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TABLE RONDE NATIONALE SUR L'ENVIRONNEMENT ET L'ÉCONOMIE

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Backgrounder

Measuring Eco-efficiency in Business

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and the Economy

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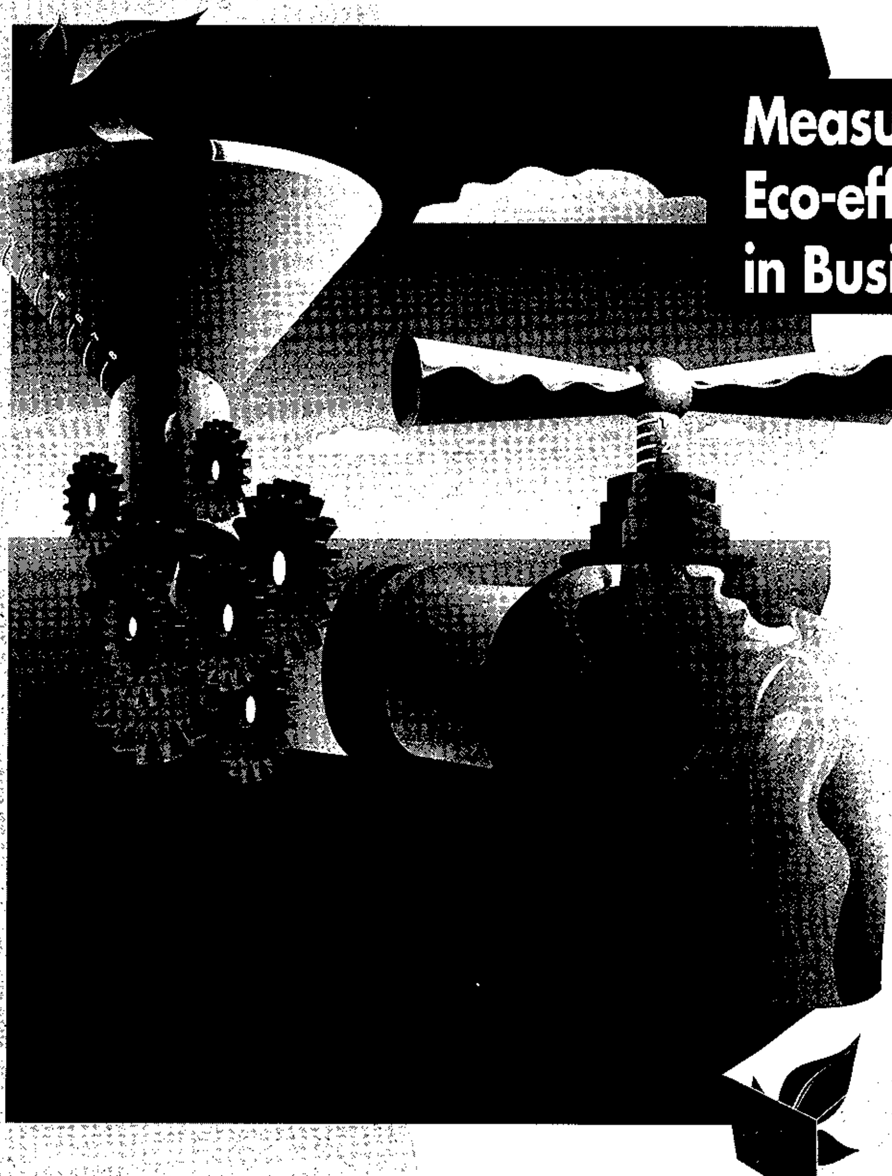

Measuring Eco-efficiency in Business

Mandate

The National Round Table on the Environment and the Economy (NRTEE) was created to "play the role of catalyst in identifying, explaining and promoting, in all sectors of Canadian society and in all regions of Canada, principles and practices of sustainable development." Specifically, the agency identifies issues that have both environmental and economic implications, explores these implications, and attempts to identify actions that will balance economic prosperity with environmental preservation.

At the heart of the NRTEE's work is a commitment to improve the quality of economic and environmental policy development by providing decision makers with the information they need to make reasoned choices on a sustainable future for Canada. The agency seeks to carry out its mandate by:

- advising decision makers and opinion leaders on the best way to integrate environmental and economic considerations into decision making;
- actively seeking input from stakeholders with a vested interest in any particular issue and providing a neutral meeting ground where they can work to resolve issues and overcome barriers to sustainable development;
- analyzing environmental and economic facts to identify changes that will enhance sustainability in Canada; and
- using the products of research, analysis and national consultation to come to a conclusion on the state of the debate on the environment and the economy.

The NRTEE's state of the debate reports synthesize the results of stakeholder consultations on potential opportunities for sustainable development. They summarize the extent of consensus and reasons for disagreement, review the consequences of action or inaction, and recommend steps specific stakeholders can take to promote sustainability.

Members of the National Round Table on the Environment and the Economy

The NRTEE is composed of a Chair and up to 24 distinguished Canadians. These individuals are appointed by the Prime Minister as opinion leaders representing a variety of regions and sectors of Canadian society including business, labour, academia, environmental organizations, and First Nations. Members of the NRTEE meet as a round table four times a year to review and discuss the ongoing work of the agency, set priorities, and initiate new activities.

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Preface

In March 1996, the federal government outlined its policy response to the Science and Technology Review and its intention to move toward sustainable development through innovation.[1] To further policy development in this area, the government sought the advice of the National Round Table on the Environment and the Economy (NRTEE) in establishing specific targets to help business and other sectors become more eco-efficient and to understand the implications of those targets for developing new technologies.

In the summer of 1996 and in cooperation with the World Business Council on Sustainable Development, the NRTEE set up a task force to explore the possibility of developing a core set of indicators for measuring eco-efficiency. These indicators would be designed to encourage companies to set measurable eco-efficiency targets, assist in assessing their progress and performance against their targets, and facilitate comparisons of environmental performance between companies of all types and sizes (as well as within sectors).

The intent was not to bring about new, mandatory external disclosure requirements. Rather the goal was to develop a few robust, widely accepted, quantifiable and verifiable eco-efficiency indicators that all companies could use — initially for management and eventually for external performance reporting.

This background document, the first publication from the NRTEE's Task Force on Eco-efficiency, presents progress to date in developing a core set of indicators for measuring eco-efficiency in business.

This *Backgrounder* was prepared by arrangement with the Canadian Institute of Chartered Accountants (CICA) under the direction of the NRTEE Task Force on Eco-efficiency. While many documents were reviewed in the preparation of this report, the authors accept full responsibility for the interpretation of the literature. The content of the paper does not necessarily represent the position of the NRTEE, the CICA, nor the members of their respective organizations.

Dr. Stuart Smith
Chair
Task Force on Eco-efficiency
National Round Table on the Environment and the Economy

1 Government of Canada, *Science and Technology for the New Century* (Ottawa: Minister of Supply and Services, 1996).

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Executive Summary

The National Round Table on the Environment and the Economy (NRTEE) is exploring the possibility of developing indicators for measuring eco-efficiency to encourage companies to (i) set measurable eco-efficiency targets, (ii) assist in assessing their progress and performance against these targets, and (iii) facilitate comparisons of environmental performance between companies. The goal is to develop a few robust, widely accepted, quantifiable and verifiable eco-efficiency indicators that all companies can use, initially for the purposes of management and boards of directors, but eventually also for external performance reporting.

To guide its work, the NRTEE's Task Force on Eco-efficiency adopted the definition of eco-efficiency proposed by the World Business Council on Sustainable Development.[1] Initial activities of the NRTEE included commissioning reviews of the literature on environmental performance measurement, including recent company reports, and identifying leading organizations engaged in similar work. The process culminated in an Eco-efficiency Measurement Workshop held April 2, 1997, in Washington, DC.

Users, Needs and Drivers

There is a wide variety of users of eco-efficiency performance information, both within and outside companies. The needs to be met by this information, together with the motivations that generate those needs, are widely varied as well. For example, motivating factors ("drivers") for directors and management are cost savings, risk reduction, improved competitiveness and a recognition of accountability to others. For the capital markets, longer term profitability and risk minimization function as drivers. Trade, environmental policy and international forces are drivers for regulators and government, while others (like suppliers, customers, communities, employees and non-governmental organizations) are driven by concern for credibility and sustainability. Therefore, there is both a wide need for eco-efficiency performance information and a relatively wide use of that information, even though the concept itself is not familiar to all companies.

As a result of these information needs and drivers, many companies have developed and implemented environmental performance measurement systems to meet their environmental and eco-efficiency goals. However, many different measures are being used, and they are not readily comparable. A special challenge in developing eco-efficiency indicators is to identify a few key indicators that can be used to measure eco-efficiency across all companies.

Indicators in Use Today

The indicators being used by some companies to measure and report on their environmental performance provide useful input in developing a core set of indicators. Examples reviewed in this report because of their relevance to eco-efficiency include

Novo Nordisk's eco-productivity index, Northern Telecom's environmental performance index, Niagara Mohawk Power's environmental performance index, British Telecom's environmental performance index and Elf Atochem's waste and water indices. Also discussed are the indicators used by Dofasco, WMC, the E.B. Eddy Group, the Investor Responsibility Research Center, and the UNI-Storbrand Scudder Stevens Fund. Monsanto's sustainability index and Ontario Hydro's resource utilization index, both under development, are also mentioned.

Several conclusions can be drawn from the examples given. First, analysis reveals that the broad types or classes of indicators in use around the world meet a number of important criteria such as relevance to eco-efficiency objectives, appropriateness to users' needs, measurability, understandability, verifiability and comparability in tracking performance over time. Limitations include complexity and lack of transparency in some instances, difficulty of comparison, largely as a result of selectivity and subjectivity, and loss of reliability when information is aggregated, indexed or normalized. Some of these limitations may be more problematic in the process of compiling, synthesizing and condensing a large amount of information. Consequently, a core set of indicators may need to be supplemented by the use of industry-specific benchmark values for these indicators, as well as by absolute measures of performance. Industry-specific eco-efficiency indicators may also be necessary.

Toward a Core Set of Indicators

The NRTEE Task Force initially proposed three indicators to measure certain aspects of business eco-efficiency: a resource productivity index, a toxic release index, and a product and disposal cost to durability ratio. These were reviewed at the Washington eco-efficiency workshop. The indicators and the recommendations for future development are as follows:

- *Resource productivity (RP) index:* The RP index aims 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. This indicator would allow companies to evaluate their performance over time to determine whether they are improving their resource and energy productivity. It does, however, pose challenges such as defining common measurements for materials and energy. Workshop participants agreed that the indicator is important in concept; however, it should deal separately with materials intensity or efficiency and energy intensity or efficiency.

- *Toxic release (TR) index:* The TR index aims to express as a single number the amount of toxic materials released during the manufacture of a product, or during a given operating period, calculated as the sum of the adjusted masses (weights) of each toxic material released. Participants felt that, as proposed, the index would be difficult to use as a reliable and objective indicator because of its dependence on weighting factors for toxic substances and the current lack of scientific data and consensus about toxicity. Relevant indicators for toxic releases could nevertheless be devised, which could employ data already being recorded, tracked, and, in some jurisdictions, reported to authorities as publicly accessible information.

- *Product and disposal cost to durability (PDCD) ratio:* The PDCD ratio relates to product stewardship and recyclability, and expresses the cost of a product as the sum of its purchase price and disposal cost divided by its years of life. It, too, poses challenges. Workshop participants agreed that the indicator is unworkable as proposed: it attempts to address a combination of material and energy efficiency, recyclability, use of renewable resources and product durability elements; this involves the use of financial measurement units, which would themselves be problematic to apply, in order to provide an understandable and relevant indicator. Further consideration needs to be given to the most effective indicator or indicators to address these elements, separately or in some combination.

The Way Ahead

Design Considerations and Challenges

Participants at the workshop noted various broad considerations and specific challenges in developing indicators for eco-efficiency. Broad considerations included the need for evolutionary development of the indicators; the need to limit the scope of current measures (i.e., by not incorporating social values, at least for the present); the urgent need to move forward now with imperfect measures and refine them over time; the fact that it may not be possible to develop an indicator for each element of eco-efficiency; and the need to focus first on providing information for internal decision making.

Specific technical challenges included how to determine which aspects of a product's life cycle should be addressed by the indicator; problems caused by aggregating large amounts of information (e.g., masking of relevant information); issues raised by weighting and normalization procedures; and how or whether to incorporate financial measures.

Priorities for Action

Participants at the Eco-efficiency Measurement Workshop agreed that work should continue to develop and refine the first two indicators, the RP and TR indices, proposed by the NRTEE. However, work on the third, the PDCD ratio, should be suspended, at least for the time being. Work on the first two indicators should be carried out according to the broad priority rankings below:

- *Indicators for improving material productivity and reducing energy intensity:* Workshop participants agreed that these two elements of eco-efficiency are ones for which indicators are particularly relevant to many users, and that separate indicators should be used to measure each element. Such indicators could be readily implemented, following development of the necessary definitions and completion of pilot testing.

  Companies in several countries have already designed and implemented indicators relating to these elements of eco-efficiency. The next step is to build on such work, develop consensus on indicator design, and promote the wide acceptance and use of indicators for these elements.

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

  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. Toxic Release Inventory or Canada's National Pollutant Release Inventory. Further work is needed, however, to examine existing requirements and practices in defining, measuring and reporting releases of substances of concern, and in assessing and comparing their toxicity.

- *Indicators for enhancing material recyclability, maximizing sustainable use of renewable resources and extending product durability:* There is value in developing appropriate indicators for each of these three elements of eco-efficiency. However, there is a need to determine users' needs more clearly and to develop definitions and design parameters before pilot testing and broader adoption by business. Indicators in these areas might include those for renewable resource depletion or consumption, use of recycled materials and recyclable content of products. They might also be linked to material productivity indicators.

