensity indicator selection and key results of the feasibility study for the eight participating companies.

***Table 2: Material intensity indicator selection and results summary***

| Company | Minimum (direct or direct plus indirect); denominator | Complementary indicator | Level/scope | Time frame; data quality indicators |
|---|---|---|---|---|
| **3M** | Direct; kg/kg | Not initially | Manufacturing site | One year; not chosen |
| **Alcan** | N/A | N/A | N/A | N/A |
| **Bell** | Modified measure of waste/employee | No | Building | One year; not chosen |
| **Monsanto** | Direct; value added | Yes | Company for minimum set, product line for complementary | One year; expert review |
| **Noranda** | N/A | N/A | N/A | N/A |
| **Nortel Networks** | Direct; cost of sales | Yes | Company | One year; not chosen |
| **Procter & Gamble** | Attempted direct + indirect, but effort terminated due to size of effort and data quality issues | For packaging only | Various levels – company, business unit and product line | Varies; completeness & representativeness |
| **West Coast Energy/Pacific Northern Gas** | Data not available | Data not available | Data not available | Data not available |

## 3.4 Use and interpretation issues

In developing and implementing the material indicators, as with the energy intensity indicators the group explored issues relating to how to demonstrate that the indicators add value to decision making, and how to prevent the indicators from misinforming audiences and decision makers. As discussed below, the key challenge is to assemble complex data sets and convert them to simple indicators that are technically

[16] Solvent use could create a similar problem in some circumstances.

sound and environmentally meaningful for internal and external audiences. Given the diverse nature of materials and the industry sectors that use them, material intensity indicators likely will require careful interpretation and use in decision making. Similarly, communication of such indicators will benefit from explanatory notes as to their context and relevance. Through the testing conducted in this project, the material intensity indicators proved to be useful both as a management and as a corporate reporting tool.

The same or similar issues relating to use and interpretation of the indicators arose for both the energy and material intensity indicators. These are summarized below.

*Aggregation:* data aggregation presents a challenge to the development of consistent and reproducible indicators. High degrees of aggregation across different product lines, facilities and manufacturing sites can mask relevant performance data. In terms of measuring material intensity, aggregating data into an overall indicator has the potential to oversimplify results and lessen its usefulness for tracking eco-efficiency and guiding decision-making. Internal and external communication of meaningful information to different audiences also can be difficult with highly aggregated indicators, and for achieving credibility for the results. Communicating the appropriate use of the indicators was seen to be a key factor in this regard (e.g., for reporting a company's eco-efficiency progress). Similarly, the ability to make meaningful comparisons using such aggregated indicators can be problematic.[17]

*Number of indicators:* the group expressed concern that a small number of highly aggregated indicators may not be as meaningful internally, nor as useful in determining possible improvement opportunities, as a suite of indicators. A selection may be required as well to reduce perverse results and redundant reporting (double counting). Most participants agreed that a wider set of indicators should be explored in order to satisfy the diverse needs of broader audiences. These needs might include water indicators where water scarcity and quality vary according to geological source or geographic region, the role of solvent recovery and recycling systems where losses and not total use per unit may be more relevant, non-product material streams that are recycled and reused rather than consumed, and the use of renewable and recycled materials.

*Numerator selection*: in numerator selection, a trade-off exists between the desire of some audiences for comparability and the unique issues of different industrial sectors. The numerator for the complementary indicators might vary by sector, e.g., in choosing a boundary for the indicator that reflects a different range of a product's life cycle.

*Denominator selection:* of the two denominators considered - unit of revenue or unit of production - the financial denominator was preferred, especially when the indicator was used for a higher organizational level. However, such a denominator might not be as meaningful for product manufacturers and commodity producers. Although both denominators might be difficult to standardize because of the different approaches that can be used to select the measures, a standard denominator for industrial sectors was seen as needed by some.

*Proprietary issues*: As for the energy intensity indicator, some participants expressed concern that the use of economic (i.e., financial) denominators in the indicators might disclose proprietary, confidential and/or competitive information.

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[17] Related to aggregation issues is the role of product mix in the indicator calculation, in that changes in the product mix (that can occur frequently and rapidly) can affect the metrics of aggregated indicators even though they are not related to performance (see further above under "Technical feasibility issues" in Section 3.3). Such changes in product mix will alter trends over time as well as design and other improvements. In addition, the specific product mix among consumer goods manufacturers varies widely; where this occurs, meaningful comparison can be facilitated by explanatory notes.

# 4. POLLUTANT DISPERSION INDICATORS



## 4.1 Overall conclusion

In evaluating options for pollutant dispersion indicators, the NRTEE Task Force and the representatives of the eight companies concluded that such indicators must address a range of public concerns about releases to the environment that cannot be reduced to a single indicator which would have any useful meaning. The purpose of these indicators must be to help users – internally and externally – to focus on reduction of a range of harmful releases to the environment, to support priority setting based on risk, and to communicate about progress towards targets. Releases of concern include more than just those substances that happen to be included in national and international lists of substances designated as "toxics" at a particular point in time.

