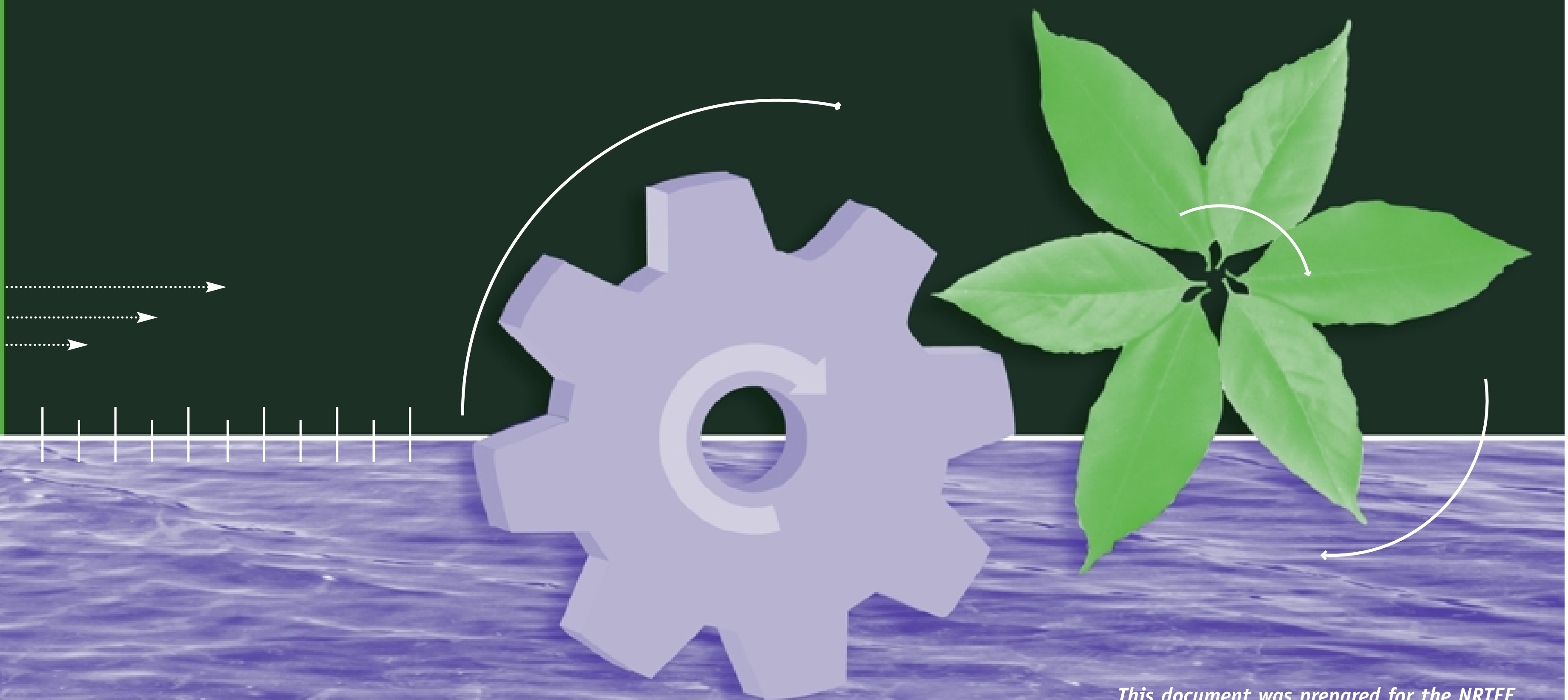
Eco-efficiency Indicators

Workbook

Calculating Eco-efficiency Indicators: A Workbook for Industry



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National Round Table on the Environment and the Economy
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Who We Are

The National Round Table on the Environment and the Economy (NRTEE) is an independent advisory body that provides decision makers, opinion leaders and the Canadian public with advice and recommendations for promoting sustainable development.

Our members are distinguished Canadians appointed by the Prime Minister of Canada. They represent a broad range of sectors, including business, labour, academia, environmental organizations and First Nations.

What We Do

The NRTEE, legislated by Parliament in 1994, explains and promotes sustainable development. Working with stakeholders across Canada, the NRTEE identifies key issues with both environmental and economic implications, examines these implications and suggests how to balance economic prosperity with environmental preservation.

Our activities are organized into programs; each is overseen by a task force of NRTEE members and representatives from business, government and non-profit organizations. The responsible task force commissions research, conducts national consultations, reports on agreements and disagreements, and recommends how to promote sustainability. The NRTEE reviews these reports and recommendations before approving them for public release. The NRTEE members meet quarterly to review progress, establish future priorities and start new programs.

How We Work

The NRTEE takes an impartial, inclusive approach. All points of view are expressed freely and debated openly. Stakeholders define the overlap between environmental and economic issues and recommend changes.

Making progress in sensitive areas is a challenge for stakeholders. The NRTEE has adopted a round table format that helps overcome entrenched differences by:

- analysing environmental and economic facts and trends;
- asking key stakeholders for their input;
- assimilating research and consultation to clarify the debate;
- pinpointing the consequences of action and inaction, and making recommendations.

The round table process is a unique form of stakeholder consultation, permitting progress on diverse issues with an environmental/economic interface. The process itself is of value in overcoming entrenched differences. At the same time, the products (reports) for each program emphasize broad policy development and provide specific recommendations for action.

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1 Introduction

About this workbook

Many leading companies have already developed key eco-efficiency indicators for their businesses *and* are routinely tracking and reporting energy, waste and water intensity indicators. Because these indicators have been developed internally within businesses or business sectors, the results are not readily comparable. The standardization of definitions and decision rules for calculating and reporting eco-efficiency indicators could help companies to set measurable eco-efficiency targets and facilitate comparisons between companies and business sectors — essentially, it would result in widely accepted, quantifiable, verifiable and transparent indicators that could be widely used. Ultimately, reporting of eco-efficiency could become as standard and routine as reporting currently accepted indicators of financial performance.[1]

Canada's National Round Table on the Environment and the Economy (NRTEE), with the active cooperation of volunteer companies, has developed and tested decision rules and definitions for energy, waste and water intensity indicators. The NRTEE's work builds on the development of principles and a framework for eco-efficiency indicators undertaken by the World Business Council for Sustainable Development (WBCSD).[2]

Participants in the NRTEE indicator program agreed that other companies in Canada and internationally should be encouraged to measure and report energy, waste and water intensity using the consistent approaches tested. Participants also agreed that it would be useful to develop a user-friendly workbook that companies could use in calculating and reporting the indicators.