- *Indicators for service intensity and lifetime product cost:* An indicator to measure the service intensity of goods and services was considered more difficult to design and implement. A similar conclusion was reached regarding an indicator for lifetime product cost, which by definition might be more difficult to apply at the level of a whole organization.

Next Steps

The NRTEE Task Force on Eco-efficiency is designing pilot tests of the two components of the resource productivity index — the material productivity and energy intensity indices. Plans are to conduct initial pilot testing in five or six volunteer companies from industry and the financial sector over, perhaps, a one-year period. The initial pilots would be followed by pilot testing in a wider group of businesses, which would provide input to a second workshop on measuring eco-efficiency.

Other work will include further exploration of an appropriate indicator for toxic dispersion and further research into the needs of internal and external decision makers for eco-efficiency indicators.

1 The seven elements of the World Business Council for Sustainable Development's definition of eco-efficiency are: 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 and increasing the service intensity of goods and services. These elements may be used as the focal points around which to develop performance indicators.

1

Introduction

Eco-efficiency: Concept and Practice

In searching for a core set of indicators for measuring eco-efficiency, the National Round Table of the Environment and the Economy's (NRTEE) Task Force on Eco-efficiency adopted the definition of eco-efficiency first put forward by the (then) Business Council on Sustainable Development and developed progressively by its successor organization, the World Business Council for Sustainable Development (WBCSD), between 1992 and 1995:

> 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. [1]

The WBCSD subsequently developed a more concrete expansion of the definition in *Eco-Efficient Leadership for Improved Economic and Environmental Performance*, by setting out seven elements of eco-efficiency:[2]

- 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

Eco-efficiency is a significant subset of sustainable development. It is significant because it offers an opportunity to engage business in the agenda of sustainable development on terms that support business goals. Moreover, eco-efficiency measures provide a practical tool for designing and implementing resource use programs for industry on a sectoral, national and international level.

For a business, being eco-efficient means doing things differently. It means integrating eco-efficiency into business strategy to produce measurable environmental and economic outcomes that, in turn, may produce broader societal benefits. As the WBCSD notes,

> 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.[3]

Research and Consultation

To focus its activities and the discussion it aimed to stimulate, the NRTEE Task Force on Eco-efficiency adopted the working hypothesis that it is both desirable and possible to develop a core set of performance indicators or measures that:[4]

- can be widely used by many if not all businesses to: (a) evaluate their performance and progress toward the achievement of objectives and targets related to specific elements of eco-efficiency; and, if possible, (b) measure the overall eco-efficiency of the business entity or unit in question;
- can be used by businesses for their internal users (e.g., boards of directors and management) and for providing information as necessary to external users, such as investors and lenders, communities, governments, suppliers and customers;
- can be used in conjunction with other financial and non-financial performance indicators, including industry-specific environmental and eco-efficiency performance indicators, to provide a more comprehensive description of an entity's contributions to value generation and impacts on the environment.

To explore this hypothesis, the Task Force commissioned reviews of the literature on environmental performance measurement, including recent company reports, and identified leading organizations, Canadian and international, carrying out similar work. The process culminated in an Eco-efficiency Measurement Workshop held April 2, 1997, in Washington, DC.

Sponsored jointly by the NRTEE and WBCSD, the workshop provided a venue where leading representatives from industry, non-governmental organizations and government could discuss their experiences in measuring eco-efficiency within companies and, to the extent possible, reach consensus on the feasibility of a core set of eco-efficiency indicators proposed by the NRTEE. Participants came from organizations in Canada, the United States, Mexico, Colombia and Switzerland; many had also worked extensively in other countries or were involved in work concerning developing countries; all were practitioners and thinkers in the areas of eco-efficiency, performance measurement and business policy.

Scope of this Report

This background report sets out the results of the Task Force's preliminary work to identify a core set of indicators for measuring eco-efficiency. The following sections:

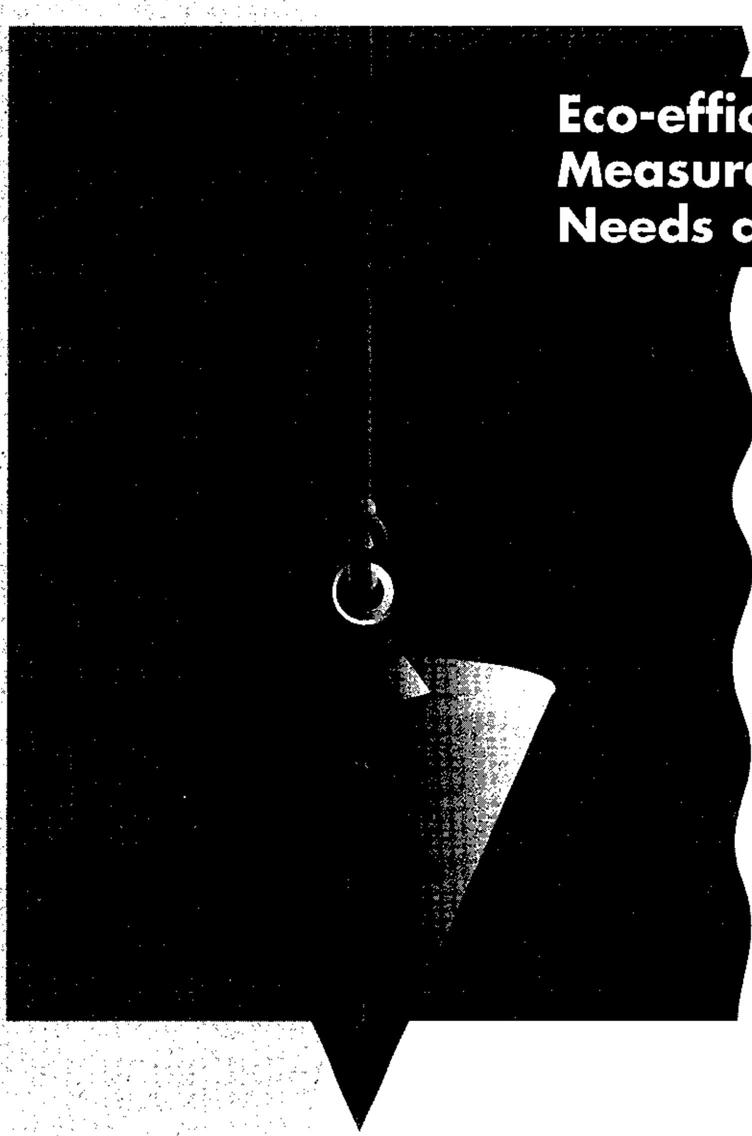
- outline the broad range of users of and needs for information about a company's eco-efficiency, and indicate the present and future drivers for needing that information;
- review examples of performance indicators being used by some companies to measure eco-efficiency;

- detail the eco-efficiency indicators proposed by the Task Force and modified at the Eco-efficiency Measurement Workshop in Washington; and
- present the priorities for action that flowed from the workshop and proposed follow-up plans of the Task Force on Eco-efficiency.

Appendices B and C provide additional background on users and needs for eco-efficiency information and on environmental performance measurement concepts and practices, and on the criteria for selecting eco-efficiency indicators.

2

Eco-efficiency Measurement: Users, Needs and Drivers



Who needs information about the eco-efficiency of a business or some aspect of its activities, products and services? What are the drivers and factors underlying such needs? To provide a context for the rest of this report, this section addresses these questions.

A shared understanding of who needs this information, what their information needs are today and, so far as we may predict, in the future, and of the drivers or factors underlying those needs, is an important starting point for discussion about the design and implementation of eco-efficiency indicators. This understanding becomes all the more important as capital market players begin to acquire an appetite for types of performance evaluation information such as eco-efficiency and other aspects of environmental performance. A recent report by the Investor Responsibility Research Center stated: "A growing number of corporations and investors are betting that environmental performance is predictive of future financial performance in their real world decisions."[5]

Furthermore, boards of directors are increasingly finding that they require greater understanding than previously of the competitive and financial implications of a company's environmental performance. This is needed, for example, in board approval of management's strategic plan and subsequent monitoring of progress against that plan, or in approval of a long-term acquisition or investment proposal.

Society now widely acknowledges that those who are stakeholders in natural capital — locally, regionally and globally — are also entitled to information about the state of that capital and changes in it. What continues to be less widely agreed is what information, quantitative and qualitative, should be provided to these stakeholders about how the performance of individual companies affects natural capital and the environment. Many companies are now voluntarily reporting information on what they have determined are aspects of their environmental performance that are of most interest and concern to their stakeholders. Some companies are required by law to report environmental performance information. Environmental statements by companies under the European Community Environmental Management System (EMAS) scheme represent another way of demonstrating accountability for environmental performance and impacts. Similarly, the Coalition for Environmentally Responsible Economies (CERES) and Public Environmental Reporting Initiative (PERI) schemes encourage and guide companies in what they choose to report about environmental performance.

Some key points to make about information users and their needs are as follows (see also Appendix B):

1 Natural capital is one of several types of capital, besides financial capital, that a business depends on for its viability and growth. Whether or not a company replaces or maintains all the various forms of capital it uses is, of course, a critical issue — not just for the company, but also for those who supply, allow access to or have other needs and uses for the type of capital in question.

2 The board of directors (or equivalent governance body) is, among other things, a key user of performance information, and is the ultimate "gatekeeper" for communication of performance information to outside parties, such as stakeholders in capital markets or in other domains such as natural capital.

3 Use of financial capital by the company is measured and reported through a common, core set of financial performance indicators and aggregate information in financial statements. This information is prepared by companies from their accounting systems according to widely accepted accounting principles or standards. This financial information may relate to a company's use of (and impact on) natural capital, but is limited to those aspects that have a price reflected or incorporated in the transactions the company enters into, and the payments it makes as part of its "licence for doing business" (including its permission to pollute or deplete natural capital, or penalties for doing so without permission). Financial indicators and information can also report the costs incurred and savings achieved through actions taken by the company to restore, protect or minimize impacts on natural capital. Costs of "free" resources such as air and water are not reported.

4 Use of and impact on the environment (natural capital) by the company are measured and reported through the use of various indicators. These may be expressed in absolute terms, or as ratios and indices, and are based on a wide range of data in a variety of units of measurement, covering a wide array of aspects of performance, from inputs to products, services, wastes and emissions.

5 Government regulatory bodies that oversee the conduct of capital markets to protect the interests of capital market participants depend on a monitoring and enforcement system in which companies must comply with legal and regulatory requirements for disclosure of performance information according to established standards for accounting and reporting. This disclosure is in part subject to independent verification. There are relatively well-defined and legally entrenched arrangements governing the company's obligations to those who provide it with the use of financial capital.

Some progress is being made toward global regulatory oversight of capital markets, harmonization of related reporting requirements and standards, and adoption of international conventions between lending and insurance institutions regarding their policies and practices in relation to sustainable development.

6 Government regulatory bodies overseeing the protection of the environment (and the rights of those who have interests in it) in Canada and the United States, for example, depend partly on companies making prescribed disclosures of performance information (e.g., regarding toxic and/or pollutant release inventories, waste reporting systems, etc.). The legal arrangements (rights, obligations, accountabilities) governing a company's use of natural capital (renewable, non-renewable, commons) and its relationships with stakeholders (i.e., those having interests in some part of the natural capital/environment) are partially but not in all respects fully and clearly established.

Some progress is being made toward global conventions regarding business conduct, sustainable development and environmental protection, but implementation and harmonization of international regulatory oversight schemes and of required or voluntary performance reporting systems and standards present complex challenges.

Drivers of Demand for Information on Eco-efficiency

Growth in external stakeholders' expectations combined with the gradual shift from "command and control" style regulation to more market-based approaches sets up significant drivers for information needs.

These drivers can be identified from many sources over the last few years. Some persuasive and eloquent themes have emerged that provide a clear and practical context for the need for eco-efficiency measurement by companies, and from which key drivers for such information may be summarized.

For example, in a 1996 publication, the WBCSD states that:

> The environment is not going to disappear as an issue for business. Companies are, and will remain under pressure from customers, investors, employees, legislators and, increasingly, from banks and insurance companies to be eco-efficient.... If companies act only when forced to do so under pressure, they will miss important market opportunities.... The pursuit of eco-efficiency allows business to cope successfully with both the immediate and longer-term challenges [e.g., the challenges of reducing environmental impact, while enhancing economic performance].[6]

It goes on to say:

> The Factor 10 Club, a group of leading international figures in environment and development, says that meeting the Agenda 21 goals will require a tenfold increase in the average resource productivity of the industrialized countries.... This is achievable if business continually improves its economic and environmental performance, to produce more from less, and add ever-increasing value. Companies who manage this will also gain new opportunities, rewards and market advantages.[7]

Notable examples exist of companies taking innovative approaches to the challenges of managing for eco-efficiency. Dow Europe, for example, has developed its six-dimensional "compass for sustainability" as a model and management tool for promoting the discovery of opportunities for eco-efficiency in the company's operations and products. Each dimension or point of the compass relates to a dimension of eco-efficiency; each dimension should then become the focus for designing relevant, practical performance measures or indicators so that management can track progress, and, if it so chooses, report to external stakeholders.

Whichever aspects of eco-efficiency they choose to address — if not all seven — companies will find that systematic use of suitable environmental performance indicators to measure eco-efficiency is essential for success in managing and in achieving credibility in reporting on their progress. Companies leading the way toward eco-efficient performance are already developing and applying such indicators of their own design; examples of these are given in Chapter 3 of this report.

A recent article in the *Harvard Business Review* makes an outstandingly clear case for business to adopt eco-efficiency as a fundamental strategic focus, for which appropriate performance measurement would seem essential if progress is to be achieved.[8] The same issue of *Harvard Business Review* profiles Monsanto's efforts and its seven sustainability teams — one of which is mapping and measuring the ecological efficiency of Monsanto's processes, and another of which is working on a system of sustainability metrics or indices.[9] (See further in Chapter 3.)