The most workable approach is considered to be the selection and design of a suite of indicators relative to the issues or categories of greatest common concern. These categories may, for example, be smog precursors or atmospheric ozone depletors, greenhouse gas emissions, or dispersion of "priority toxics" in water. Where the science is sufficiently advanced, aggregation of substances within specific issues (such as for greenhouse gases or ozone depletion) may be appropriate. Design and implementation of an adequate set of pollutant dispersion indicators is going to be an evolutionary process likely to take longer than for the energy and materials intensity indicators. Flexibility is also needed to recognize that over time some environmental releases become less important, such as emissions of ozone-depleting substances being addressed and brought under control internationally, and new issues may be identified.

The eight companies made valuable progress towards the selection of a suite of issues-related pollutant dispersion indicators that would, after design and testing, be meaningful, widely applicable and scientifically acceptable. A useful next step would therefore be for a cross-section of companies to design and test indicators for three issues, such as greenhouse gas emissions (for which data are generally readily available), smog precursors and atmospheric ozone depletion. Scientific research is needed to determine ways to aggregate various substances and releases within categories in ways that are acceptable and meaningful.

## 4.2 From toxic dispersion to pollutant dispersion indicators

The "toxic release index" originally proposed by NRTEE for consideration was based on a numerator that aggregated masses of toxic substances released during an operating period or during product manufacture, each to be adjusted by a toxicity weighting factor. This indicator was intended to address the third element of eco-efficiency in a literal sense – "reduction of toxic dispersion."

Stakeholder input from the Washington workshop had strongly supported in principle the need for a toxic release indicator, recognizing that in some countries toxic release data is already collected and reported for regulatory purposes, such as the USA's TRI program, and Canada's NPRI program. However, the lack of international consensus on priority and other substances to be addressed, and the lack of scientific evidence as to their relative toxicity, were viewed from the outset as serious impediments to a single indicator approach.

In the early stages of planning the feasibility study, proposals focused on the design and testing of two toxic dispersion indicators based on aggregation of substances from existing toxic registry lists. During the course of their discussions, the participating companies and NRTEE Task Force members realized that addressing dispersion of toxics was not only difficult from the point of view of substance selection and aggregation, but also was too narrow an approach when in fact public concerns extend to a broader range of non-product outputs regarded as pollutants.

Further, firm consensus emerged that no single indicator based either on toxic substances alone or on a broader list of pollutants was likely to communicate meaningfully to users about toxic or other non-product output releases to the environment. The study concluded that design of a core set of toxic or pollutant dispersion indicators would only be workable and acceptable when there was sufficient international consensus on substances that cause concern, and on weightings that reflect relative hazard and toxicity that might permit meaningful aggregation into a small number of indicators.

The discussions leading to these conclusions and the shift in focus were valuable in many ways as a result of the insights and issues that came to light. These discussions and the issues and considerations relating to the original proposals for toxic dispersion indicators are summarized in Appendix B.

Consideration therefore turned to an approach based on a small set of indicators for the categories of pollutant dispersion that are of broad public and international concern. Participants began to seek consensus on categories for pollutant dispersion indicators that might eventually be widely acceptable, and feasible to measure and report in a meaningful way. Such categories or classifications would use terms or words that are generally recognized, understood and that reflect domains of general public concern.

Possible categories for indicator development that emerged from discussions were grouped in a preliminary model. The model rationale was based on using environmental media and scale to create major categories. Within each category, appropriate issues phrased in terms used by the public would be identified. Possible examples of categories within this model are as follows:

| General category | Specific pollutant categories to consider |
|---|---|
| Water | • dispersion of "priority" chemicals<br>• other dispersed pollutants |
| Air | • acid rain precursors<br>• smog precursors<br>• dispersion of "priority" chemicals<br>• other dispersed pollutants |
| Global issues | • greenhouse gas emissions |

"Priority" substances refer to bio-accumulative, persistent toxic compounds according to, for example, Canada's voluntary ARET (Accelerated Reduction/Elimination of Toxics) scheme.[18] ARET lists chemicals under the following five-part classification system:

| | |
|---|---|
| **A1** | Highly toxic, bio-accumulative and persistent (consensus on chemicals relative to criteria) |
| **A2** | Highly toxic, bio-accumulative and persistent (consensus not reached) |
| **B1** | Highly toxic and bio-accumulative |
| **B2** | Highly toxic and persistent |
| **B3** | Highly toxic |

[18] For further details about the ARET system, see *The ARET Substance Selection Process and Guidelines*, ARET Secretariat, January, 1994, or the Environment Canada website at ... *(Ed. add in URL.)*

A number of complementary categories were also identified for consideration.

*For releases to water:*

- oxygen depletors
- micro-organisms
- eutrophication

*For releases to air:*

- particulates
- stratospheric ozone depletors

*For releases to land as well as water and/or air:*

- endocrine disruptors
- managed waste – hazardous and non-hazardous.