This workbook has been developed in accordance with that advice. It outlines and defines the energy, waste and water indicators that were developed during the NRTEE program and provides basic instructions for companies that wish to calculate these indicators for their organizations.

Structure of this workbook

This workbook provides definitions of the three core eco-efficiency indicators that were developed during the NRTEE indicator program. It also includes definitions for several complementary indicators that are associated with the core indicators. Users will find instructions and tables for calculating each of the core indicators as well as advice on calculating the complementary indicators.

Reporting of eco-efficiency could become as standard and routine as reporting currently accepted indicators of financial performance.

Wherever existing procedures are available in references, those instructions have not been reproduced here. Instead the appropriate references are provided.

The workbook is divided as follows:

- **The need for indicators** — the value of eco-efficiency indicators in helping businesses improve their financial and environmental performance.
- **Reporting the indicators** — the decisions each company must make on the use, purpose, and scope of the indicators before it begins to calculate its indicators; advice on how to use the indicators for performance tracking and reporting, and cautions about comparisons.
- **Energy intensity indicator** — the definitions and decision rules for the core energy intensity indicator and instructions for its calculation.
- **Waste intensity indicator** — the definitions and decision rules for the core waste intensity indicator and instructions for its calculation.
- **Water intensity indicator** — the definitions and decision rules for the core water intensity indicator and instructions for its calculation.
- **Resources and tables** — additional resources for calculating the indicators.
- **Complementary indicators** — advice on how to calculate complementary energy, waste and water intensity indicators.
- **Working examples** — examples of how two facilities calculated their three core indicators.

It would be impossible to address every special case a company could encounter when calculating these indicators, but a basic framework is laid out. If your company is unable to comply completely with all of the decision rules for any of the indicators, then when reporting the indicator, both internally and externally, you should provide explanatory notes outlining the deviation from the decision rules or definitions and the reason for the deviation.

Feedback

We would appreciate hearing from you about the value of the indicators to your organization. Please send your comments to:

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Chapter 2 *The need for indicators*

Chapter 3 *Reporting the indicators*

2 The need for indicators

Sustainable development context

Eco-efficiency has been widely accepted as a concept that can help businesses understand how achieving both environmental and business goals can be compatible. The WBCSD has noted that "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]

Eco-efficiency is a significant subset of sustainable development, defined by the Brundtland Commission as "development which meets the needs of the present without jeopardizing the needs of future generations."[4] 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.[5]

As the WBSCD notes, "eco-efficiency brings together the essential ingredients — economic and environmental progress — which are necessary for economic prosperity to increase with more efficient use of resources and lower emissions."[6] To transform eco-efficiency from a concept into a reality, companies must measure and monitor their performance in order to set goals for improvement and to track and quantify that improvement.

Eco-efficiency — The seven elements

The WBCSD has identified the following seven elements of eco-efficiency:[7]

- 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.

The three core indicators developed by the NRTEE — for energy, waste and water intensity — were designed to help companies evaluate their performance over time with respect to the WBCSD's first two elements of eco-efficiency: reducing material requirements through improved waste and water management and reducing energy intensity.

Eco-efficiency is a significant subset of sustainable development, defined by the Brundtland Commission as "development which meets the needs of the present without jeopardizing the needs of future generations."

The journey toward these indicators may be as valuable as the results themselves, and businesses are encouraged to consider these indicators as one way, but not the only way, of improving their businesses and the environment.

Value of indicators

The use of energy, waste and water intensity indicators can help businesses maintain and enhance competitiveness while reducing environmental burdens. These indicators address the two elements of eco-efficiency that are within the direct responsibility of a company (reducing the energy intensity of goods and services, and reducing the material requirements for goods and services). They do not address the issue of consumption. The journey toward these indicators may be as valuable as the results themselves, and businesses are encouraged to consider these indicators as one way, but not the only way, of improving their businesses and the environment.

The calculation and reporting of the energy, waste and water intensity indicators outlined in this workbook can benefit a variety of users: individual facility managers, corporate managers and a company's stakeholders.

Value to facility managers

Eco-efficiency indicators, when used for internal monitoring and reporting within facilities, have proven useful for:

- justifying capital investments;
- identifying and prioritizing opportunities for improvement;
- tracking and ensuring continuous improvement;
- setting goals for improvement; and
- providing information for input into corporate strategic decisions.

Value to corporate managers

Companies have used eco-efficiency indicators as effective management tools. They have also found them useful for:

- reporting to external stakeholders;
- setting goals for improvement;
- replying to external questions; and
- promoting resource stewardship and conservation.

As well, companies see value of the indicators as a tool for benchmarking with similar facilities within a company or for benchmarking with other similar organizations. However, comparisons of indicators between businesses and business sectors should be made with caution. Businesses in the same sectors may be operating under different economic, political, environmental and natural resource constraints. The manufacturing processes in different business sectors are inherently different resulting in different achievable eco-efficiencies.

Value to employees, customers, financiers, regulators

The energy and water intensity indicators can be used to report performance to a variety of internal and external audiences (e.g., employees, shareholders, regulators, the public and financial institutions). Because these two indicators are generally amenable to standardized calculating and reporting across most business sectors, their use could enable external stakeholders to compare similar organizations within business sectors provided denominators (units of production or service delivery) are comparable and details of the companies' product mix, operating conditions and operating constraints are known.