Finally, management of risks — risks to environmental quality, to human health, to employee safety, as well as to a company's physical and monetary assets, should at all times be recognized as a key driver of needs for relevant, reliable and timely information about performance.

In summary, the following internal and external drivers of demand for information about eco-efficiency can be identified:

Internal drivers

- increasing management recognition of the environment-economy interface, such that improved business practices triggered by eco-efficiency result in increased competitiveness and profitability (e.g., avoided or lowered costs, new opportunities, technologies, products)
- increasing need to monitor improvement in environmental performance and eco-efficiency over time and in comparison with competitors
- new expectations by boards of directors for management to address eco-efficiency as an integral part of corporate policy and strategy
- the need to set action targets and priorities for improving eco-efficiency
- employee satisfaction and motivation through a "common sense" approach and understanding of eco-efficiency
- management of environmental risks that may themselves be reduced through eco-efficient management

External drivers

- environmental management and labelling standards such as ISO 14000, EMAS and BS 7750, and industry codes of practice such as the chemical industry's Responsible Care program
- customer demands for more information and supplier accreditation initiatives
- regulators' requirements for more information, and new economic/trade incentive schemes to promote one or more aspects of eco-efficiency
- changing expectations of financial stakeholders (e.g., investors, lenders)
- general external stakeholder concerns and expectations, and related needs for reliable, credible information to build trust and grant "permission to do business"

Exhibit 2.1 summarizes the key drivers of needs for eco-efficiency performance information in relation to major user categories.

Exhibit 2.1

Eco-efficiency Information Drivers

Users of information	Drivers	Information needed for
Management board of directors	Improved competitive performance	• Strategic decision making • Approval of plans, acquisition and investment proposals
	Recognition of accountability to all stakeholders	• Performance evaluation and monitoring for improvement both financial and non-financial
	Due diligence and risk mangement	• External reporting, both mandatory and voluntary
Capital market players (financial stakeholders such as shareholders, bankers, insurers, financial analysts)	Longer-term profitability and risk minimization	• Financial performance evaluation — both past, current and future performance • Potential liabilities • Corporate financial sustainability
Regulators/ governments	Trade and environmental policy International forces	• Compliance monitoring • Formulation of policy, economic/trade incentives, etc.
Other stakeholders (e.g., suppliers, customers, communities, employees, NGOs)	Credibility "Permission" to do business Concern for sustainability	• Impact of activities on human health and environment • Product/services information

3

Environmental Performance in Use Today

A review of recent corporate reports and selected studies about eco-efficiency, environmental performance indicators and reporting provides examples of companies using indicators that relate to one or more elements of eco-efficiency. Several interesting examples, drawn from both national and international companies, are described below.

The criteria for selecting appropriate eco-efficiency indicators are reviewed in Appendix C following a survey of reports by leading organizations on environmental performance measurement and indicators development and use.

Novo Nordisk's Eco-Productivity Index (Denmark)

Novo Nordisk is a biotechnological company headquartered in Denmark. It has companies and offices in 54 countries and employs approximately 13,000 people. In its *Environmental Report 1995*, Novo Nordisk included an eco-productivity index (EPI). This index is intended to indicate the effectiveness of the company's use of resources in its production on an annual basis. The indicator relates the scale of the company's production to its consumption of, respectively, raw materials, water, energy and packaging, using a base year of 1990 and an index value of 100.

The higher the EPI score, the better the company's specific resource utilization. (Absolute figures for resource consumption are also provided by the company, but an increase or decrease in this amount does not necessarily reflect the efficiency of its resource consumption.)

The EPI is calculated as follows:

$$EPI = \frac{\text{Indexed turnover in constant prices}}{\text{Indexed resource consumption}} \times 100$$

The turnover index (volume/product mix) is adjusted for exchange rate and price fluctuations.

Novo Nordisk's EPI is powerful in that it aggregates and normalizes information and allows for comparison of the company's performance over time. It is also an effective and simple communication tool. However, the indicator may be too aggregated for such areas as raw materials consumption since it is not broken down into specific raw materials.

Northern Telecom's (Nortel) Environmental Performance Index (Canada)

Nortel, a Canadian developer of communications products, systems and networks that employs approximately 57,000 people in over 90 countries, has developed an environmental performance index (EPI) for measuring its overall environmental performance. Details of this are described in Nortel's 1995 *Environmental Progress Report*, as well as on Nortel's Web site. The EPI, which is designed to distill a large volume of quantitative environmental performance data into one composite and meaningful final score, essentially rates the company's annual environmental performance relative to a base year using a weighting and scoring scheme. This "score" allows users of the information to assess Nortel's progress toward its stated environmental targets.

The index has 25 components or parameters, based on the environmental aspects associated with Nortel's operations. Quantitative, non-financial information relating to the parameters is grouped into four categories: compliance, environmental releases, resource consumption and environmental remediation. Each category contains several parameters such as the number of fines, total release of air toxics, consumption of electricity and number of remediation sites. After adjusting for fluctuations in production (annual fluctuations in production are addressed through normalizing parameters using the cost of sales adjusted for inflation for all Nortel facilities), data collected for each parameter are given a raw, unweighted score ranging from -1.0 to +1.0 based on performance relative to the goals set by the company for that parameter (compliance parameters are scored instead from -1.0 to 0). A weighted score is then calculated for each parameter by multiplying the raw score by a weight assigned to the parameter. The assigned weight reflects the importance of the parameter to Nortel's goals in terms of impact on the environment, financial and public image risk to the company, its control over the parameter, and how the parameter measures environmental performance. This weighting is not expected to change frequently.

The scores are totalled in every category and added to the benchmark level for each. The final EPI score is calculated as the sum of the products of the weight and the score in each category as follows:

EPI = (weight compliance x score compliance) + (weight environmental releases x score environmental releases) + (weight resource consumption x score resource consumption) + (weight environmental remediation x score environmental remediation)

Nortel's EPI is based on the collection of quantitative data in a standard format and its parameters measure the company's incremental progress toward its long-term goals using 1993 as the benchmark level. (For example, Nortel's 1994 score was 143, relative to a 1993 baseline score of 100. Its target was 175.) However, the scale used by Nortel is relative and as such can only be used to measure the company's progress toward its own goals over time. As discussed further below, Niagara Mohawk's EPI is subject to the same limitation.

Niagara Mohawk Power's Environmental Performance Index (United States)

Niagara Mohawk Power is an investor-owned electric and gas utility supplying power from hydroelectric, coal, oil, natural gas and nuclear sources. Headquartered in Syracuse, New York, it serves 1.5 million customers in upstate New York. In 1992, the company implemented an environmental performance index (EPI) that uses a weighting and rating scheme to reflect environmental performance in three broad categories: emissions/waste, compliance and environmental enhancements. Each category consists of approximately 20 measures.[10] (Prior to implementing its EPI, Niagara Mohawk Power had evaluated other approaches, ranging from an index based on key environmental indicators such as air emissions to a very broad index.)

In the emissions/waste category, a raw score is obtained for each of the parameters through comparison to a benchmark. A weighted score is then arrived at by multiplying the raw score by a pre-assigned weighting factor and then by a factor of 20 to bring the relative weight of this category score in line with the other two category scores. For parameters in the compliance category, a raw score ranging from -2 to +2 is similarly assigned to each, using a base benchmark. (A score of 0 indicates no change in performance relative to the established baseline; scores of +1 and +2 represent improved performance, and scores of -1 and -2 represent poorer performance.) These raw scores are then multiplied by an assigned weighting factor and totalled to arrive at an overall score for the category. In the environmental enhancements category, parameters are rated based on the dollars spent annually on programs providing environmental benefits. One index point is earned for every $200,000 worth of investment, with a maximum of 30 points available for each enhancement (representing a total of $6 million).

To arrive at a final score, the weighted scores for each of the three categories are totalled. The composite index is then used to compare the company's performance from year to year. For the emissions/waste and compliance categories, benchmarks are based on the company's average annual performance for the three years from 1989 to 1991. Performance in the environmental enhancements category is determined directly by the annual dollar investment. Alone, the absolute composite index is meaningless, as it is based on subjective weights and scores for each of the components in the index. When compared to the absolute possible index value, however, the index provides a useful measurement of the company's environmental performance against its goals. Perhaps more importantly, changes in the absolute value allow the company to monitor its performance over time.

Both the Nortel and Niagara Mohawk EPIs are useful for explicitly identifying these companies' goals, and in measuring progress toward their stated targets. They appear to address one or more elements of eco-efficiency. They also satisfy the criteria of reliability and understandability (although perhaps not simplicity), and they are relatively comprehensive and verifiable. On the other hand, both indices are highly subjective and as such do not allow for comparison between companies or across industry sectors. Furthermore, although aggregated, neither index is normalized to provide performance information in terms of units of output or production. As discussed further in the conclusion of this section, Niagara Mohawk is attempting to address the comparison limitation of its EPI by participating in an industry-specific environmental benchmarking program that allows it to compare its performance to that of other electric utilities.

British Telecom's (BT) Environmental Performance Index (United Kingdom)

In *A Report on BT's Environmental Performance 1995/96*, BT, a British telecommunications company, indicated that it had met its environmental target of reviewing its use of EPIs against industry best practices and measures of sustainable development. The result of the review was a report entitled *Developing Environmental Performance Indicators for BT*,[11] produced in collaboration with Imperial College, London, and Ashridge Management Research Group.

According to the report, BT has developed both a list of indicators for use in measuring its environmental performance relative to its level of business activity, and a methodology for developing a single index that shows the company's overall environmental performance. This index will incorporate the company's significant environmental effects, which are identified broadly as procurement, fuel and energy, air emissions, local impacts, wastes, product stewardship, employee involvement and environmental management.

The methodology used in developing the index was as follows. First, BT classified its indicators into the three categories of resource consumption, emissions and wastes, and enhancements. It then selected a mixture of absolute, normalized and aggregated indicators and assigned weights to the three categories (25 per cent to the first two categories and 50 per cent to the third category) and to the individual indicators. A weighted value was calculated for each indicator relative to a base value, with the final step being to sum the weighted values to arrive at a single index. (The company identified three ways of assigning weight: with financial values, using scientific methods, and by scoring based on qualitative judgment. The latter method is most commonly used and was adopted by BT.)

In calculating its index, BT's aim was to provide an overall picture of its environmental performance that, although based on subjective judgment in some respects, would be simple, understandable and selective. Like the indices of Nortel and Niagara Mohawk Power described above, the value of BT's index clearly would be dependent on the types of measures selected and the weightings assigned to reflect their relative importance.

Elf Atochem's Water and Waste Indices (France)

Elf Atochem, headquartered in Paris, is a $10 billion chemical manufacturer employing over 35,000 people worldwide. It is the twelfth largest chemical company in the world. Two useful indices appear in the company's 1995 corporate and environmental information found at the World Wide Web site of Elf Atochem North America (http://www.elf-atochem.com).

- The water index, established by the French Chemical Manufacturers Association, is consolidated at both the industry and company level. The six parameters used in this index indicate the impact of substances on waterways: chemical oxygen demand, suspended solids, phosphorus, nitrogen, soluble salts and toxicity. A baseline of 100 from the year 1984 is used, and annual improvement is reflected by a lower number.

- The waste index quantifies tonnage of hazardous waste generated by the company according to the disposal method used (e.g., external landfills, on-site landfills, external incineration and on-site incineration). For this index the company uses a base score of 100 from the year 1989.

These two indices provide a standardized, aggregated method for comparing performance over time and between companies and industry sectors. They also address eco-efficiency elements. However, they are neither weighted nor normalized, nor do they provide an overall, composite score for environmental performance.

Exhibit 3.1 assesses the five examples of performance indicators described above according to the set of criteria proposed in Appendix C of this report.

Exhibit 3.1

Comparison of Eco-efficiency Indicators Currently in Use

Criteria	Novo Nordisk (eco-productivity index)	Nortel (environmental performance index)	Niagara Mohawk Power (environmental performance index)	British Telecom (environmental performance index)	Elf Atochem (water/waste indices)
Addresses one or more elements of eco-efficiency	x	x	x	x	x
Simple and understandable	*	*	*	*	*
Appropriate to users" information needs	x	*	*	*	x
Measurable and cost effective to produce	x	x	x	x	x
Facilitates tracking of performance against objectives and over time	x	x	x	x	x
Comparable between business entities and across sectors	x				x
Transparent and neutral	x	*	*	*	x
Reliable and representative of the performance aspect being measured	**	**	**	**	**
Verifiable	x	x	x	x	x

x = meets criterion
* = partially meets criterion
** = unable to determine whether meets criterion

Other Environmental Performance Indicators

Other examples of environmental performance indicators currently in use include those of WMC, Dofasco, The E.B. Eddy Group, the Investor Responsibility Research Center, and the UNI-Storbrand Scudder Stevens Fund, each of which is described below.

WMC, an Australian mineral resource company and a major exporter of value-added minerals, includes in its *WMC Environment Progress Report 1994-5* normalized information relating to its four key eco-efficiency targets of reducing (1) use of water (in kilolitres per tonne of ore milled), (2) use of energy (in megajoules per tonne of ore milled), (3) emissions of carbon dioxide (in kilograms per tonne of ore milled/processed), and (4) sulphur dioxide emissions (in kilograms per tonne of ore milled/processed). The information is provided in aggregate form, as well as being broken down according to specific company operations. WMC now intends to set water, energy and emission targets per unit of product and to consider, in future reports, ways of presenting data on industrial water use, energy use and emissions per unit of product. The company also plans to consider including environmental financial accounting per unit of product.