To report such releases in a valid and meaningful way as absolute masses is in itself scientifically challenging; to do so in the form of an indicator that relates these masses meaningfully to unit of product or value created is even more so. Progress will be gradual, depending on continuing advances in scientific understanding of the effects of releases on human and other life forms, which in turn will affect levels of perceived and actual risk.

### 4.3 Further technical issues for pollutant dispersion indicators

Further technical issues that arose are summarized below.

*Overlap with energy indicators:* The potential overlap with energy indicators (C6) for energy-related GHGs was noted in Chapter 2. As a result, there is a need to decide whether GHG-related indicators will be a completely separate category or will be considered within the energy intensity or pollutant dispersion suites of indicators.

*Aggregation:* For pollutant dispersion indicators, aggregation of data about different substances is a fundamental problem. Aggregation could oversimplify complex environmental issues or concerns. 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). An alternative view was that the pollutant dispersion issue should be considered in a context similar to energy and materials, in which case some aggregation is preferred to avoid having too many pollutant dispersion indicators overwhelm the other indicators.

*Methodology*: As with the material and energy indicators, consistency with respect to the methodology for data collection and handling is required for pollutant dispersion indicators.

*Name for indicators*: The appropriateness of the name "pollutant dispersion indicator" may need wider consideration. Pollution indicator and pollution intensity indicator were suggested as possible alternative names. These names, along with the current "pollutant dispersion indicator," need to be informally tested with various internal and external audiences.

*Denominator*: Participants agreed that the same denominators used for the energy and material intensity indicators (unit of production or unit of revenue) should be used for pollutant dispersion indicators. In discussing the denominator, the group's primary issue of concern remained confidentiality, particularly within the chemical industry. In the feasibility study, companies were not being asked to disclose confidential information and may take whatever steps necessary to ensure confidentiality (e.g., rolling up data or using a value-added type of denominator).

Other technical observations regarding pollutant dispersion indicator development were as follows.

*Regulations*: 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, pollutant dispersion indicators must be able to distinguish those substances with a demonstrated higher level of activity (e.g., highly toxic, persistent and bio-accumulative substances) from the broader population of chemicals.

There exists wide variation not only between different regulatory jurisdictions, but also within jurisdictions, such that the regulated "level" of pollutants may vary between provinces and states, as well as between countries. The same is true for the pollution release and transfer registries (PRTRs), an issue encountered when the group considered the ARET, TRI and NPRI lists, and thus creating difficulty in arriving at a common basis for pollutants. Analytical differences also exist between jurisdictions. For example, biochemical oxygen demand (BOD) is measured on a five-day basis in Canada and the USA, whereas in Nordic countries an eight-day basis is used for measurement. $SO_2$ and nitrogen oxides are measured differently in different countries as well.

*Level of indicator*: Indicators, by definition, are not meant to deal with in-depth issues very well, but for the board of directors broad indicators can be developed that will also be of interest to the public. The group believed that indicators at this level will need to be highly aggregated so as not to overwhelm users with detailed information, although they can still provide directional information on the sound management of pollutants.

*Indicator categories*: 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 over time and become of less importance (e.g., many companies have already addressed ozone depleting substances) and new issues will emerge (e.g., endocrine disruptors).

*Risk-based approach*: Looking at inputs and outputs in terms of "risk" requires more detailed accounting of releases and where they end up through transportation and food chains. The reason is that risk is tied to exposure as well as inherent bio-chemical properties, and therefore when, where and at what rate a pollutant is released is of significance.

### 4.4 User issues

The context for pollutant dispersion indicators is shaped by user expectations that do not yet clearly point to any particular indicator, but which need to be taken into consideration. Furthermore, lack of comparability between pollutants makes comparison between companies reporting different pollutant releases difficult.

For many companies, the primary motivation of management (not necessarily of boards of directors) to track pollutant releases is the need to manage and prevent liabilities, to comply with regulations (including those that require reporting releases of prescribed substances, e.g., under the TRI or NPRI), and to be able to anticipate and possibly exercise influence over public policy issues and agendas. Many companies may not yet perceive clear value-added benefits in committing greater efforts and resources to the implementation of pollutant dispersion indicators for reasons beyond the above. However, there is a trend for companies to report their pollutants in a comparable way in order to fulfill their commitments to continuously improve their environmental performance.

Governments and regulatory agencies are likely to continue to implement requirements for companies to report releases of toxic substances and other pollutant releases such as smog precursors, acid rain precursors, ozone-depleting substances, and greenhouse gases (especially as countries begin to address their obligations or targets under international treaties, of which the Kyoto climate change commitments may be of special significance, particularly as emissions reduction trading schemes are introduced).

These types of commitments and reporting requirements can represent company cost drivers and create sources of business uncertainty and risk; they also make performance data publicly accessible. Capital market participants, especially lenders, institutional investors and financial analysts, are likely to become more rather than less interested in reliable information about aspects of performance such as pollutant and toxic emissions that may impact long-term shareholder value creation or represent business risk.