Companies that participated in the NRTEE indicator program suggested that waste intensity indicators are less amenable to external reporting than the energy and water indicators. The waste indicators defined in this workbook measure only quantities of wastes, and those quantities are not weighted for environmental impact. Thus they do not necessarily reflect a company's environmental burden per unit of production or service delivery. The waste intensity indicators are also subject to more variation in measurement and reporting across business sectors. This makes them harder to standardize and less relevant as a benchmarking tool for external stakeholders. However, the waste indicators are valuable tools for companies that are beginning to think about their environmental burden and their material productivity.

3 Reporting the indicators

Companies need to make some preliminary decisions before information can be gathered and values calculated for these indicators: how will the indicators be used? what is the project boundary? what is the reporting period for the indicators? and what are the appropriate denominators?* This section provides information to help you decide each of these issues.

Use of the indicators

Questions to consider when deciding on the uses and audience for the indicators include:

- Will they be included in the company's corporate environmental report?
- Will they be reported internally to the company's board of directors?
- Will they be compared with the indicator results of similar companies within the same industry?
- Will facility managers use them as a tool in making their processes more efficient?
- Other uses?

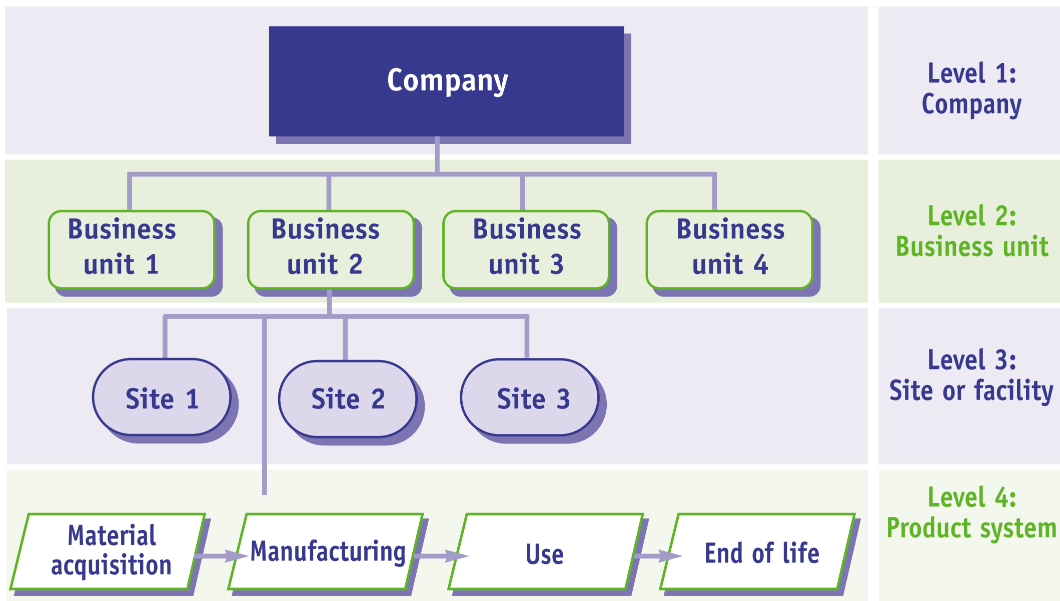
The intended use of the indicators will help you determine an appropriate project boundary, reporting period and denominator for the project.

* Eco-efficiency is normally measured as a rate, such as MJ/t or MJ/units of product. The denominator — in this case "t" or "units of product" — will vary depending on the service or product the company produces.

Selection of boundaries

As illustrated below, indicators can be applied at multiple levels within a company (e.g., company, business unit, facility [site] or product).

Figure 3.1 ***Levels within a company at which indicators can be applied***[8]



Once the use and target audience for the indicators have been identified, the next step in calculating any of the indicators is to define its project boundary. Possible project boundaries include:

- ***Corporate*** — the entire company;
- ***Business unit*** — a business unit within the corporation, which could include several different facilities and/or products;
- ***Product line*** — a particular product line within the corporation, which could be produced at a single facility or at several facilities;
- ***Facility or facilities*** — one or more facilities (sites) operated by the corporation; or
- ***Unit processes*** — one or more unit operations within a facility.

Most companies that tested these indicators selected one or several facilities as their project boundary. Data are generally available at the facility or site level, and facilities are generally under the responsibility of an overall manager who has the authority to make decisions about improving performance. Allocation of energy or material use between different products or unit operations within a facility may provide additional information for the manager, but allocation within a facility is often difficult because of a lack of metering at the individual product or process level.

Indicator calculations can be rolled up (aggregated) to move from a lower project boundary to a higher project boundary. However, the value of aggregating the indicators must be determined by each individual company. Rolling up the indicators to the corporate level might be useful internally (enabling year-to-year comparisons), but it would be difficult to use these aggregated results to compare companies unless much were known about the product mix and about operating constraints within each company.

Selection of reporting period

Once you have chosen a project boundary, you must select an appropriate and meaningful reporting period. Points to consider include:

- Should the reporting period coincide with the company's fiscal year?
- How often should the indicator results be evaluated?
- What are the billing frequencies and dates for company resources (e.g., electricity bill, other utility bills, supplier invoices for materials, waste disposal)?
- Other company-specific issues?

Shorter reporting periods are likely to be more useful to the person directly responsible for the indicator results, but they require greater effort than longer ones. Those involved in day-to-day management may want to measure monthly, or even more frequently, especially during the initial stages of eco-efficiency monitoring. Users who are more removed from day-to-day management will probably find quarterly or yearly reporting adequate.

Materiality

Ideally, all energy, material (for the waste indicator) and water streams should be included in the indicator calculations. In some instances, however, the effort of obtaining all the necessary information may not justify the benefits to the company.

In deciding whether to include or omit a particular item of information, you must judge its "materiality." Materiality depends on each company's particular circumstances and should generally be determined in relation to an item's significance to users of the information. An item of information (or an aggregate of items) should be considered to be material if it is probable that its omission or misstatement would influence or change a decision.[9] In other words, you need to ask whether the substance or energy source in question would make a substantial difference to the nature, costs and/or environmental impact of your operations.