Dofasco, a Canadian producer of steel products, includes in its *Dofasco Environmental Report 1995* normalized information relating to its energy efficiency, air and water emissions and solid waste disposal. With the exception of energy efficiency, which is reported in gigajoules per tonne of steel shipped, all performance information is provided on the basis of loadings per tonne of steel shipped.

The E.B. Eddy Group is a Canadian forest products company. In its 1993 report, *A Question of Balance: Status Report on Sustainable Development*, the company provided normalized information relating to its efficiency of resource conversion and wastes generated in its paper-making processes. This information included normalized data on pulp supplied, material, water and energy usage, materials use efficiencies for resource conversion, and normalized data on solid wastes, air emissions and wastewater quality for wastes generated. Similar data were provided for the company's pulping and bleaching activities and sawmilling operations.

The Investor Responsibility Research Center (IRRC), based in Washington, DC, recently released a publication entitled *Corporate Environmental Profiles Directory 1996.*[12] This three-volume directory, intended for stakeholders making business and investment decisions related to environmental performance, summarizes key environmental performance information and indicators from a variety of sources for companies in Standard and Poor's 500 index. The IRRC has developed and presents in this report normalized performance indices designed to achieve neutrality with respect to company size (i.e., per $X of revenue) and to allow for comparison with industry average benchmarks. These indices include the IRRC compliance index and the IRRC emissions efficiency index.

Although the focus of the report is on compliance information (largely as a result of its availability), the IRRC does provide information on five sustainable development indicators. In its study, the IRRC asked companies to provide aggregated information on energy consumption, water and raw materials usage, recycled materials usage and hazardous waste generation for their U.S. and international operations for 1988 (or other baseline year) and for 1995. The percentage change in performance was calculated where information was provided for both years.

Survey results revealed that many companies do not track this information. In some cases, the information is tracked at the facility level but not aggregated. Other companies indicated that they were in the process of developing similar indicators and would be able to provide such data in the future. The information that was collected was not normalized to account for differences in company size, production levels or diversification and outsourcing within industry groups. As a result, although changes in the performance of individual companies can be compared over time, comparison across companies is currently not possible.

Another example of environmental performance indicators relevant to eco-efficiency is that of the UNI-Storbrand Scudder Stevens Fund, a joint enterprise between a major Norwegian insurance company and a U.S. investment firm. This enterprise manages the Environmental Value Fund (EVF), a pool of $70 million managed for six institutional investors. The investment policy for the EVF incorporates the use of the EVF sustainability index, with performance benchmarks for various industry sectors. The index developed for the EVF is based on the environmental and sustainability criteria developed by the WBCSD, including factors such as material efficiency, toxic releases, energy intensity and water use. Application of the index to the world's 500 largest companies has demonstrated a significant positive correlation between corporate environmental (and eco-efficiency) initiatives, and economic performance in terms of superior annual rate of return.[13]

The final two examples in this section describe indices under development by Monsanto and Ontario Hydro.

U.S. chemical producer Monsanto is developing a sustainability index to measure the environmental sustainability of its operations. In order to develop and implement a strategy for sustainability, the company set up seven "sustainability teams." The eco-efficiency team is mapping and measuring the ecological efficiency of Monsanto's processes, by determining inputs consumed and outputs generated relative to value produced. In this regard, the company's goals are to move beyond optimizing raw inputs to consider energy and water and to improve measurement of all wastes. The index team is developing criteria for measuring sustainability using a set of metrics that attempt to balance economic, environmental and social factors.

Measures will track the sustainability of products and of the business as a whole. These "sustainability metrics" are to be integrated into the company's "balanced scorecard" approach to business management. This scorecard sets objectives for and links financial targets, internal processes, customer satisfaction and organizational learning.[14]

Recognizing that resource productivity gains can reduce both the impact and cost of generating and distributing electricity with environmental and economic benefits, Ontario Hydro is developing a resource utilization index to measure and influence the company's resource and energy use improvement. Fuel productivity and commodity use measures are under consideration for use as components of this index, described in Ontario Hydro's *Sustainable Development Report* for 1995.

Summary and Conclusions

This overview of indicators currently in use reveals that broad types or classes of eco-efficiency indicators are already being implemented by companies around the world, even though they may have some limitations. For present purposes, the most useful of such indicators may be those that are indexed, aggregated and normalized to some degree. Certain problems (e.g., comparability) may prove to be insurmountable in the process of deriving composite indicators, in which case benchmarking techniques — similar to the one used by Niagara Mohawk referred to above —

allowing a company to measure and compare its performance to the best in an industry or against a reputable standard, may be needed in conjunction with these composite eco-efficiency indicators.

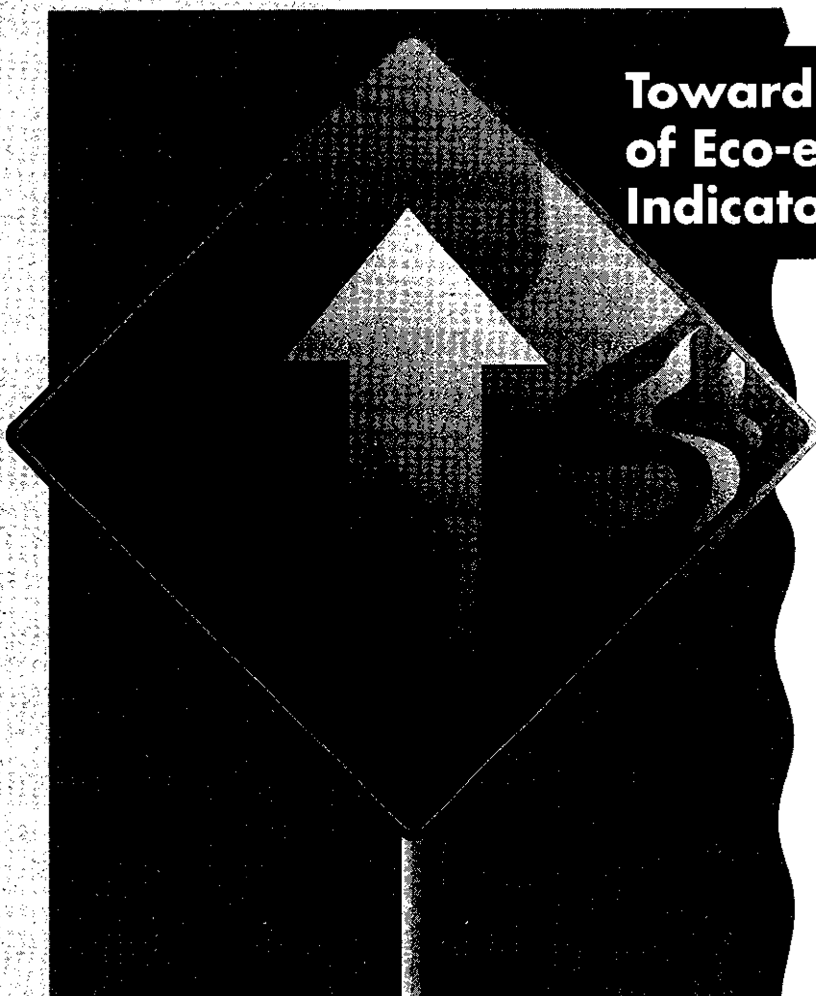
Several conclusions can be drawn about the five main indicators that have been provided as examples of current practices. First, companies around the world are already developing indicators that meet a number of important criteria, such as the need to address the elements of eco-efficiency as defined by the WBCSD: appropriateness for users, measurability, verifiability and comparability in terms of tracking performance over time.

At the same time, however, these indicators, although understandable, are not necessarily simple or transparent, and, with the exception of Novo Nordisk's eco-productivity index and Elf Atochem's indices (at least its water index), do not readily allow comparison between businesses or industry sectors. Their reliability may also be questionable in some aspects. These shortcomings may prove to be problematic in developing a core set of a few, composite indicators, as the process of compiling, synthesizing and condensing a large amount of information into one or even several meaningful measures is often extremely difficult. Further, the effects of subjectivity, judgment and bias in a weighting scheme, uncertainty in measurement, and differences in the products and operations of companies are compounded when such information is aggregated, indexed or normalized, and ultimately may render accurate comparison less meaningful.

On balance, the identification and review of these examples supports the proposition that well-designed indicators can be implemented to measure and report aspects of a company's eco-efficiency. The challenge is to determine which and how many indicators are needed, in order for them to be useful as a core set of indicators for all companies. In view of the limitations identified, a core set of indicators may need to be supplemented by the use of industry-specific benchmark values for these indicators, as well as by absolute measures of performance. Industry-specific indicators may also be necessary. This is somewhat analogous to financial performance measurement, where core indicators or measures are calculated and reported uniformly across all companies and sectors, though the values of these indicators may vary between industry sectors, depending on the nature of the business.

4

Toward a Core Set of Eco-efficiency Indicators



The previous chapter presented evidence of companies already using or developing indicators that to various degrees address the selection criteria set out in Appendix C and that relate in some way to the elements of eco-efficiency outlined in Chapter 1. This section focuses on three indicators initially proposed by the NRTEE Task Force on Eco-efficiency to measure certain aspects of business eco-efficiency. These indicators were presented to and discussed by an international group of experts at the Washington Eco-Efficiency Measurement Workshop in April 1997. The indicators with their recommended modifications are presented below.

Resource Productivity Index

The proposed resource productivity (RP) index would have expressed the materials and energy contained in a company's products, by-products and usable wastes as a percentage of the materials and energy consumed in their production.

$$\text{percentage} = \frac{\text{product out (matter plus energy)}}{\text{energy in + matter in}} \times 100$$

The RP index addressed the first two elements of eco-efficiency and would have allowed companies to evaluate their performance over time to determine whether they are improving their resources and energy productivity.

Discussion: Key Points and Consensus Views

The intent of the RP index was generally supported by all the workshop groups. Its elements were believed to be measurable and its results would allow for comparison between companies. The relative simplicity of developing and implementing the index was a further attraction.

However, as a result of the difficulty of equating mass and energy, workshop participants agreed that the materials and energy portions of the equation, although linked, need to be separated and that two indices, one for material productivity and one for energy intensity, should be created.

More specific points raised about the RP index included:

- The scope or boundaries of the indicator must be defined, so for example, should the RP index apply to the entire life cycle of a product, or should it be restricted to its production or manufacturing processes, at least initially?
- The terms *products, by-products* and *wastes* need to be clearly differentiated and defined.
- The various components of the formula may need to be weighted in some manner, for example, to reflect the relative advantages and disadvantages of using renewable or non-renewable sources of energy and recyclable or non-recyclable products, as well as the relative toxicities, if any, associated with the materials and energy used and generated. For example, the possibility that increasing the efficiency of raw material use could result in an increase in toxic releases should be considered. A proposal was also made to value products and by-products equally.

- The concepts of value-added and social costs were discussed to determine how they could be included in the calculation, but no practical conclusions were reached.
- The use of long-term rather than short-term measurements should be considered in calculating the RP index.
- Linkages between the RP index as a physical measure and relevant financial performance measures should be considered.
- The role of packaging in the indicator should be determined, and the definitions of product and by-product need to address packaging.

Proposed Modifications

The following two indices were proposed to separate the RP index into its two components.

Material productivity index (eco-efficiency element 1)

$$\frac{\text{weight of product and weight of by-product out}}{\text{weight of material in (recycled + raw materials)}} \times 100$$

Alternatively, the material productivity index could be expressed as a ratio rather than a percentage. The result in both formulations would provide an indication of the amount of waste generated or released in the creation of a product.

Energy intensity index (eco-efficiency element 2)

Two versions of this indicator were proposed as follows:

(1) On a company-wide basis

$$\frac{\text{joules}}{\text{product unit or service}}$$

Alternatively:

$$\frac{\text{energy generated by product}}{\text{energy consumed in product}} \times 100$$

(2) On a sector-wide basis

$$\frac{\text{joules}}{\text{product unit or service}}$$

Subsequent to the workshop, one further point of consideration has been raised: that is whether a transportation element could be factored into the design of the energy intensity index.

Linkages to Other Indicators

The RP index may be linked to the toxic release index (see below) in that different energy or material sources and production technologies have different associated toxicities and/or toxic emissions. As noted above, the resulting environmental impacts might be factored in by weighting or reflected in some other manner in the index calculation.

Concerns about the practical difficulties of "weighting" were noted, especially regarding the need for comparability and consistency.

Both the material productivity and energy intensity indices could be broken down further into specific material and energy types. For example, the material index could be partitioned into types of resources, such as water, and the energy index could be divided according to use of renewable and non-renewable energy. Weightings could then be applied to each in order to arrive at an aggregate material index and an aggregate energy index.

Note: Monsanto has developed a computer simulation model for analyzing the energy, materials and emissions of its products over their full life cycle. The results can be aggregated into one or more measures.

What Needs to be Done to Advance Development and Use of the Indicator(s)?

Design Considerations

- Consider materials and energy separately, as well as the possibility of even more specific indicators within the material and energy indicators, for example, for renewable and non-renewable materials and energy.

- Clarify the scope of application of the indicator (i.e., life cycle or limited to production/manufacturing processes or some combination of the life cycle stages including resource extraction, procurement, manufacturing processes, production, product use and disposal) and the level of application (i.e., facility, plant, company, industry sector, etc.).

  Note: Participants at the workshop generally favoured a staged approach, starting with a more limited scope and level of application and extending or broadening these over time. The use of a more specific level of application initially (e.g., taking measures at the site level) would allow decision makers to identify opportunities that might be hidden by an indicator based on higher level measurements. This approach might also encourage more companies to participate.

  Finding appropriate definitions of product, by-product and waste:

- For the material productivity index, determine whether a value-added component can and should be incorporated into the indicator.

- Consider the treatment of packaging in the material equation.

- Examine the weighting issue further, for example, for the use of virgin rather than reusable or recyclable materials and renewable, scarce or non-renewable materials and energy.