Community, employee and societal stakeholders in general are also not likely to reduce their concerns about toxic and other pollutant releases into the environment, and will continue to seek reliable, meaningful information about such matters.

A well-designed eco-efficiency approach to reporting on toxic or pollutant releases is seen to be superior for many users to reporting only releases of prescribed lists of substances. Perhaps of more importance is that pollutant dispersion indicators are an almost essential complement to materials and energy indicators, because the combination can provide users with signals about whether improvements in material or energy intensity are being accompanied by increased or decreased levels of pollutant or toxic dispersion.

# 5. CONCLUSIONS, LESSONS AND FUTURE DIRECTIONS

## 5.1 Conclusions

The following overall conclusions from the study were reached.

1. Core indicators for energy efficiency – energy consumed per unit of output – are widely applicable and meaningful, and may be readily implemented by many companies. Energy-related greenhouse gas emissions call for special attention and may be addressed better in designing pollutant dispersion indicators. Practical issues concerning implementation and interpretation have been identified, decision rules have been established, and the stage has been set for broader testing and demonstration of this indicator.

2. Core indicators for materials intensity – materials consumed per unit of output – are feasible, but are more applicable and meaningful in some industry sectors than others. Implementation by a given company needs to take into consideration special factors that depend on the nature of the company's business and products, in particular the effect of water used in production processes and water included in product output. Further studies on these indicators by a wider range of manufacturing sector companies will be valuable.

3. Design of a small set of meaningful eco-efficiency indicators for pollutant dispersion requires more consideration and research, but clearly a suite of indicators related to key issues of public concern is more likely to be feasible and useful than any single aggregate indicator. Pollutant rather than toxic dispersion was considered to be a more appropriate term for the range of releases that are of public concern.

In all three cases, the active participation of the eight companies in evaluating possibilities and experiences in testing indicators yielded important insights and lessons about what works, what is relevant and meaningful, and what is required for implementation of the proposed indicators.

## 5.2 Lessons learned

Chapters 2 to 4 of this report describe in greater detail the lessons learned and challenges identified in designing, implementing and interpreting the three types of indicators addressed in the NRTEE study. Attempting to meet the needs of key internal and external users poses a number of practical challenges. These lessons and challenges are summarized below.

### *Technical feasibility*

The key issues identified relating to technical feasibility were:

- agreeing on acceptable levels of precision in measurement, thresholds and scientific validity;
- deciding between indices (relative to a base level or year) and normalized indicators (relative to unit output or value added);
- establishing numerators and denominators that will produce meaningful information, and deciding whether users find more meaning in indicators that show improvement by upwards or downwards directional trends (some users may be accustomed to expect one direction, others the opposite direction);

- setting levels of aggregation that are meaningful without masking important information;
- avoiding arbitrary allocations of performance data between products or facilities;
- accommodating fluctuations in product lines, acquisitions and disposals of businesses and divisions, major shifts in production volumes; and
- addressing availability, completeness and quality of internal and external data for indicator calculation.

*Use and interpretation*

Other challenges relate to the meaning that users may ascribe to indicators and the completeness of information provided about environmental performance. The participating companies identified a number of challenges concerning the use and meaning of indicators:

- an indicator that may be effective in prompting a CEO or board of directors to ask appropriate questions and initiate further inquiry may be less meaningful or useful to management of a facility or product line.
- indicator design has to guard against the "perverse effect" problem, that is, the risk that a particular indicator by itself may trigger a decision by a user with a view to improving one aspect of performance, while unintentionally causing an adverse effect in some other aspect of performance. A set or suite of indicators and other information may be necessary to provide appropriate directional context for proper understanding of any one indicator.
- one aspect of design of eco-efficiency indicators that the feasibility study participants noted but did not attempt to resolve is whether the numerator should relate to environmental burden (e.g., materials and energy consumed, pollutants dispersed) and the denominator to output or value created, or vice versa. Users in different parts of the world have different expectations and perceptions as to the directional trends of indicators that are most readily understood or considered desirable.
- a core set of eco-efficiency indicators is not expected to communicate all the necessary information about a company's environmental performance. The companies participating in the NRTEE feasibility study confirmed that other quantitative (for example, absolute) measurements and qualitative information are often also necessary to provide a complete and meaningful picture of environmental performance. Explanatory notes about specific indicators may also be helpful to users in properly interpreting the meaning of indicators – somewhat analogous to notes to financial statements.

*Indicator development*

The NRTEE effort has demonstrated a prototype process for the development of eco-efficiency indicators. The key to progress for such indicators is active, phased experimentation and shared learning among companies to discover which eco-efficiency indicators are the most appropriate, meaningful and cost-effective to produce. The phases in this process may be summarized as follows:

- consideration of indicator needs by a wide audience of stakeholders;
- agreement on a technical framework and operating rules to test defined indicators by volunteer companies;

- actual feasibility testing and sharing of learning by participants; and
- further testing and drawing of conclusions.

Appendix C provides a chronology of the NRTEE workshops in this process and highlights the focus of each. The next stage in this process would be refinement and wider demonstration projects with a larger and more diverse group of industry volunteers.