If you judge something to be "material" to your operations, you should include it in the indicators. You should also ensure that you document and report the decisions about what was excluded from the indicator calculations and the reasons for these decisions.

Selection of denominator

The main purpose of these indicators is to evaluate the energy and material productivity of companies over time. This productivity is a surrogate for environmental performance. To facilitate comparisons over time (or across different facilities or companies), it is desirable to "normalize" energy, material and water use to adjust for facility size or changes in production over time. Thus the indicators are measured as a ratio of the environmental burden (i.e., use of resources) of a company at the level of its project boundary to the amount of product or service value produced by that section of the company.

$$\frac{\textbf{Environmental burden}}{\textbf{Unit of production or service delivery}}$$

You must choose the denominator that will be most useful to you. Possibilities for denominators include:

- tonnes of product;
- units of product produced or shipped;
- dollars of sales;
- megawatt hours; or
- square metres of floor space.

The choice of denominator will depend in part on the type of business being operated. Most manufacturing companies that have tested these indicators have found tonnes of product to be the most useful denominator. You should include in the denominator the quantity (in the appropriate units) of only your customarily desired products. This means that by-products or wastes generated by the process that are sold or for which income is received should not be included unless they are customarily desired in the process. However, two or more products may come from a company facility or manufacturing process. These are considered co-products and should be included in the denominator only if they are intended products (i.e., your company is in the business of making them) and not wastes (which are disposed of or sold or given away to prevent their release to the environment).

Service industries such as research laboratories may find it more meaningful to use measures such as area of floor space or number of employees or customers served as the denominator.

In order to calculate any of the indicators, the appropriate units for the denominator must be selected. The number of units in the denominator must then be calculated over the chosen reporting period (e.g., tonnes of product produced this quarter, dollars of sales in the last year).

***Cautionary note*:** Although the data are usually readily available, choosing a financial denominator leads to issues of comparability over time. Financial denominators are affected by price shifts in commodities, recessions, etc.

Example project decisions

The following decision matrix outlines some suggestions for audiences and reporting periods for each of the potential project boundaries. Each "X" is a possible application of the indicator. A combination of audience, reporting period and project boundary that is not suggested in the table could also be used.

Example 1: Corporate reporting

As Vice-President, Environment, for your company, you wish to use these indicators as measures of your company's eco-efficiency when reporting to the public, your shareholders and analysts in your corporate environmental report. Appropriate choices may be:

Project boundary — entire corporation

Reporting period — the one-year period since your previous corporate environmental report

Denominator — the total production of your company in appropriate units (e.g., tonnes, dollars, widgets)

Figure 3.2 **Decision matrix**

	Project boundary				
	Corporate	Business unit	Product line	Facility(ies)	Unit process
Audience					
Facility managers		x	x	x	x
Corporate managers	x	x	x	x	
Employees, customers, financiers, regulators	x				
Reporting period					
Weekly or more often				x	x
Monthly			x	x	x
Quarterly		x	x	x	x
Annually	x	x	x	x	x

Example 2: Tools for facility managers

As a facility manager within your corporation, you have direct control and responsibility for production within your facility. You are looking for tools to track your performance that may give you ideas for how to make your process more efficient, whether in its use of energy, water or other materials. Appropriate choices may be:

Project boundary — the entire facility or site for which you are responsible

Reporting period — a reporting period that is most meaningful for you; depending on your billing information and how often you want to see the results of your indicators, you could use a monthly, quarterly or annual reporting period

Denominator — the unit of production most appropriate to your business (e.g., tonnes of product, number of vehicles, theoretical litres of food packed, dollars of sales)

Data quality and accuracy

Successful monitoring of eco-efficiency depends on the availability and quality of the data used. Data needed to calculate indicators were generally readily available within the companies that participated in the NRTEE indicator program and were judged by the companies to be quite accurate. For complementary indicators that address life-cycle steps outside the responsibility of the company, data were frequently less accurate and available and often required estimation.

For the energy intensity indicators, companies found that data at the site and facility level were generally available; however, metering was often insufficient for allocating energy consumption to processes within a facility. Companies estimated the accuracy of their indicator values to be generally within ± 10% or better because the values were derived from metered data used for billing purposes.

For the waste intensity indicators, companies found that data at the site and facility level were generally available; however, once again, information was generally insufficient for allocating waste quantities to products at a facility. Companies estimated the accuracy of their indicator values to be generally within ± 10% because waste disposal costs merit the careful monitoring of wastes, and releases to the environment have to be reported to regulators.

For the water intensity indicators, data availability and accuracy were found to be generally high (accuracy exceeded ± 10%) because metering is in place for billing and regulatory purposes.

The accuracy of the three indicators was generally found to be sufficient for tracking performance from one reporting period to another.

Successful monitoring of eco-efficiency depends on the availability and quality of the data used.