Other Considerations

- Explore the use of financial values for the indicators and consider whether socio-economic costs/values can be brought into the equation.
- Explore possible linkages to public policy.

Practical Steps

To move forward the two modified indicators, the following steps were suggested:

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

Toxic Release Index

The toxic release (TR) index was proposed to express as a single number the amount of toxic materials released during the manufacture of a product, or during a given operating period, calculated as the sum of the adjusted masses (weights) of each toxic material released.

total mass = (TS1M x TS1WF) + (TS2M x TS2WF) + (TS3M x TS3WF) + ... etc.

where:

TS1M = toxic substance 1 mass
TS1WF = toxic substance 1 weighting factor

Discussion: Key Points and Consensus Views

The importance of measuring toxics was universally agreed upon and there was strong support in principle for this type of indicator. Support was bolstered by the existence of regulatory reporting requirements and data measurement, collection and recording methods for toxic emissions. Moreover, use of the indicator would allow for comparison in performance over time and between companies.

Nevertheless, the TR index poses serious problems with respect to the definition, quantification and weighting of toxics, each of which may involve highly subjective processes. To date, no satisfactory validation exists for the toxicity measures on which the indicator is based. The notion of clustering groups of toxics, using a small number of descriptors, was proposed as a more feasible alternative to assigning a unique toxicity factor to each toxic. A similar, but simplified approach would address chemicals at two levels: (1) persistent, bio-accumulative and toxic, and (2) risk-managed (dosages), with weightings/priorities assigned at each level.

Additional shortcomings of the TR index included the difficulty of accurately allocating quantities of toxics in processes in which different types of products are made, and the omission of the important concepts of exposure and dosage in the equation.

More specific points raised about the TR index included:

- An alternative approach to measuring the quantity of toxics — which to some degree is already addressed by regulatory reporting schemes such as the U.S. Toxic Release Inventory (TRI) and Canada's National Pollutant Release Inventory (NPRI) — could be to estimate their potential effects on a site or company-specific basis. This approach would include consideration of pathways, exposures and effects on different organisms, as well as transport and fate (media/multimedia). For example, Monsanto uses a three-factor formula to measure the potential effects of toxics:

> hazard (human effects + effects on other animals + phytotoxicity) x cube root of the mass of release (to address dispersion) x media factor (to address pathways and exposure via the pathways)

- In some respects, the TR index is not an indicator proper but rather a tracking or recording system for toxic releases, and as such could be subcategorized according to amounts of toxics released, disposed of, destroyed or recycled. A separate category could provide information about toxics spilled. Data currently exist in the form of regulatory reporting schemes for toxic emissions and spills that would facilitate further development and use of such an indicator or indicators. However, one limitation of adapting a U.S. TRI-type reporting scheme is that no weightings are applied, such that reportable quantities are the same for all chemicals (although spill reporting schemes in the United States do have several levels depending on toxicity).
- The TR index might be more useful as a broad tool for identifying problem areas than as a precise indicator.
- The aggregation proposed by the TR index can provide a useful relative measure and establish trends over time (in addition to the absolute measures that exist with the U.S. TRI and NPRI in Canada). On the other hand, such aggregation may conceal important information.
- The issue of inherent toxicity versus actual risk (risk assessment approach) should be addressed, as should the need to consider and include product use or product dispersion where products are toxic (e.g., pesticides, fertilizers). Similarly, indicators for hazardous products that are not toxic should also be considered.

- The issue of which aspects of the life cycle should be included in the indicator needs to be addressed.

Proposed Modifications

One workshop group proposed the following two-part strategy to modify the TR index:

1 Adopt a virtual elimination strategy for the 13 priority chemicals recognized on international lists, and report progress in eliminating these chemicals (e.g., as a percentage of reduction in terms of set goals/targets, assuming a base year is established). No weightings would be needed and the results for different companies could be compared. The first implementation step would be to aggregate the mass loading. The results could also be normalized, for example, per $1,000 revenue (see the emissions efficiency index used by the IRRC and described in Chapter 3).

2 Address other priority chemicals based on their toxicity, bio-accumulation and persistence (e.g., chemicals that are reportable under the U.S. TRI and the NPRI), by relating the tonnage released per unit of product or service. Total releases could be measured by mass on a company, geographic, national or other basis with the goal being reduction over time. The results could be normalized as suggested in part 1 above.

Results from parts 1 and 2 could be combined to create one aggregated indicator using the following:

$$\frac{\text{mass of 13 chemicals (higher weighting?)} + \text{mass of other priority chemicals}}{\text{\$ value (or unit of product or service)}}$$

Other suggested modifications to the TR index were to:

- report on toxic emissions according to specific media, for example, air or water
- develop a methodology for weighting toxics, but allow companies to assign the actual weights (this would reduce comparability, however)
- refine the RP index to address toxic emissions, such that the toxic component of the total mass released is calculated to supplement existing toxic regulatory reporting requirements

Alternative indicators suggested were:

- the number or quantity of spills
- emission compliance rates
- percentage of emissions/spills above legally allowable levels

Linkages to Other Indicators

As noted above, the TR index has linkages to existing reporting frameworks for toxic emissions such as the U.S. TRI and Canada's NPRI and ARET (Accelerated Reduction and Elimination of Toxics) and as such could be used to supplement these absolute values. Alternatively, the TR index could be characterized as a segment of the RP index that focuses on toxic emissions.

What Needs to be Done to Advance the Development and Use of the Indicator(s)?

The following actions were proposed:

- Define the scope of the indicator and reach consensus on the list of specific chemicals (using existing lists and agreed-upon criteria where possible).
- Consider using a phased approach to implementation (see the two-part approach described above).
- Review existing models/methodologies for measuring toxicity and for reporting on toxic emissions, for example, industry efforts including Monsanto's potential effects model.
- Build on existing infrastructure developed for reporting under programs such as the U.S. TRI and Canada's NPRI; consider developing a model to supplement legislated reporting for use as a prioritizing tool.
- Conduct field trials.
- Analyze results and engage in further discussion and trials.

Product and Disposal Cost to Durability Ratio

The product and disposal cost to durability (PDCD) ratio was proposed as a way to incorporate the concepts of product stewardship and durability in a single measure by expressing the cost of a product as the sum of its purchase price and disposal cost divided by its years of life. An alternative formulation would include the cost of using the product over its lifetime in terms of the energy and materials consumed.

$$\text{ratio} = \frac{\text{purchase price} + \text{disposal cost}}{\text{years of life}}$$

Or:

$$\text{ratio} = \frac{\text{purchase price} + \text{cost of energy and/or materials used} + \text{disposal cost}}{\text{years of life}}$$

Challenges posed by the PDCD ratio include appropriately defining and measuring the components of the equation in monetary terms. For example, the purchase price is intended to serve as a proxy for all the costs incurred in producing the product, and the disposal cost is intended to reflect the true costs of disposal less the value of recycling or reuse of the product. The years of life denominator also needs clear definition, for example, "designed useful life." An additional factor for consideration is the time value of money.

Discussion: Key Points and Consensus Views

There is much less support for this indicator as a useful or compelling metric for eco-efficiency, due primarily to its limited applicability to the concept of eco-efficiency, the difficulty of making accurate calculations in the absence of full cost accounting, and the emphasis on durability at the expense of factors such as recyclability and the need for innovation to create better products. The indicator was considered to be more applicable, if at all, to products than to a company as a whole. Participants agreed that the indicator needs to be substantially reworked if it is to be pursued further in this process.

The following is a summary of the key points made about the PDCD ratio:

- It is essentially a financial indicator of life cycle costs that could be used as an input to eco-efficiency, but it is not very useful or powerful for actually promoting or measuring eco-efficiency. Furthermore, the indicator is not immediately understandable or transparent, nor is it easy to accurately cost the components of the indicator over the life cycle of a product.
- Its application is limited primarily to the hard goods sector.
- It might be used to indicate lifetime product costs at the community or consumer/household level. As such, it would resemble a consumer eco-label or consumer financial index.
- It is difficult for companies to allocate disposal costs precisely to particular products. Moreover, these costs are extremely variable between jurisdictions as well as over time within a jurisdiction. Finally, in the absence of adequate full-cost accounting techniques and methodologies, these costs cannot be calculated accurately enough to be meaningful.
- As a measure of durability, the indicator results may conflict with those for recyclability. The emphasis on durability may also stifle innovation for products that are more eco-efficient and disregards the value of convenience. Increasing durability may also increase disposal costs. There are important but complex linkages between durability, recyclability and societal values.
- The role of packaging needs to be considered in the equation.

Proposed Modifications

The following modifications to the PDCD ratio were suggested:

- The manufacturer's gate price should be used rather than the purchase price.
- The concept of durability (the years of life denominator) should relate to the useful life of the product rather than to its actual life. (For example, a car's durability would be calculated as the number of years it functions efficiently in terms of gas consumption, etc.) Alternatively, the concept of the adaptability of a product might be considered as a relevant factor in the equation.
- The proposed RP index could perhaps be extended to encompass this indicator by using a full life cycle for its measurement.

The following alternative indicator was proposed for use at the community or consumer/household level.

Lifetime Cost Index (Eco-efficiency Element #6)

To allow consumers to make comparable material choices and to reflect the customer cost of ownership and notions of extended product stewardship, the lifetime cost index could be expressed as follows:

$$\frac{\text{purchase price} + \text{useful life cost of energy and/or materials} + \text{disposal cost}}{\text{years of life}}$$

To address the potential conflict between durability and recyclability, one group proposed development of a separate measure for each:

Durability Index (Eco-efficiency Element #6)

This indicator would provide information about the service/useful life on a product by product basis, by reporting how long products last based on the materials used in their production. It also could be merged with the following indicator:

Material Recyclability Index (Eco-efficiency Element #4)

This indicator would report on the amount of recyclable material in a product and/or the amount of material actually recycled.

Linkages to Other Indicators

An extended or revised version of the RP index might be able to incorporate some of the key elements of the PDCD ratio, thereby avoiding the need to rework the indicator completely. As noted above, the proposed lifetime cost index may have useful linkages with eco-labelling schemes and consumer financial indices. However, there was concern about trying to load too much into a single indicator.

What Needs to be Done to Advance the Development and Use of the Indicator(s)?

As noted above, the indicator as currently envisaged needs to be reworked before it can be pursued as a feasible option. With respect to the alternative indicators proposed, the following steps could be taken:

For the lifetime cost index: determine and define its applicability and scope; partner with consumer organizations to develop and implement the indicator; evaluate and possibly integrate the indicator with eco-labelling and extended product stewardship schemes; pilot test use of the indicator.

For the durability index and material recyclability index: investigate their feasibility needs; flesh out their details; and determine their numerators. Ways to combine or merge the two indicators based on years of use should also be considered.

Other Indicators to Consider

Other possible indicators were considered to address elements of eco-efficiency not adequately incorporated into the RP and TR indices. This resulted in the following suggestions to address the sustainable use of renewable resources and service intensity elements of eco-efficiency.

(a) Sustainable Use of Renewable Resources

To measure the sustainable use of renewable resources, two concepts were discussed: process inputs and a depletion index.

Process Inputs

After separating process inputs into renewable and non-renewable resources, this indicator would require calculating the percentage of renewable materials and the percentage of renewable energy inputs in a production process. The renewable/non-renewable ratio as a percentage of the total materials and as a percentage of the total energy could be calculated as two separate measures. The indicator could be related to material recyclability. Issues to be addressed are the distinction between virgin and recycled materials (should virgin non-renewables be treated differently from recycled) and the notion of scarcity (should a scarce renewable resource be treated differently from an abundant non-renewable resource, for example).

Depletion Index

The depletion index would be calculated as follows:

$$\frac{\text{\% of renewable resources in product (including recycled, reclaimed, reused)}}{\text{\% virgin material}}$$

This index would not apply to energy inputs or to non-renewable resources in the short term.

(b) Service Intensity of Goods and Services

An indicator for the service intensity of goods and services would reflect the amount of functional use per unit of product or service:

$$\frac{\text{use}}{\text{unit of product or service}}$$

Or:

$$\frac{\text{energy or material inputs}}{\text{unit of product or service}}$$

Efforts also were made to determine how to measure the value of a product, for example, in terms of multiplicity of uses or longevity of service life. An indicator might be developed to reflect the value or function delivered by a product according to its effective mass or energy, based on the percentage of recyclable or reusable mass or energy:

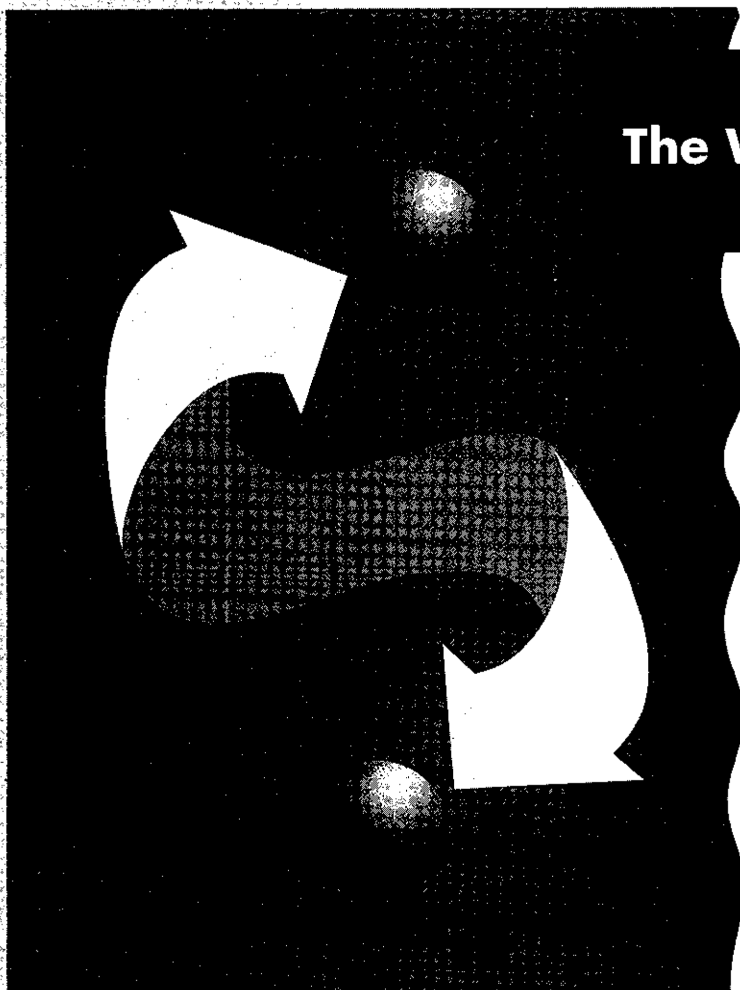
$$\frac{\text{product value}}{\text{effective mass or energy}}$$

What Needs to be Done to Advance the Development and Use of the Indicator(s)?