### 5.3 Future directions

As a result of the feasibility study, the NRTEE recognizes that active experimentation by companies is the best way to discover which eco-efficiency indicators are the most appropriate, meaningful and cost-effective to produce. This is vital to progress. Learning and consensus building based on sharing the results of such work is invaluable to complement insights from other stakeholder consultations and research initiatives. Specific next steps to consider identified by participants are set out below.

***Energy intensity indicators***

In terms of future challenges for development of the energy efficiency indicators, issues identified for further work included building external credibility, standardization of numerators and denominators, and how many and which of the complementary indicators to pursue. Linking energy intensity indicator development with climate change initiatives regarding greenhouse gases is also considered important.

***Material intensity indicators***

In terms of further work required to develop material intensity indicators, the group identified the most important step to be that of testing the use of these indicators in a wider range of companies, particularly those in the manufacturing sector, which was under-represented in the feasibility study. Further refinement of definitions and decision rules for inclusion is also needed (i.e., for direct and indirect materials). Consideration should be given to the design and testing of a wider set of indicators, such as a separate water indicator, and to indicators that address waste management, such as recycling and reuse of materials, and the use of renewable versus non-renewable materials.

***Pollutant dispersion indicators***

Continued design, testing and evaluation of pollutant dispersion indicators by companies and industry associations is needed. As previously suggested, a concrete and useful next step would be for a cross-section of companies to design and test indicators for three issues, such as greenhouse gas emissions (for which data are generally readily available), smog precursors and atmospheric ozone depletion. Further scientific research is needed to support aggregation of data into meaningful pollutant dispersion indicators. Industry associations might play a useful supporting and/or coordinating role in this regard.

***Common themes***

*Continuing experimentation by companies*

To move forward and build upon the lessons learned from this project, continued evaluation by the participating companies and testing by a wider group of companies will be valuable. The NRTEE will seek cost-effective ways to facilitate sharing of experiences among participating companies, including the convening of a progress review meeting later in 1999. Recruiting more companies from a wider cross-section of sectors to test the energy and material intensity indicators and to further the design and testing of pollutant dispersion indicators is also very desirable.

*Roles for industry associations*

Industry associations may be able to play a useful role in encouraging companies to experiment with the design and implementation of eco-efficiency indicators, in related research, such as for pollutant dispersion indicators, and in disseminating sector-specific guidance about eco-efficiency indicators.

*Wider communication and use of study*

Communication of the results of the study will be valuable to industry and business associations and to other stakeholders. Learning how to interpret the indicators may be as important as developing and reporting them. Integration of the feasibility study results with eco-efficiency measurement and reporting initiatives by other organizations in Canada and internationally also will be valuable.

## APPENDIX A: The participating companies

| Name of company | Company products or services | Company statistics | Level at which study conducted | Responsibility for study | Environmental performance reporting | Lessons learned/utility to company | Future plans & recommendations |
|---|---|---|---|---|---|---|---|
| **3M** | Tape, abrasives, adhesives, encapsulated products, cleaning products, filtration products, anti-corrosion pipe coatings, health care products. | World-wide: 70,000 employees in 200 countries, over 50,000 products, annual global revenue US$14 billion<br>Canada: 7 plants, 1,000 employees. | Two manufacturing facilities in Canada | John Howse, Manager – Environment, Heath and Safety; Ian Service, Senior Specialist, Environment and Regulatory Affairs<br>Contact at: jrhowse@mmm.com | Reports issued periodically (2 in last 3 years). | Materials indicators less useful than waste indicators already in use, energy efficiency indicators already in place, interested in GHG indicators. | Will continue until feasibility testing period complete. |
| **Alcan** | Aluminum industry: bauxite mining, alumina refining, power generation, aluminum smelting, manufacturing and recycling. Produces and markets aluminum products. Is the world's leading supplier of flat-rolled aluminum. | Parent of worldwide group of companies involved in all aspects of aluminum industry, operations in 30 countries, over 33,000 employees worldwide. | Site, significant unit processes. | Steven Pomper, Director of Environment<br>Contact at: steven.pomper@ alcan.com. | Corporate report every 3 to 5 years. Annual report at site level. Some regional reporting planned. | Material indicators not applicable, interested primarily in energy and GHG indicators. Communication is key to establishing consistency and rigorous uptake. | Will incorporate energy and GHG indicators in annual assessment process. More work required to harmonize PDIs across company. |
| **Bell Canada** | Canada's largest telecommunications provider. | 7 million customers in Ontario & Quebec, approx. 42,000 employees, gross annual revenues over Cdn. $8.5 billion. | Office building | Yves Ouimet, Director of Environment<br>Contact at: youimet@qc.bell.ca | Annual environmental performance report. | Indicators pose unique challenges to service companies, data collection difficulties. | Will continue developing and testing indicators with a view to ongoing use. |