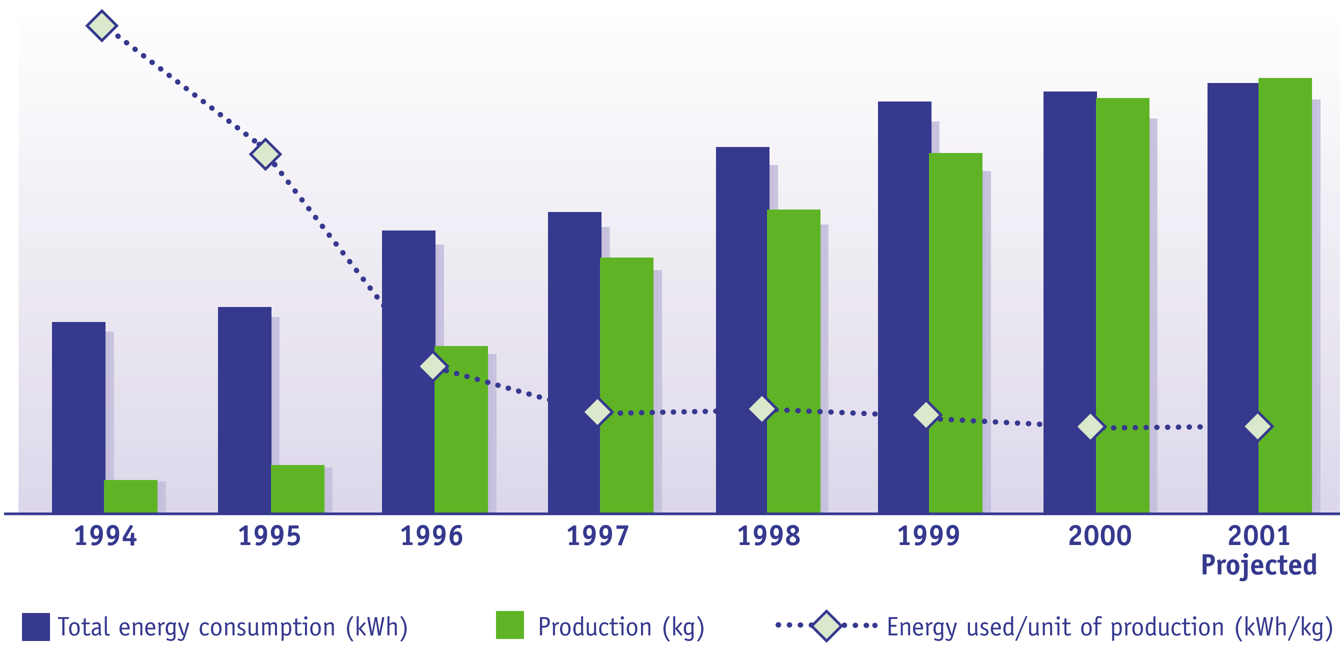
Communicating indicator results

When presenting the indicators to a target audience, it is important to provide the context for the indicators — the reporting period selected, the project boundary chosen, the denominator used and the reasons for these choices. It is also useful to show trends in the indicators over time.

The following chart depicts energy intensity over time for a food production facility. Note that the value of the energy intensity indicator has decreased over time while both the quantity of production and energy consumption have increased. Energy use per unit of production has decreased, indicating an improvement in energy intensity.

It may be impossible for companies to comply completely with all of the decision rules for the indicators in this workbook. In this situation, you should include explanatory notes, outlining the deviation from the decision rules or definitions and the reason for the deviation, in indicator reports, both internal and external.

Figure 3.3 **Energy intensity over time for a food plant**



4 Energy intensity indicator

Many companies routinely measure and track energy intensity indicators at both the facility and corporate levels. During the NRTEE indicator program, a core energy intensity indicator was developed. This section defines the core energy intensity indicator. Worksheets to help you calculate the value of the indicator as it applies to your company are provided in Chapter 7.

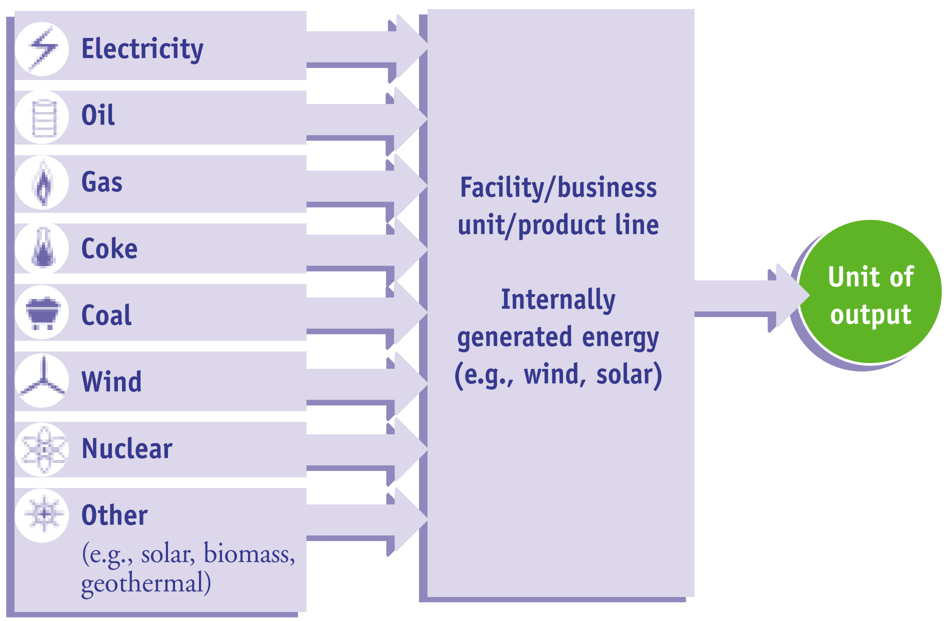
A set of complementary energy intensity indicators that provide a perspective on additional stages in a product or service life-cycle were outlined during the NRTEE indicator program and are included in Chapter 8 (Complementary indicators). These complementary indicators (life-cycle energy, net energy, transportation energy of materials and transportation energy of personnel) were chosen from the defined suite of complementary indicators because they were tested by at least one of the companies that participated in the program and because their calculation is relatively straightforward. While detailed instructions for calculating the complementary indicators are not provided in this workbook, Chapter 8 provides some advice for companies that wish to undertake their calculation. Chapter 9 provides examples of how two companies have calculated the energy intensity indicator.

Core energy intensity indicator

The core energy intensity indicator (see schematic below) measures all the direct and indirect fuels used to produce the product(s) or deliver the service(s) per unit of production or service delivery.

$$\text{Core energy intensity} = \frac{\text{Energy consumed within the project boundary from all sources}}{\text{Unit of production or service delivery}}$$

Figure 4.1 **Schematic of core energy intensity indicator**



Possible sources for the information include billing information from your company's purchasing department and direct meter readings from your facilities or other sources.