Each of the indicators described above requires further work in terms of definitions, scope and conceptual refinements prior to implementation on a trial basis.

5

The Way Ahead



The Eco-efficiency Measurement Workshop convened by the NRTEE and WBCSD produced the following consensus on the three eco-efficiency indicators proposed by the NRTEE:

- The resource productivity index, important in concept, should deal separately with material productivity and energy intensity.
- As originally proposed, the toxic release index would be difficult to use as a reliable and objective indicator because of its dependence on weighting factors for toxic substances and the current lack of scientific data and consensus about toxicity. Relevant indicators for toxic releases could nevertheless be devised, which could employ data already being recorded, tracked and, in some jurisdictions (e.g., the United States and Canada), reported to authorities as publicly accessible information.
- The product and disposal cost to durability ratio is unworkable as proposed. It attempts to address a combination of material and energy efficiency, recyclability, use of renewable resources and product durability elements. Further work is needed to develop an indicator(s) to address these elements, separately or in combination. Also, this indicator involves the use of financial measurement units, which would themselves be problematic, to provide an understandable and relevant indicator.

From these overall conclusions flowed the following, more detailed conclusions and recommendations, grouped according to the broad priority rankings assigned by the workshop participants as a whole. Before addressing these, however, stakeholders consulted by the NRTEE Task Force on Eco-efficiency drew attention to broad considerations, concerns and challenges that need to be addressed in indicator design. A listing of these considerations and challenges is given below followed by the priorities for action and next steps.

Broad Considerations

- *Evolutionary development:* The development and implementation of eco-efficiency indicators needs to be voluntary and evolve over time — the process should progressively address the elements of eco-efficiency, developing linkages to financial reporting and full life cycle assessment and costing.
- *Socio-economic issues and sustainable development:* As a subset of sustainable development, eco-efficiency has linkages to the broader socio-economic context and values. However, questions arise as to whose values to incorporate in eco-efficiency indicators and how to measure such values. Stakeholders generally agreed that, for the present, it would be more practical to limit the scope of eco-efficiency measures and not to try to incorporate social values in them.
- *Need for trade-offs:* There is a need for trade-offs between simplicity and completeness in the eco-efficiency indicators. It is urgent to move forward now with imperfect measures and refine them over time.

- *Tools, not goals:* Eco-efficiency indicators should not be the drivers or the goals for improved eco-efficiency. Rather they should be tools for informed decision making. The process of goal setting (by companies, industry sectors, the broader public) and its relationship to the use of indicators should be examined.

- *Addressing each element of eco-efficiency:* The development of an indicator for each element of eco-efficiency should be considered. However, the final four eco-efficiency elements may conflict with the first three or may lead to perverse results in certain instances, and it may not be possible to develop useful indicators for these last four elements.

- *Meeting users' needs:* A distinction needs to be made between internal and external use and reporting of the indicators, that is, between providing information for managerial decision making and providing "auditable" or transparent numbers for external reporting. The first step in the process should be to provide information for internal decision making.

Specific Design Challenges

Stakeholders also raised several specific technical challenges in indicator design:

- *Product-related indicators:* Which aspects of a product's life cycle, from resource extraction to production processes to product use and disposal, should be addressed by the indicator? Once this has been decided, what is the appropriate level of data aggregation? Should this be at the facility, division, product line or company level?

- *Aggregation:* Aggregation itself raises a number of issues. When large amounts of information are synthesized into a few overall performance measures, relevant information can be overlooked or masked and therefore not reflected in the final indicator. Furthermore, if information is both aggregated and weighted for a composite indicator or index, subjective weighting schemes may compound any existing problems with the accuracy or reliability of underlying data and make the indicator difficult to verify.

- *Weighting, normalization and indices:* Should particular indicators be normalized or be calculated as indices? Moreover, is some kind of weighting of indicator components needed? A problem with weighting is that subjective judgments are frequently incorporated into weighting schemes based on qualitative factors. It may be more desirable to adopt scientific and objective means of assigning weights, such as those used in risk assessment models.

- *Financial versus physical measures:* Should indicators be based on financial measures as well as physical ones? Financial measures may allow for easier linkages with other, existing financial performance indicators, but in the absence of full-cost accounting, the true financial costs may not be captured accurately.

Priorities for Action

First Order of Priority

Indicators for Improving Material Productivity and Reducing Energy Intensity

Indicators for these two elements of eco-efficiency are particularly relevant to many users and can be readily implemented, subject to necessary definitions being developed and pilot testing. Material productivity and energy intensity should be the subjects of separate indicators, however, and not combined in a single one.

Companies in several countries have already implemented indicators for material productivity and energy intensity. The next step is to build on such work, develop consensus as to indicator design, and promote the wide acceptance, implementation and use of indicators for these elements. Emerging international consensus on the need to control human activities that may influence climate change could help build support for widespread use of an appropriate energy efficiency indicator.

Second Order of Priority

Indicator for Reducing Toxic Dispersion

Development of one or more indicators for toxic dispersion or releases is also highly desirable and relatively feasible, since toxic release data for specified substances are already routinely tracked and recorded by companies under existing domestic laws (in some countries) and international treaties (in many countries). 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.

Third Order of Priority

Indicators for Enhancing Material Recyclability, Maximizing Sustainable Use of Renewable Resources and Extending Product Durability

Appropriate indicators for each of these three elements of eco-efficiency would be valuable. However, there is a need to determine users' needs more clearly and to develop definitions and design parameters before pilot testing and broader adoption by business. Indicators in these areas might include those for renewable resource depletion or consumption, use of recycled materials and recyclable content of products. They might also be linked to material productivity indicators.

Fourth Order of Priority

Indicators for Service Intensity and Lifetime Product Cost

An indicator to measure the service intensity of goods and services would be more difficult to design and implement. The same holds for an indicator for lifetime product cost, which, by definition, might be more difficult to apply at the level of a whole organization.

Next Steps

The work of the NRTEE Task Force on Eco-efficiency reveals broad consensus that it is feasible to develop and implement indicators that can measure and report on eco-efficiency in a meaningful way. There is also consensus that the elements of eco-efficiency, already a focus for strategic management in some companies, offer a useful framework for developing a core set of eco-efficiency indicators that all companies can use both for internal and for external reporting purposes.

Building on the results from the Washington workshop, the NRTEE Task Force on Eco-efficiency is designing pilot tests of the two components of the resource productivity index — the material productivity and energy intensity indices. Current plans are to conduct initial pilot testing in five or six volunteer companies from industry and the financial sector over, perhaps, a one-year period. The initial pilots would be followed by pilot testing in a wider group of businesses, which would provide input to a second workshop on measuring eco-efficiency.

Other work will include further exploration of an appropriate indicator for toxic dispersion and further research into the needs of internal and external decision makers for eco-efficiency indicators. This may include development of a clearer, shared understanding of which users' needs are to be addressed and what types of decisions (such as investment decisions by boards of directors and capital market investors) should be informed by eco-efficiency indicators. Such an understanding would guide future efforts to develop appropriate indicators and to communicate effectively with the various user groups about the purpose, implementation and interpretation of the proposed indicators.

Work to improve understanding of needs and drivers could involve a further workshop to examine and compare the applicability of the eco-efficiency elements and related indicators across sectors. This would identify which indicators have general and which have sectoral applicability.

Endnotes

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

2 Ibid., p. 6.

3 Ibid., p. 5.

4 In this paper, the terms "indicator" and "measure" are used synonymously.

5 Investor Responsibility Research Center (IRRC), *Corporate Environmental Profiles Directory 1996*, Executive Summary (Washington, DC: IRRC, 1996), p. 5.

6 Op cit., endnote 1, p. 7.

7 Ibid., p. 9.

8 Stuart L. Hart, "Beyond Greening: Strategies for a Sustainable World," *Harvard Business Review*, January-February 1997, p. 66.

9 Joan Magretta, "Growth Through Global Sustainability: An Interview with Monsanto's CEO, Robert B. Shapiro," *Harvard Business Review*, January-February 1997, p. 78.

10 Niagara Mohawk Power Corporation, *Agenda Environment, Environmental Performance Report for 1993*, and Joseph Miakisz, "Measuring Environmental Performance at Niagara Mohawk Power," *Total Quality Environmental Management*, Autumn 1994, pp. 47-55.

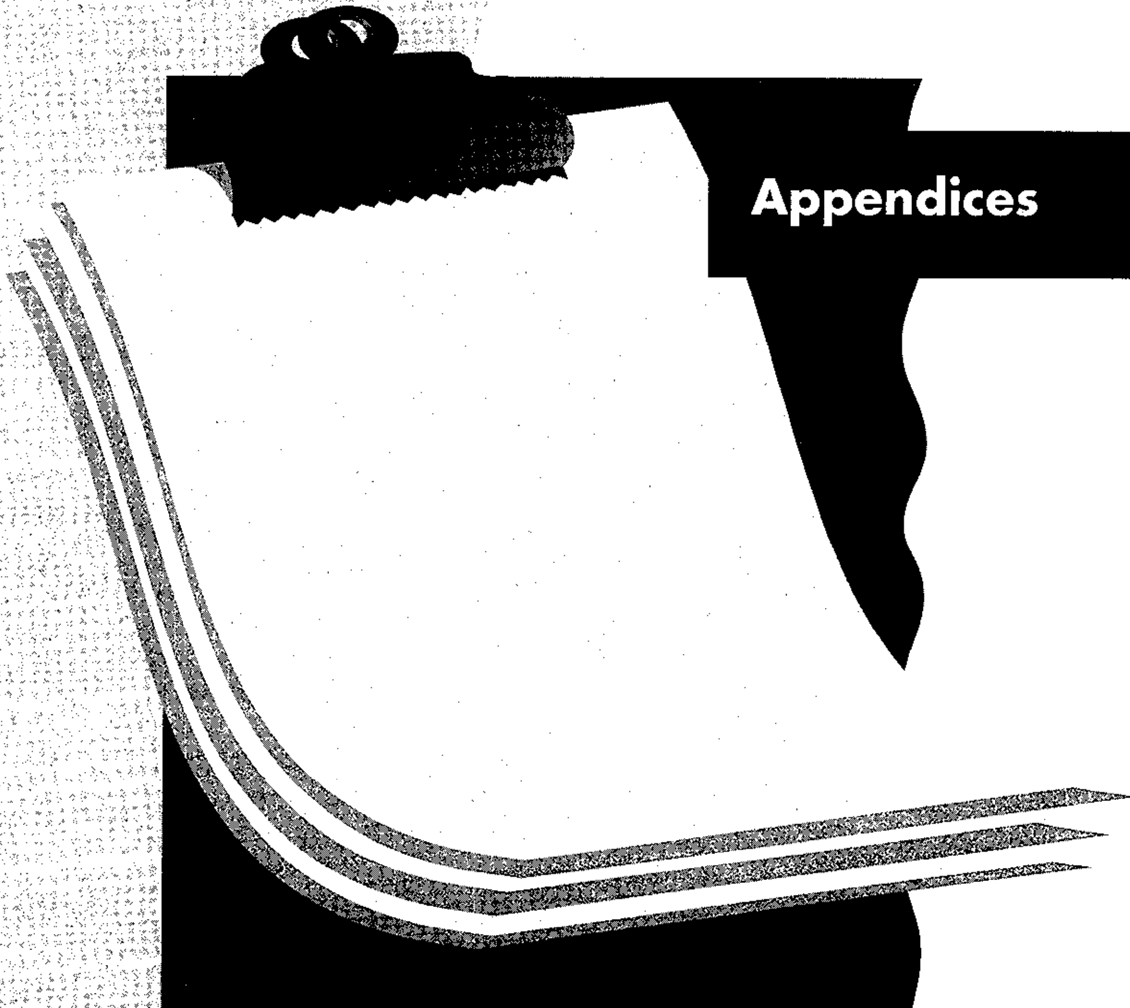
11 Reference to and excerpts from the Executive Summary of this confidential report are made with permission from BT.

12 Op cit., endnote 5.

13 Delphi Group, *Financing Sustainable Consumption & Production: Engaging Capital Markets*, draft for Environment Canada, February 16, 1997.