| Name of company | Company products or services | Company statistics | Level at which study conducted | Responsibility for study | Environmental performance reporting | Lessons learned/utility to company | Future plans & recommendations |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Monsanto** | Biotechnology, food ingredients, pharmaceuticals, agricultural products. | World-wide: 23,000 employees in 150 countries, over 500 products, annual global revenue US$8 billion. | Company and one product line | Earl Beaver, Director of Waste Elimination Contact at:.... *(Ed. Need info.)* | Reports issued annually. | Prefer value-added denominators; packaging information difficult to obtain; energy co-generation contentious, significant concern re data adequacy, reliability, etc. & comparability, perverse results. | Need to work more closely with Centre for Waste Reduction Technology (USA), need more contact with Europe and NGOs. |
| | | | | | | | |
| **Noranda** | Mining & metallurgical: leading producer of zinc & nickel, also produces copper, primary & fabricated aluminum, lead, silver, gold, sulphuric acid, cobalt &wire rope. Major recycler of secondary copper, nickel & precious metals. | Total mining & metal assets of Cdn. $8.9 billion at year-end 1997, 80% of products sold outside Canada, over 21,000 employees worldwide. | Site | Leonard Surges, Manager, Environment Contact at: surgesl@ibm.net | Annual environment, safety and health report. | Material indicators not applicable, high level of interest in energy and GHG indicators. Issues: data availability, allocation, denominator selection. | |

| Name of company | Company products or services | Company statistics | Level at which study conducted | Responsibility for study | Environmental performance reporting | Lessons learned/utility to company | Future plans & recommendations |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Nortel Networks** | One of the world's largest suppliers of digital network solutions, e.g., communications and Internet Protocol optimized networks. | Conducts business in over 150 countries, approx. 80,000 employees, 1997 revenue of US$18 billion. | Company | Tony Basson, Contact at: tbasson@nortel.com | Annual reports. | Issues: data collection indicator scope & definition, denominator selection. | Will continue to develop and use indicators. |
| | | | | | | | |
| **Procter & Gamble** | Consumer goods, incl. laundry & cleaning products, kitchen towels, bathroom tissue, baby diapers, etc. | Worldwide approx. 110,000 employees in over 140 countries, 350 product brands, US$35.7 billion. | Several levels, incl. company, business unit (paper) and product line (paper towels) | Willie Owens, Principal Scientist, Corporate P&RS, Global LCA Technical Development; Amardeep Khosla, Manager, Technical Policy – Canada, Worldwide Technical Policy Contact at: owensjw@pg.com; khosla.as@pg.com | Reports issued annually. | Significant learning benefits for P&G from feasibility study, building on related previous work. | Continue work where needs identified for improvements in existing data & indicator reporting practices. |
| | | | | | | | |
| **Pacific Northern Gas[PNG], owned by WestCoast Energy** | Integrated transmission & distribution co. part of a North American energy company whose interests include a natural gas system, distribution & storage facilities, retail energy products & services. | PNG serves customers in west-central and northeastern BC. WestCoast Energy is based in Vancouver, with assets of $10 billion. | Data not available. | K.C. Caswell, Team leader, Engineering & Environment Contact at: cawced@ibmmail.ca | | Service company challenges, $CO_2$ issue (swamping indicators). | |

## Appendix B: Original proposals and considerations for toxic release indicators

This appendix describes the original proposals for toxic release indicators and the issues considered in developing and evaluating those proposals. Although these indicators were not tested as a feasibility study, many important issues, concepts, definitions, decision rules and practical lessons came to light in the process of considering them.

The "toxic release index" proposed by NRTEE for consideration was based on a numerator that aggregated masses of toxic substances released during an operating period or during product manufacture, each to be adjusted by a toxicity weighting factor. As described in Section 4.2, stakeholder input from the Washington workshop supported the need for a toxic release indicator, and recognized that toxic release data is already being collected and reported in various countries for regulatory purposes. However, taking a single indicator approach raised the issues of the lack of international consensus on the substances to be addressed and their priority, and on scientific evidence about their relative toxicity.

The Washington workshop concluded that:

> *Development of one or more indicators for toxic dispersion or releases is also highly desirable and relatively feasible.... The potential exists to design and implement two toxic release indicators – one related to the goal of virtual elimination of the persistent, bio-accumulative toxic substances covered by international treaties, and one to address a longer list of toxic chemicals, such as those in the U.S. TRI or Canada's NPRI. Further work is needed, however, to examine existing requirements and practices in defining, measuring and reporting toxic releases, and in assessing and comparing their toxicity.*[19]

NRTEE therefore commissioned the preparation of a report on current practices regarding toxic release indicators and work on that topic in Canada and elsewhere. The report[20] provided suggestions and a point of departure for the work of the NRTEE Task Force and the eight volunteer companies in addressing indicators for pollutant dispersion. Key points from the report, subsequently discussed and challenged in the course of the study, included:

- pollutant dispersion indicators (rather than *toxic release* indicators) were to be capable of being "used voluntarily by industrial and business organizations to provide a simple, readily understood metric of the organization's performance in eco-efficient management of toxic chemical releases to the environment. The essential elements of such performance indicators are the annual quantity of toxic substances released by an organization per unit of production or business activity."