The core energy intensity indicator is measured in megajoules and includes electricity as well as energy derived from fuels such as gas, oil, coal, coke and other sources.

The core energy intensity indicator includes all of the following energies that are applicable:

- ***Fossil energy*** — energy derived from any fossil source of carbonaceous material, including oil, coal and natural gas.
- ***Non-fossil energy*** — energy derived from any non-fossil source, including hydroelectric, geothermal, nuclear, wood and others.
- ***Process energy*** — energy (electric and non-electric) required to operate process equipment.
- ***Inherent energy*** — the fuel content or energy value of materials. Materials used in the manufacturing process may have significant energy value. One example is nickel sulphide ore. Both the nickel and the sulphide in the ore release significant quantities of energy when they are oxidized. The energy value (heat of combustion) of the nickel sulphide should be included in the calculation of energy intensity.
- ***Transportation energy*** — the energy required to transport materials, energy or personnel within the project boundary.
- ***Energy generated*** — any energy generated from renewable sources (e.g., wind, solar, hydro) within the project boundary used to produce the product or service.

Calculating the core energy intensity indicator

Gathering data

You will need to gather data for each of the energy sources that enters your project boundary over the chosen reporting period. Energy entering the boundary could include electricity, coal, oil, coke, natural gas, gasoline and others. Chapter 7, Table 7.1, lists possible fuel sources that may be entering your project boundary. Steps 1 to 6 below each refer to columns in Chapter 7, Table 7.1.

Step 1: Check off each fuel source that is applicable to your project boundary in **Column A**.

Step 2: Collect the data for each of the energy sources that you have checked off in Column A. Possible sources for the information include billing information from your company's purchasing department and direct meter readings from your facilities or other sources. Make sure that the data you collect are applicable to your reporting period (i.e., make sure that you have data that are valid from January to December if you are reporting annually by those months, or make adjustments to your gas bills if they are billed from the 15th of the month to the 15th of the following month if you wish to measure your indicator from the beginning to end of the month). Enter the numerical value of each of the energy sources coming into your boundary in **Column B**.

Step 3: Clearly indicate in **Column C** the units in which the numerical value of your energy sources is being reported in Column B.

Calculating energy usage

Step 4: Use Chapter 7 (Conversion factors for energy sources) to find the conversion factors for converting each of your energy sources into the common unit for reporting the core energy intensity indicator (megajoules). Enter the appropriate conversion factor for each energy source into **Column D**.

(If you have information on the energy content of the specific fuels you use, use that information, rather than the information from Chapter 7 [Conversion factors for energy sources], for converting the energy to megajoules.)

Step 5: Multiply the value indicated in Column B by the conversion factor in Column D for each of your fuel sources. Place the results in **Column E**.

Step 6: Sum all of the values in Column E. Place the results in the box labelled "**Total energy**." This is the total energy entering your project boundary in megajoules.

Calculating energy intensity

As defined earlier, the core energy intensity indicator is the total energy consumed within the project boundary from all sources divided by the unit of product or service delivery.

Step 7: Enter the appropriate values as indicated below.

Core energy intensity = Total energy consumed within the project boundary from all sources / Unit of production or service delivery

= Total energy (from Chapter 7, Table 7.1) [MJ] / Denominator value [e.g., t, $, # of widgets]

= ______________ [MJ] / [ ]

Core energy intensity = ____________ [MJ/]

Special cases

1. *What if I generate my own energy on-site?*

Any electricity generated within your project boundary from renewable sources (e.g., wind, solar, hydro) must be included in your calculation of total energy (Chapter 7, Table 7.1). This total energy is the numerator of your core energy intensity indicator. If some electricity, hot water or steam is generated from fossil fuels (coal, oil or gas) *within* your project boundary, include the fuel entering your project boundary, but do not include the energy value of the electricity, hot water or steam produced in your calculation of total energy.

2. *What if one of my input materials includes a flux that contains inherent energy? Should I include the energy value of the flux as one of my fuel sources as well as the weight of the flux if I am using the "mass balance" approach to calculate the waste intensity indicator?*

If the energy value of the flux would affect the economics or environmental impact of your operations, then include the energy value of the flux in the calculation of the energy intensity indicator. Use your judgement about your business and your definition of materiality when deciding whether the energy value of the flux should be included. Include an explanatory note if you have not included the flux and provide the rationale for exclusion.

If the weight of the flux is greater than 1% of the weight of co-products, then you should include it in your calculation of the waste intensity indicator if you are using the "mass balance" approach (see Chapter 5).

5 Waste intensity indicator

Many companies routinely measure and track the wastes from their processes (emissions to air, water and soil) and are interested in continuously reducing their material inefficiencies, both to save costs and to reduce their environmental impact. A core waste intensity indicator was developed during the NRTEE indicator program and is defined in this section. Also provided are instructions to help you calculate the value of the core waste intensity indicator as it applies to your company.

A complementary waste intensity indicator, the waste utilization indicator, was also developed during the NRTEE program. This workbook does not provide detailed instructions for calculating the waste utilization indicator. However, Chapter 8 (Complementary indicators) includes some advice for companies that wish to undertake this calculation. The waste utilization indicator provides an opportunity to track the effectiveness of efforts to find uses for waste streams. Chapter 9 (Working examples) of this workbook includes examples of how two companies have calculated the waste intensity indicator.

Core waste intensity indicator

The core waste intensity indicator is considered essential for companies reporting waste intensity. The indicator measures the total material entering the product boundary minus material that ends up in the product and co-product per unit of production or service delivery. It can be defined as follows:

$$\text{Core waste intensity} = \frac{\text{Total material (direct + indirect) entering the project boundary} - \text{material that ends up in the product and co-product}}{\text{Unit of production or service delivery}}$$

A *waste* is any output that is disposed of, released to the environment or not considered to be "intended product from a manufacturing process." This definition provides the distinction between a co-product and a waste.