14 Op cit., endnote 9, p. 78.

Appendices



Appendix A

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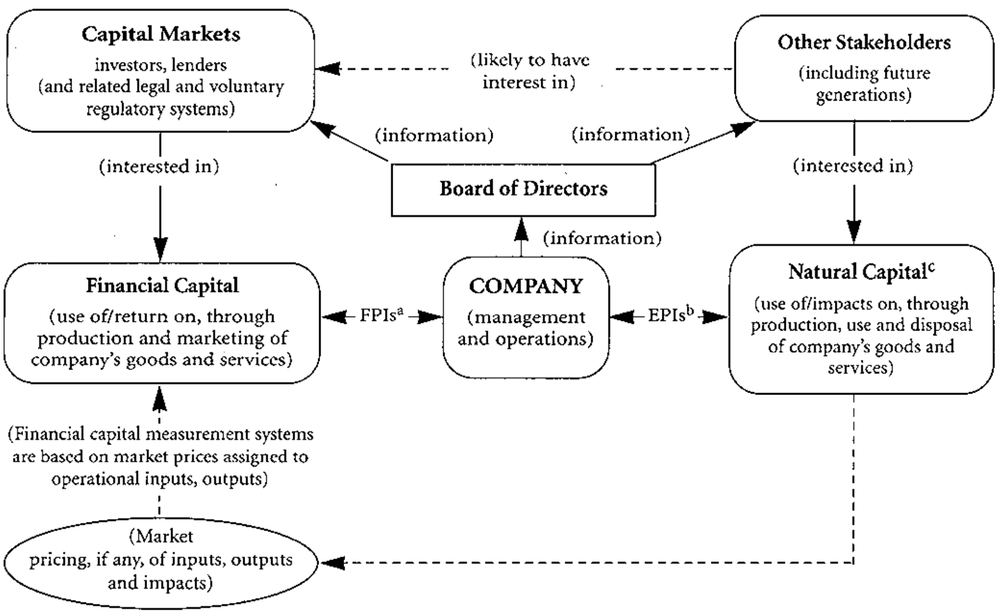
Appendix B

Framework for Considering Eco-efficiency: Information Needs and Users

Figure 1 presents a schematic way of looking at eco-efficiency information and its users. The main points to be made about this figure are outlined below.

Figure 1

Framework for Considering Needs for and Users of Eco-efficiency Performance Indicators



Notes:

a Financial performance is measured by Financial Performance Indicators (e.g., EPS, ROI, financial statement ratios, etc.) for which generally accepted standards have been developed over time.

b Indicators about eco-efficiency as well as existing EPIs for natural resource and energy use, waste generation and recycling, toxic and other emissions, etc.

c For purposes of clarity and simplicity, this diagram does not show subsets of natural capital (e.g., critical, renewable, non-renewable) and ownership rights thereof, nor are other domains of capital depicted, such as man-made, human, social.

Note that the existence and nature of contracts or understandings, explicit or implicit, between the company and the various capital domains are different for each domain. The company's behaviour toward, relationships with and accountability to stakeholders for each domain vary accordingly.

Interests of investors and lenders in capital markets are protected through various legal and regulatory regimes. Interests of stakeholders in natural capital are protected to various degrees through other legal and regulatory regimes. Both types of regimes depend in part on availability of reliable information about company performance.

The Company, Its Management and Board of Directors

The company, with its management and operational functions, is shown at the centre of the figure. Management of a business is regarded as having the most important and urgent need for information about the company's eco-efficiency, since management has the most direct influence on the company's performance. The company's board of directors is shown in a separate box, since the board has roles and responsibilities distinct from those of management. The board itself depends primarily on management for the information it needs for the decisions it has to make — for example, approving plans, acquisitions and investment proposals, evaluating management performance, approving annual reports and financial statements, and so on.

The board of directors is also the gatekeeper for (and frequently has to approve) the information about the company that is provided to external stakeholders — some information is provided according to legal and regulatory requirements (e.g., financial statements required by company law and securities regulators), some is provided on a more discretionary basis (e.g., corporate environmental performance reports), especially where the board has approved a company policy of transparency and accountability on matters such as codes of conduct or environmental stewardship.

Other Interested Parties

Two broad classes of stakeholders are shown: first, those who are participants or players in the capital markets, such as shareholders, bankers, insurers, financial analysts, bond raters and the capital market regulatory system of securities commissions and company law administrators. In many cases, shareholders are pension funds, mutual funds and other institutional investors, rather than private individuals (in which case, employees, for example, may be indirect stakeholders in capital markets). Besides players in capital markets, many others have an interest in the company's performance; these are broadly recognized in the figure as *other stakeholders.*

Capital Markets and Financial Capital

The capital markets are the source of financial capital entrusted to the company through a system of contractual and accountability arrangements that has evolved over many decades, even centuries. The company's performance in stewardship of that financial capital is measured and evaluated against the expectations of financial stakeholders through various types of financial performance indicators and information. These too have developed over many years, together with a set of accounting and reporting standards that have become "generally accepted" — indeed, prescribed by law and regulation — and that provide a high degree of comparability of results between companies and over time.

Environmental Performance Measurement and Accounting Practices

The usefulness of financial performance measures (such as earnings per share, debt-equity ratio, return on investment and, more recently, economic value added) is limited by what is captured and reported by the company's accounting system. This is based on transactions between the company and other parties, normally valued at prices set within the marketplace, which are then accounted for and reported according to generally accepted accounting principles (standards). Costs of environmental impacts of the company's activities and products that are not reflected in marketplace transaction prices or costs, such as the eventual costs to society of various forms of environmental degradation or depletion of natural resources, are not incorporated in the company's accounting system. Costs incurred by the company in meeting societal expectations for environmental protection are normally recorded in the accounting system, as are the costs, such as fines and penalties, of failing to meet expectations.

Conventional financial performance measures do not therefore reflect a full picture of the company's performance, but rather have been geared to providing information about aspects perceived as relevant to the expectations of financial stakeholders. These shortcomings are well described in books such as *Financing Change* (Stephen Schmidheiny and Federico Zorraquin, 1996), *Costing the Earth* (Frances Cairncross, 1991) and *The Ecology of Commerce* (Paul Hawken, 1993), where the authors argue that financial performance measures are sending incomplete and therefore misleading signals to the marketplace, consumers and investors alike, so far as sustainability of the natural capital base is concerned. As financial stakeholders start to change their own expectations or views as to what constitutes relevant aspects of company performance, then presumably they will seek additional, new types of performance measurement information beyond the financial information they are accustomed to receiving and interpreting.

In theory, one way to remedy these accounting and reporting shortcomings might be for individual companies to adjust where necessary the pricing and values assigned to transactions, assets, etc., and to compute values for environmental impacts of various kinds, so as to reflect more fully the "true" environmental costs of doing business, which might then be entered into accounting systems or incorporated in new financial reporting models and methods. This approach, even if theoretically feasible (and which has been attempted by a few companies, for example, in Australia and the Netherlands), would take much time to accomplish as a generally accepted practice and would involve too many subjective judgments and valuation methods to make it feasible in the near future. The reality is that marketplace pricing structures are highly complex and are the basis for international trading and competition. Accounting information may inform and support, but not actually direct the outcome of processes for price adjustment and price setting.

Another option would be to give capital market participants a relevant and reliable set of indicators that provide information about environmental performance, particularly eco-efficiency, and that, when used together with financial information, would provide a more balanced and complete picture of overall corporate performance, trends, and prospects relative to factors that drive competitiveness and value generation. The key to this approach would be to provide information that financial stakeholders view as essential and relevant, as reliable, timely, and comparable between companies, and as verifiable as the financial information to which they have been accustomed. A core set of widely accepted eco-efficiency indicators would accomplish this goal.

Other Stakeholders and Natural Capital

The second broad class of stakeholders, shown as *other stakeholders*, includes suppliers, customers, communities, employees, environmental non-governmental organizations, and governments and their agencies, including environmental regulators. Governments and regulators arguably act as surrogate stakeholders on behalf of society and exist to protect the long-term interests of society in the maintenance and well-being of the natural capital provided by the earth and its ecosystems. Furthermore, other stakeholders such as employees often have important interests in capital markets themselves, through pension schemes, for example.

In relation to natural capital, the concept of sustainable development requires protection of the interests of future generations as well as today's population. Figure 1 depicts only natural capital, but in reality the company depends on access to and the use of other domains of capital — such as manufactured, human and social capital — in which outside stakeholders also have interests. The commercial and legal/contractual arrangements for the company's stewardship of and accountability to stakeholders for all aspects of natural capital are at present imperfectly and incompletely entrenched in laws and regulations, and accordingly the marketplace pricing structures for the company's use of natural capital frequently reflect the inadequacies and inconsistencies in these stewardship arrangements. Legal and regulatory requirements regarding stewardship of natural capital, however, are changing over time to reflect societal expectations. Whether in anticipation of these trends or applying the precautionary principle, prudent companies are becoming increasingly thorough in their risk assessment and management practices.

Furthermore, companies are at least now devising and implementing systems of environmental performance measurement appropriate to the environmental policies and goals they have set for themselves — which in many cases now go well beyond the performance level of legal and regulatory compliance. These measurement systems have evolved somewhat more recently than financial ones, but a wide array of environmental performance indicators is now found across the industrial landscape — so many, in fact, and in so many formats and units, that they can be confusing and create difficulties for comparability within companies, let alone between them.

Within this general field of evolving environmental performance indicators, eco-efficiency indicators are being developed and applied by some companies, and within this field lies the challenge of identifying a few key indicators that measure the essence of eco-efficiency in such a way as to provide the greatest value to management, boards of directors, capital market participants and other stakeholders.

Appendix C

Environmental Performance Measurement: Current Concepts and Practices

Many companies have been measuring various aspects of their environmental performance for several years as part of their internal management of operations and evaluation of performance against policies and objectives, and in some cases to capture information needed for regulatory compliance reporting and monitoring purposes.[1] One outcome of these efforts has become a major challenge in itself, namely, the proliferation of environmental performance indicators (EPIs) of many types, each measuring a wide range of aspects of environmental performance and each using a diverse set of metrics and measurement units.

There have been several attempts to classify or categorize environmental performance measures or indicators within more orderly and logical frameworks, groupings and headings. These have also, in many cases, been accompanied by attempts to formulate criteria for the selection and assessment of the suitability of EPIs. In 1994, the Canadian Institute of Chartered Accountants (CICA) noted that:

> ... the number of industry associations and standards setting bodies around the world working on environmental performance indicators suggests that many organizations are struggling with how to measure environmental performance from a common reference point for internal management purposes. It is understandable, therefore, that organizations are finding it difficult trying to distill complex environmental issues into a few relevant indicators for external reporting.... It will take a significant amount of time and resources to develop common industry environmental performance indicators and to gain consensus from organizations to use them.[2]

Over the last few years, significant attention has been given by companies, industry associations, and professional and international bodies to the development and refinement of approaches to environmental performance evaluation and in particular to the design, selection and use of EPIs at the company or business (micro) level, as distinct from the macro level.

This appendix provides a list of some of the recent studies, surveys and reports by leading organizations about developing and implementing environmental performance measurement and indicators, and summarizes the indicator selection criteria proposed or adopted in some of these reports.

1 International Organization for Standardization (ISO) — *ISO/CD 14031, Environmental Performance Evaluation — Guidelines,* 1996

This draft document represents an emerging international consensus among industry and other stakeholders regarding some important concepts and principles about environmental performance measurement and indicators. The ISO document is intended to be useful for various types and sizes of organizations in all sectors.

The ISO draft guideline does not address eco-efficiency, as such, but it does acknowledge improvement of environmental performance, and how environmental performance evaluation is a useful tool for achieving an organization's environmental policies, objectives and targets. Further, among the many examples of performance indicators provided in the Annex to the draft document are some that might fairly be characterized as indicators of eco-efficiency and several more that would be essential components of such indicators.

The concepts and definitions provided in the ISO draft, while not developed with eco-efficiency specifically or explicitly in mind, nonetheless serve a useful purpose by providing an acceptable set of concepts and related definitions for consideration in the development of eco-efficiency indicators.

The ISO/CD 14031 draft guideline proposes the following criteria for the selection of environmental performance indicators. They should be:

- appropriate to the organization's management efforts, its operations or the condition of the environment analyzed
- useful for measuring performance against the organization's environmental objectives and targets
- relevant and understandable to internal and external interested parties
- obtainable in a cost-effective manner
- adequate for their intended use based on the type, quality and quantity of data
- representative of the organization's environmental performance
- measurable in units appropriate to the environmental performance
- responsive and sensitive to changes in the organization's environmental performance and able to provide information on current or future trends in environmental performance

2 United Nations Environment Programme (UNEP) — (a) *Industry and Environment*, Vol. 18, Nos. 2-3, April-September 1995; (b) *Company Environmental Reporting: A Measure of the Progress of Business & Industry Towards Sustainable Development*, Technical Report No. 24, 1994

(a) In an article in *Industry and Environment* entitled "Environment-related performance measurement in business," (p. 40) authors Peter James and Martin Bennett propose a framework for measuring the environmental performance of businesses. In this framework, the following generic environmental performance measures are identified in a continuum from decreasing environmental significance to increasing business significance: impacts, risks, emissions/wastes, inputs, resources, efficiency, customer and financial. Measures in the middle of the spectrum, such as emissions/wastes, inputs and resources, are characterized as having both environmental and business significance and may be considered, in this context, as useful starting points for the development of eco-efficiency indicators.