- a substance list such as that used in Canada's voluntary ARET program should be considered, since that list groups substances based on concerns about toxicity. The report noted, however, that currently no international generally accepted weighting or ranking of level of toxicity concerns for reported substances exists, and that although several countries and industry associations maintain some type of Pollutant Release and Transfer Register (PRTR), careful attention needs to be paid to the quality and reliability of reported release data.

- the most appropriate type of denominator to deal with year-to-year fluctuations of substance releases and production/activity levels and to provide a consistent basis for comparisons would be of a financial or economic nature, such as sales or cost of sales.

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[19] *Backgrounder*, p. 36.

[20] *Discussion Paper on International Performance Indicators for Dispersion of Toxic Chemicals into the Environment* by Peter Robson, unpublished NRTEE paper, 1997.

The report also provided a detailed practical example of the calculation of a possible pollutant dispersion indicator for a hypothetical company.

The volunteer companies met with NRTEE Task Force members and invited experts early in 1998 to develop a plan for testing one or more indicators that would relate to releases of toxic substances. Although the term "pollutant dispersion indicator" was adopted, the group's focus continued to be on developing one or two aggregate indicators of toxic substance releases. The outcome of this planning stage was two proposed minimum indicators and related decision rules that the participating companies would each review internally before reconvening to discuss, to modify as needed and to agree upon for feasibility testing purposes. Other conclusions reached at this planning stage were as follows.

***Purpose and nature of work in developing indicators***

Future work on the indicators should attempt to ensure that:

- the indicator(s) developed help companies engage in an intelligent dialogue both within the company and with outside stakeholders.

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

- the list of pollutants used in the feasibility study follow the decision rules and are created from existing credible lists of pollutants agreed to by the participating companies.

- for the feasibility study, the list (of substances) recognize different levels of concerns for pollutants, using criteria such as those in the ARET classification.

***Criteria for developing indicators***

Pollutant dispersion indicators were to be:

- useful as an analytical tool and easy to reproduce from year to year;
- adaptable, i.e., capable of being modified over time, for example as a result of scientific evaluations and changes in lists of substances;
- credible to stakeholders and users, and responsive to external concerns;
- applicable in different countries and for sector-specific indicators;
- auditable;
- relevant to both organic and inorganic substances;
- complementary to 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 performance improvement, not having perverse effects on decision making regarding other aspects of eco-efficiency;
- valuable at several levels within a company, from product to corporate, and for several purposes; and
- capable of being calculated from data and measurements that are available or obtainable in a cost-effective manner and in accordance with clear, appropriate decision rules.

***The proposed indicators***

Following is the approach taken and resultant indicators (based on toxic substance releases) and related decision rules that were originally proposed as the basis for the feasibility study.

*What to include in the indicator – Step 1: defining and classifying non-product outputs*

Step 1 was to consider the exact scope or categories of what are characterized as non-product outputs (NPOs), since these contain the substances that are to be tracked and incorporated into pollutant dispersion indicators. NPOs are outputs other than the products, services or by-products that are regarded as part of the company's revenue-producing lines of business and are typically the focus of marketing strategies, sales efforts, etc. NPOs therefore include both substances released directly to the environment – to air, water or land, whether deliberately or accidentally – and those that are not released directly to the environment but are managed through recovery (reuse and recycling) or through controlled disposal techniques (e.g., compost, incineration, landfill, transfer to safe storage). There exists of course the possibility of releases to the environment also arising from recovery and controlled disposal processes – whether "within the gates" or after leaving the company's direct control. These were termed "indirect releases".

The full range of NPOs to be considered for pollutant dispersion indicators would be direct releases plus indirect releases, but the group recognized that the latter may present problems where data are not available or the indirect releases occur after managed NPOs have left the company (but are not simply moved between company facilities).

For pilot-testing purposes, the volunteer companies agreed to consider at least substances contained in direct releases in their calculations. Indirect releases would be considered where data were available (companies would need to define exactly the nature and source of indirect releases being so considered).

*What to include in the indicator – Step 2: deciding what NPO substances to include*

Step 2 of the approach proposed for purposes of the NRTEE feasibility work was to decide exactly what NPO substances should be included in two proposed minimum indicators, based on measurements of mass of releases of substances in NPOs that are included in the TRI, NPRI and ARET lists as follows.

*Minimum indicator 1:* substances that are common to TRI and NPRI, plus any other additional ones that are common to ARET and TRI. This would result in a list of 195 substances. For the purposes of this indicator, no toxicity weighting was to be applied to individual substances.

*Minimum indicator 2:* substances common to TRI and ARET, grouped according to classes in the ARET classification system but combining or aggregating these in such a way as to result in three, not five classes: A1 plus A2, B1 (alone), and B2 plus B3. This would result in a list of 78 substances, grouped in 3 classes based on the ARET toxicity weighting criteria.