The core waste intensity indicator includes all materials relevant to the product and/or process. "Relevant" materials include all those that make up more than 1% by mass of the products and co-products leaving the manufacturing site. They include all raw materials, packaging associated with inputs and all products and releases to the environment, excluding water. Materials may be in solid, liquid or gaseous form. Of these, materials with a cumulative mass contribution of at least 90% of the total weight of products or co-products are to be included.

Fuel is also included as a material. The quantity of fuel reported in kilograms is included in the calculation of the core waste intensity indicator. Water, however, is not included in the core waste intensity indicator.

Wastes associated with capital investments within the project boundary are not included in the waste intensity indicator because they confound the routine tracking of waste intensity.

Waste includes not only waste that ends up in a dumpster or is sold to reusers or recyclers, but also substances discharged into water and air if their amount is "material." Some companies choose not to include releases to air and water in waste intensity. In these cases, releases to air and water may represent an insignificant fraction of the total waste (< 10%) and/or these releases may be tracked and reported separately. If you choose not to include releases to air and water, you should include an explanation of why not when communicating your indicator results.

Calculating the core waste intensity indicator

You should calculate the waste intensity indicator in a manner that is most useful to your operations. You should explain what you have included in the indicator, and why, in the explanatory notes accompanying the indicator report.

There are two ways to calculate the core waste intensity indicator:

- the mass balance approach; and
- the waste output approach.

For companies whose manufacturing processes are based largely on chemical reactions (e.g., chemical and plastics manufacturers) or have few input materials, the mass balance approach is relatively straightforward. For companies with a relatively large number of input materials (e.g., food and automobile makers), the waste output approach may be more practical.

The mass balance approach

You will need to gather data regarding what materials enter and leave your project boundary over the chosen reporting period. Steps 1 to 12 below refer to columns in Chapter 7, Table 7.2.

Materials taken in

Step 1: List all the direct and indirect materials that enter your project boundary in **Column A**. Material inputs include materials directly incorporated in the product and co-product and indirect materials used in the manufacturing process. Examples of indirect materials include but are not limited to pump lubricants and non-aqueous fluids such as air and solvents.

Step 2: Collect the data for each of the material inputs listed in Column A. It is most likely that the best source of information on what enters your project boundary is your purchasing department. Invoices for all of the material that you are paying for will show you how much material enters the boundary. Make sure that the data you collect are applicable to your reporting period. Enter the numerical value of each of the quantities of materials entering your project boundary in **Column B**.

Step 3: Clearly indicate in **Column C** the units in which the numerical value of your material inputs is being reported in Column B.

Step 4: You now need to convert each of the material inputs into a common unit of measurement (kilograms). Enter an appropriate conversion factor for each material in Column A into **Column D**.

Step 5: Multiply the value indicated in Column B by the conversion factor in Column D for each of your materials. Place the results in **Column E**.

Step 6: Sum all of the kilograms of inputs into one number representing the kilograms of total material (direct + indirect) that enters your project boundary. Place the results in the box labelled "**Total material taken in**."

Materials leaving as product or co-product

You must now calculate the amount of material that leaves your project boundary as product or co-product for the reporting period that you have chosen. Co-products are two or more products coming from the same manufacturing process. A co-product must be a "customarily desired product" of your manufacturing process. You must be in the business of making this co-product rather than simply selling a by-product of your process. Any output that is disposed of, released to the environment or not an intended product from a manufacturing process is not to be considered as a product or co-product.

Step 7: List all of the products and co-products that leave your project boundary in **Column A**.

Co-products are two or more products coming from the same manufacturing process. A co-product must be a "customarily desired product" of your manufacturing process.

Step 8: Collect the data for each of the products and co-products that you have listed in Column A over your reporting period. Enter the numerical value of each of the quantities of products and co-products leaving your project boundary in **Column B**.

Step 9: Clearly indicate in **Column C** the units in which the numerical value of your products and co-products is being reported in Column B.

Step 10: You will now need to convert each of the product and co-product quantities into a common unit of measurement (kilograms). Enter an appropriate conversion factor for each product and co-product in Column A into **Column D**.

Step 11: Multiply the value indicated in Column B by the conversion factor in Column D for each of your products and co-products. Place the results in **Column E**.

Step 12: Sum all of the kilograms of products and co-products into one number representing the kilograms of total product plus co-product that leave your project boundary. Place the results in the box labelled "**Total amount of product and co-product**."

Calculating core waste intensity (mass balance approach)

As defined earlier, the core waste intensity indicator is the total material (direct + indirect) entering the project boundary minus the material that ends up in the product and co-product per unit of production or service delivery.

Step 13: Calculate your waste intensity using the calculation below.

$$\text{Core waste intensity} = \frac{\text{Total material entering the project boundary} - \text{material in the product and co-product}}{\text{Unit of production or service delivery}}$$

$$= \frac{\text{Total material taken in (Step 6)} - \text{total amount of product and co-product (Step 12) [kg]}}{\text{Denominator value [e.g., t, \$, \# of widgets]}}$$

$$= \frac{\_\_\_\_\_\_\_\_\ \text{[kg]}}{[\quad\quad]}$$

Core waste intensity = ________ [kg/   ]

The waste output approach

Many companies have far too many materials entering their project boundary to calculate the core waste intensity indicator using the mass balance approach. However, most companies measure and track waste production very closely. If your company tracks and monitors waste and you have too many material inputs to use the mass balance approach, then the waste output approach may be the easiest way to calculate your waste intensity indicator. Steps 1 to 6 below refer to columns in Chapter 7, Table 7.3.

Waste leaving the project boundary

Step 1: List all of the types of wastes that leave your project boundary in **Column A**. It is important to note that waste generated includes not only waste that can be put in a trash bin, but also salvageable wastes that you sell or give to reusers and recyclers. Wastes also include discharges to water and air, if they are material to your operations.

Step 2: Collect the data for each of the wastes that you have listed in Column A. Make sure that the data you collect are applicable to your reporting period. Enter the numerical value of each of the wastes leaving your project boundary in **Column B**.