Five considerations are identified as driving the process of developing EPIs:

- the need to measure the most significant environmental areas
- the need to address the most urgent concerns, e.g., regulatory compliance
- the value of measuring areas with both business and environmental significance
- the feasibility of measurement, both in terms of financial costs and the availability of data
- the need to balance simplicity of measurement with reasonable comprehensiveness

Ten key factors (the 10 "Cs") for successful environmental performance measurement are then proposed, based on experience from other relevant areas of performance measurement, in particular in the area of total quality management:

1. cascading
2. commitment
3. comparison
4. comprehensible
5. comprehensive
6. continuous improvement
7. controllable
8. cost
9. credibility
10. customer focus

In the same issue of *Industry and Environment*, in an article entitled "Indicators for a sustainable development: UNEP's role in a collaborative effort," (p. 21) author Marion E. Cheatle identifies the following criteria for developing sustainable development indicators at a macro level — criteria that may also be relevant for indicator development at the level of a business entity (the criteria are summarized here in a slightly adapted form):

- national in scale or scope
- relevant to main objective of assessing progress toward sustainable development (or eco-efficiency)
- understandable (clear, simple and unambiguous)
- realizable within the capacity of the preparers of the information, in light of time, logistics, technical and other restraints
- conceptually well-founded
- limited in number, remaining open-ended and adaptable to future developments
- broad in coverage of all aspects of sustainable development (or eco-efficiency)
- representative of international consensus to the extent possible
- dependent on data that are readily available or available at a reasonable cost/benefit ratio
- adequately documented, of known quality and updated at regular intervals

(b) In UNEP's Technical Report No. 24, *Company Environmental Reporting* (pp. 61-63), the following environmental performance indicator selection criteria are identified:

- comparability
- credibility
- quantification
- transparency
- extendibility

3 International Institute for Sustainable Development (IISD) — (a) *Coming Clean: Corporate Environmental Reporting*, 1993; (b) *Global Green Standards — ISO 14000 and Sustainable Development*, 1996

(a) In *Coming Clean: Corporate Environmental Reporting*, the IISD noted that the leaders in the field of corporate environmental reporting were using indicators that were quantifiable, significant and comparable. Current "best practice" was characterized as involving the use of indicators that measured significant environmental impact, could be self-assessed and externally verified, and were comparable over time or with best representative environmental standards (i.e., benchmarks).

(b) In a more recent publication, *Global Green Standards — ISO 14000 and Sustainable Development*, the IISD provides a "heads-up" analysis of the ISO 14000 series standards, including, in Chapter 8, an overview and commentary on the ISO/CD 14031 draft document *Environmental Performance Evaluation* (referred to under heading 1 above). The potential benefits of sound environmental performance evaluation processes, including the performance indicators used therein, are described as environmental performance evaluation processes that can:

- provide credible information
- provide a systematic approach
- enable benchmarking
- help identify problems
- facilitate improvement
- identify savings
- facilitate reporting (external as well as internal)

4 World Resources Institute (WRI) — (a) *Corporate Environmental Performance Indicators: Bridging Internal and External Information Needs*, 1996; (b) *Corporate Environmental Performance Indicators: A Benchmark Survey of Business Decision Makers*, 1996 (in press)

(a) In *Corporate Environmental Performance Indicators*, authors Daryl Ditz and Janet Ranganathan of the WRI outline a framework for selecting EPIs that begins with five categories of environmental performance for a generic manufacturing firm:

- *Emissions:* Indicators in this category would report on quantities and types of potentially hazardous materials released to the air, water or land. Reporting on toxic chemical emissions is required for the United States Toxic Release Inventory (TRI) and for Canada's National Pollutant Release Inventory (NPRI).

- *Waste generation:* Waste generation indicators would report on quantities and types of wastes created prior to treatment or disposal. This information would supplement the emissions data above and assist in distinguishing between pollution control and pollution prevention. (Interestingly, proposed changes to Canada's NPRI for the 1997 reporting year include the addition of pollution prevention tracking.)
- *Materials efficiency:* These indicators would report on quantities and types of materials used in manufacturing. The State of New Jersey now has requirements for information on chemical inputs, allowing for a form of materials accounting.
- *Energy use:* Energy use indicators would provide information about the quantities and types of energy used in the manufacture of a product.
- *Product performance:* Product performance indicators would report on quantities and types of materials and energy used, and waste created through product use and disposition.

The authors point out that a 1995 survey by the Investor Responsibility Research Center revealed that only a minority of companies was providing corporate-wide information on energy and materials use, water consumption and hazardous waste generation. However, "in the hands of companies with a genuine commitment to 'eco-efficiency' and product stewardship, these EPIs will help track progress and motivate improvement.... The key lies in integrating EPIs into practical applications" (p. 8).

According to the proposed framework, EPIs should be:

- sufficient in scope to cover relevant environmental dimensions
- transparent in terms of their definition, origin and meaning
- comparable to permit tracking over time and across firms, sectors and companies

(b) The WRI is completing a survey, entitled *Corporate Environmental Performance Indicators: A Benchmark Survey of Business Decision Makers*, of company use of EPIs in the following broad categories: chemical releases, water use, regulatory compliance, chemical inputs or use, energy use, environmental expenditures, efficiency of chemical use, and greenhouse gas emissions. As part of the survey, participating companies are asked to rank the importance of the following characteristics of EPIs.

- comparable (over time, across products, across facilities within a single company, within an industrial sector, across industrial sectors and across countries)
- verifiable
- publicly reported
- normalized

At the time of preparation of this report, the survey results were not available.

5 Canadian Institute of Chartered Accountants (CICA) — *Reporting on Environmental Performance,* 1994

In *Reporting on Environmental Performance,* CICA proposed an environmental reporting framework based on providing information having the following four key characteristics:

- relevance (in terms of predictive value, feedback value, timeliness and significance)
- reliability (in terms of verifiability, neutrality and representational faithfulness)
- understandability (in terms of knowledge of business, environment and economic impacts)
- comparability (in terms of consistency)

These characteristics are universally recognized as being useful in the context of financial reporting.

The characteristics of EPIs in the CICA's framework are, in turn, as follows:

- consistent with environmental objectives
- responsive to audience information requirements
- understandable to audiences

A classification scheme for indicators similar to that found in ISO/CD 14031 is also set out (i.e., that indicators may be absolute or relative, indexed, normalized, weighted). The actual types of EPIs in this framework are characterized as relating to inputs (natural resources, land), outputs (products, by-products, services), impacts (emissions, discharges, wastes, noise, odour, dust), and effects (well-being of people, plants and animals). Other factors or considerations involved in selecting and implementing EPIs are identified as the availability of data, the appropriateness of the number of indicators selected, and the need to provide a balanced view of performance. Limitations noted included the frequently low level of precision in measurement and the lack of both common definitions and industry standards.

6 KPMG — *A Measure of Commitment: Guidelines for Measuring Environmental Performance,* 1992

In KPMG's publication *A Measure of Commitment,* seven basic principles for choosing environmental performance measures are described. Measures should be:

- consistent with policy and corporate objectives
- not too many
- simple and understandable
- appropriate for users
- capable of tracking performance against objectives

- measurable
- transparent

Further, the following "basic choices" for selecting indicators are proposed:

- impact or contributor measures
- use of risk and external measures
- quantitative/objective or qualitative/subjective
- relative or absolute
- negative or positive

The KPMG study also provides a number of brief but useful case studies or examples drawn from a wide cross-section of companies.

7 Matteo Bartolomeo, Fondazione ENI Enrico Mattei (FEEM) — *Environmental Performance Indicators in Industry*, 1995

In *Environmental Performance Indicators in Industry*, author Matteo Bartolomeo of FEEM identifies four EPI characteristics. They should be:

- understandable
- objective
- significant
- comparable

In this proposed framework, environmental indicators consist of two categories: performance indicators and impact indicators. Performance indicators are of the following types: process (raw materials, energy, emissions, accidents, products), system (compliance, EMAS implementation and integration with other business units), and eco-financial (environmental liabilities, marginal cost of abatement and insurance premiums). Impact indicators consist of physical and monetary indicators.

8 World Bank (WB) — *Monitoring Environmental Progress: A Report on Work in Progress, Environmentally Sustainable Development Series*, 1995

In *Monitoring Environmental Progress*, the World Bank identified the following characteristics of EPIs in its framework. They should:

- be understandable and easy to interpret
- show trends over time
- be responsive to changes in underlying conditions

- have a threshold or reference value established against which conditions can be measured
- be well founded in scientific and technical terms
- be calculated from data that are readily available, or are available at a reasonable cost
- contain documented data of known quality (verifiable and reliable)
- be updated regularly

The following indicator sets were proposed:

- pressure or driving force indicators
- state indicators
- response indicators
- impact indicators

9 Interagency Working Group on Sustainable Development Indicators (SDI Group) — *Proposed 1997 SDI*

In the United States, the SDI Group, which reports to the Council on Environmental Quality in the Executive Branch of the U.S. federal government, has prepared an inventory of proposed sustainable development indicators (*Proposed 1997 SDI*) intended for use at the macro level. Five criteria for such indicators are recommended that may be relevant to business entities in developing eco-efficiency indicators. Indicators should be:

- understandable to a variety of user groups
- all-inclusive
- expandable to allow for greater detail
- compatible with other frameworks and indicators
- internally consistent

Criteria Summary

Attempts to select or design effective performance measures or indicators of any kind are best guided by a set of principles or criteria. If a proposed measure or indicator satisfies such criteria, it is more likely to be useful for its intended purpose and users.

What, then, are appropriate criteria for assessing the effectiveness of eco-efficiency indicators, whether in use or proposed? The sources identified in this appendix provide more extensive guidance on this question. Table 1 below summarizes the various selection criteria proposed by these sources, while Table 2 briefly explains the meaning of those criteria.

Review and synthesis of the selection criteria from these sources suggests that the following nine criteria are particularly useful in selecting and designing indicators for measuring eco-efficiency. The criteria are that an indicator should:

- address one or more elements of eco-efficiency
- be simple and understandable
- be responsive and appropriate to the needs of users, internal and external
- be measurable and cost effective to produce
- facilitate tracking of performance against objectives and over time
- facilitate comparisons between business entities and sectors
- be transparent and neutral
- be reliable and fairly represent the performance to which it relates
- be verifiable

Table 1

Summary of Eco-efficiency Indicator Selection Criteria

Selection criteria*	ISO**	UNEP	IISD	WRI	CICA	KPMG	FEEM	WB	SDI
Relevant/appropriate	x			x	x	x			
Reliable/credible/accurate		x			x			x	
Understandable	x				x	x	x	x	x
Comparable (time/standards)	x	x	x	x	x	x	x	x	x
Consistent					x	x			x
Verifiable	x		x	x	x			x	
Quantifiable/measurable	x	x	x			x	x	x	
Cost effective/ data available	x				x			x	
Significant			x		x		x		
Transparent		x		x		x			
Expandable		x							x
Responsive to change	x							x	
Current and predictive	x				x			x	
Limited/appropriate in number		x			x	x			
Comprehensive/ representative	x	x		x	x				x

* Certain selection criteria have been combined as noted.

** The acronyms listed and the relevant sources of the criteria identified by each agency are set out in this appendix (Appendix C).

Table 2

Definitions of Eco-efficiency Indicator Selection Criteria

Selection criteria	Explanation
Relevant/appropriate	Relevance depends upon what a particular audience wants to know about a company's performance, e.g., in this context, whether the indicator allows the audience to evaluate the company's eco-efficiency. Relevant indicators should have predictive value, feedback value, timeliness and significance.
Reliable/credible/accurate	An indicator is reliable when it agrees with the underlying data, is capable of independent verification and is reasonably free from error and bias. Reliable indicators also provide neutrality and representational faithfulness.
Understandable	Indicators should be simple and capable of being easily understood by the audience. They should be user-friendly (clear and unambiguous) and presented so as to allow the audience to understand how the indicator is derived.
Comparable	Comparability allows different pieces of information to be related. Indicators thus should be reported consistently and regularly, and should allow for performance comparison between business entities, sectors and across time toward goals (i.e., performance tracking).
Consistent	Indicators should be consistent both with a set of predetermined principles and objectives, e.g., with the elements of eco-efficiency, as well as internally consistent and founded on scientific principles.
Verifiable	Indicators should be capable of independent verification.
Quantificable/measurable	Indicators should be capable of objective quantification/ measurement.
Cost effective/data available	Measurement should be feasible, both in terms of cost effectiveness and availability of data.
Significant	Indicators should include all significant relevant information.
Transparent	Indicators should be straightforward, open and not reflect a hidden agenda.
Expandable	Indicators should be capable of being upgraded and extended to meet or adapt to future needs and requirements.
Responsive to changes	Indicators should be capable of responding to changes in underlying conditions.
Current and predictive	Indicators should provide current information (i.e., be updated on a regular basis) and have predictive value.
Limited/appropriate in number	Indicators should be presented in an organized manner and be of an appropriate number.
Comprehensive/ representative	Indicators should fairly represent the subject matter to which they relate.

Notes

1 Environmental performance is defined for the purposes of this appendix as "the results of an organization's management of the ways in which its activities, products or services interact with and cause adverse or beneficial changes in the environment." (This definition is adapted from the ISO 14000 definitions of environmental performance and impact.)

2 Canadian Institute of Chartered Accountants (CICA), *Reporting on Environmental Performance* (Toronto: CICA, 1994), p. 91.

Appendix D

Eco-efficiency Measurement Workshop

Agenda

Date	April 2, 1997
Place	Washington, DC
Sponsors	The National Round Table on the Environment and the Economy and the World Business Council for Sustainable Development

08:00 - 08:30	Welcome and introductions
08:30 - 08:50	The concept of eco-efficiency Mr. Allen Aspengren, Manager, Global Eco-efficiency Programs, 3M — Environmental Technology and Safety Services
08:50 - 09:10	Objectives of the workshop Dr. Stuart Smith, Chairman, ENSYN Technologies Inc., and Chair, National Round Table on the Environment and the Economy
09:10 - 10:00	Opening plenary
10:00 - 10:20	Working session set-up and group organization
10:20 - 12:30	Working sessions on measurement and next steps
12:30 - 13:30	Lunch and recap
13:30 - 16:00	Working sessions, continued
16:00 - 17:00	Results sharing and next steps
17:00 - 17:15	Concluding remarks
17:15	Reception

Participants

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General Motors Corporation

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Manager, Global Product Responsibilities
S.C. Johnson & Son, Inc.

Al Aspengren
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Measuring
Eco-efficiency
in Business

National Round Table
on the Environment
and the Economy

Table ronde nationale
sur l'environnement
et l'économie

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