***Additional decision rules proposed for study purposes***

At least for feasibility study purposes, the companies also agreed to track and report total masses under each of the three groupings, so as to allow for experimentation with alternative weighting schemes for indicator design.

Unit of production (or service) was to be the denominator for the indicators tested, but participating companies would have the option to use unit of revenue or value-added as the denominator where they considered appropriate.

The companies also agreed to carry out "reality checks" by watching out for instances where there might be significant releases of substances that cause concern but are not included in the above groupings for minimum indicators 1 or 2. A further proposed step was to compare the selected lists with those in European priority substance lists and to consider any discrepancies in due course.

A set of complementary indicators was considered as well, being indicators that the volunteer companies might choose to evaluate as to relevance and usefulness in concept, and as to feasibility in practice. These indicators were ones that might be developed based on modifications to the substance lists proposed above, e.g., greenhouse gases emissions, air pollutants (e.g., smog precursors), combined NPRI and ARET releases (for Canadian companies), or minimum indicator 1 plus all other TRI substances (for American companies).

For indicator testing purposes, substance releases would be measured in metric units, such as kilograms or tonnes. Data for calendar 1996 would be used where possible as the time period for which indicators would be calculated. Current NPRI and TRI reporting thresholds would be used for the minimum indicators 1 and 2, recognizing that the differences between these two sets of thresholds would need to be resolved at some stage. In the event of indicators being normalized to a product or service (rather than a financial measure), any allocations of substance releases among products or services would be made on the basis of mass.

**Conclusions regarding the two indicators originally proposed**

Following an extended period of consideration, the companies and members of the Task Force expressed significant concerns about the two proposed indicators that focused on releases of listed toxics. These concerns included:

- the risk of confusion to users through departure from established (and, to regulators and environmental managers, somewhat familiar) substance lists or inventories such as TRI, NPRI and ARET, and in fact creating new lists. Also, companies in the USA would have had to deal with the shift from a strictly mass-based approach to one based on levels of toxicity, persistence and bio-accumulation;

- the challenge of reaching consensus and general acceptance about the design of an appropriate suite of indicators, and the number of indicators needed for meaningful reporting – one or two indicators clearly would not suffice for such a complex topic;

- whether the indicators should encompass or address pollutants such as acid rain or smog precursors or greenhouse gas emissions. This was beyond the original concept of toxic dispersion, but nevertheless was seen as a key pollutant release issue;

- the continued need for consensus on the question of denominator(s) for the indicators; and

- the reality that companies were already tracking, reporting and in many cases managing substance releases required under TRI and NPRI, and could not see sufficient value (for internal users, at least) in implementing additional indicator schemes, even ones that use existing data.

Two companies offered further specific concerns.

1. Monsanto indicated that its total emissions of toxic substances were small relative to its overall pollutant emissions, and that much of what would otherwise be direct toxic releases to the environment is in fact managed by transfer to various forms of treatment and disposal. These factors suggested the appropriateness of pollutant dispersion indicators broader than just ones relating to the proposed groupings of listed toxic substances. In fact, one indicator for total mass of all (ARET, TRI, NPRI) substance releases and a second indicator to add in other priority pollutant releases (greenhouse gases and acid rain precursors) had been developed, both normalized relative to a form of value-added (sales revenues less cost of raw materials).

2. Procter & Gamble observed that it perceives considerable challenges to be overcome to devise a suite of meaningful, comparable pollutant dispersion indicators for use by external stakeholders. The company prefers an approach that facilitates risk assessment and risk management decisions, focusing on three broad categories of substance releases: TRI substances, high production volume (HPV) substances, and persistent organic pollutants (POPs). For TRI and HPV substances, there is a need to distinguish between actual and managed releases. For POPs, the important issue is management of NPOs rather than direct releases. Further, in a risk-based approach, there are different challenges in assessing toxicity for humans as distinct from toxicity for eco-systems in general.

Attention therefore turned to an approach based on issues or categories of pollutants, as described in Chapter 4.

## Appendix C: Chronology of workshops

The table below summarizes the workshops for the NRTEE Task Force members and representatives of the participating companies during the course of the project, as well as the forum held by the NRTEE immediately prior to Globe '98 in March 1998 to communicate with a wide group of interested stakeholders about the project. Copies of the detailed technical reports prepared from each workshop are available on the NRTEE website, as are highlights of the forum proceedings.

| Workshop date, location | Workshop focus |
|---|---|
| | |
| April 2, 1997, Washington, DC | Broad stakeholder consultation meeting. |
| | |
| November 12-14, 1997, Toronto, ON | Planning feasibility study for energy and material intensity indicators. |
| | |
| January 26-27, 1998, Toronto, ON | Planning feasibility study for toxic dispersion indicators. |
| | |
| March 16, 1998, Vancouver, BC | Mid-study progress review – all three types of indicator. |
| | |
| March 17, 1998, Vancouver, BC | Forum to communicate with interested stakeholders about study. |
| | |
| June 23-25, 1998, Montebello, PQ | Review of findings and conclusions for all three types of indicator. |
| | |