If the quantities are significant, it is likely that your company must report its emissions to air and water under Canada's National Pollutant Release Inventory (NPRI). The NPRI guidelines contain significant instructions for calculating those emissions, and this workbook does not duplicate that work. If your emissions to air are material to your process, we recommend that you use the NPRI instructions at *http://www.ec.gc.ca/pdb/npri/* to calculate your emissions. The same methodology may be applicable to substances not included in the NPRI. Place the numerical value of these emissions in **Column B**.

Step 3: Clearly indicate in **Column C** the units in which your waste outputs are being reported in Column B.

Step 4: You will now need to convert each of the quantities of wastes into a common unit of measurement (kilograms). Enter an appropriate conversion factor for each material in Column A in **Column D**.

Step 5: Multiply the value indicated in Column B by the conversion factor in Column D for each of your wastes. Place the results in **Column E**.

Step 6: Sum all of the kilograms of wastes into one number representing the kilograms of total waste that leave your project boundary. Place the results in the box labelled "**Total wastes generated**."

Calculating core waste intensity (waste output approach)

As defined earlier, the core waste intensity indicator measures the total material entering the product boundary minus material that ends up in the product and co-product per unit of production or service delivery. Using the waste output approach, this is equivalent to the total waste leaving the project boundary per unit of production or service delivery.

Step 7: Calculate your core waste intensity using the calculation below.

Core waste intensity = Total waste leaving the project boundary / Unit of production or service delivery

= Total wastes generated (Chapter 7, Table 7.3) [kg] / Denominator value [e.g., t, $, # of widgets]

= ________ [kg] / [ ]

Core waste intensity = ________ [kg/]

Special cases

1. *What if the waste produced within the project boundary does not leave the project boundary because I dispose of some wastes in a landfill within my project boundary?*

Using the mass balance approach, the waste disposed of in the on-site landfill would be included (i.e., it is in the materials included in the calculation of the difference between the weight of raw materials entering the project boundary and the weight of materials leaving in the co-products). If you use the waste output approach, you should include any wastes being managed within your project boundary in the numerator.

2. *What if water is an integral component of either my input materials or my co-products, making it difficult to report weights of materials on a dry basis?*

If it is not practical for you to report material weights on a dry basis, do your calculations including water or moisture and include an explanatory note with your indicator report indicating that you have not followed the decision rule and explaining why not. The important thing is that the indicator numbers are helpful to your company in reporting and monitoring progress over time.

Another option would be to select a physical denominator other than weight for your calculations. For example, in the forest sector, one company used “thousands of square feet of 1/16 inch thickness panel” as the denominator.

3. *What if the waste coffee grounds from my process are burned to produce energy within my project boundary?*

In this case, the weight of the waste coffee grounds would be included in the waste intensity indicator. However, you could also choose to report the complementary waste intensity indicator, outlined in Chapter 8, in addition to the waste intensity indicator. The weight of waste coffee grounds would then be included in the numerator and would be counted as part of the waste that is utilized.

4. *What if a major expansion takes place while the waste indicator is being tracked and I cannot accurately separate the waste due to the expansion from that due to routine facility operations?*

This issue can be addressed by including the weight of the construction waste in the indicator. You should provide an explanatory note indicating that the waste intensity indicator for the relevant reporting period does not reflect normal operations.

5. *What if I sell used packaging to a packaging recycler? Is the packaging included as part of my waste?*

If the revenue from the used packaging is not a critical factor in your business, the used packaging is considered a waste. It would be considered as “waste utilized” in the complementary waste utilization indicator. It would not be considered a co-product in the indicator denominator.

6. *What if the fly ash produced from coal-fired electricity generation is used in cement or concrete production?*

Since the fly ash is not an intended product of electricity generation, it is considered a waste and should be included in the numerator of the waste intensity indicator. The quantity of fly ash used would be included as “waste utilized” in the complementary waste utilization indicator.

6 Water intensity indicator

Water use is an increasing concern for companies, both from availability and quality perspectives. As a result, water intensity has been identified as an important subset of material intensity for companies.

A core water intensity indicator was developed during the testing program. Worksheets for its calculation are included in Chapter 7. The water intensity indicators are reported in cubic metres of water used per unit of production or service delivery.

A complementary water intensity indicator, water discharge, was also developed during the NRTEE indicator program. This workbook does not provide detailed instructions for calculating the water discharge indicator. However, Chapter 8 (Complementary indicators) includes some advice for companies that wish to undertake its calculation. Chapter 9 (Working examples) provides examples of how two companies have calculated the water intensity indicator.

Core water intensity indicator

The core water intensity indicator can be used to measure, track and report water usage in companies for which water represents an important material. The core water intensity indicator represents the amount of water taken into the project boundary per unit of product or service delivery and can be defined as:

$$\text{Core water intensity} = \frac{\text{Water taken in}}{\text{Unit of production or service delivery}}$$

Water taken in includes most water taken into the project boundary, including water taken from water bodies, wells and the municipal supply. It excludes water taken in with raw materials (e.g., wet lumber) and rainwater or snow (unless it is specifically collected for use within the project boundary).

Calculating the core water intensity indicator

You will need to gather data for each of the water sources that enters your project boundary over the chosen reporting period. Steps 1 to 6 below refer to columns in Chapter 7, Table 7.4.

Step 1: Check off each water source that is applicable to your project boundary in **Column A**.

Gathering data

Step 2: Collect the data for each of the water sources that you have checked off in Column A. It is most likely that, due to regulations and permitting requirements, the water that enters your project boundary is accurately metered. Make sure that the data you collect are applicable to the reporting period that you have chosen. Enter the numerical value of each of the water sources coming into your boundary in **Column B**.

Step 3: Clearly indicate in **Column C** the units in which the numerical value of your water sources is being reported in Column B.

Calculating water usage

Step 4: If the information on the water entering your boundary is not in units of cubic metres, enter a conversion factor to convert the quantities of water to cubic metres for each water source in **Column D**.

Step 5 (if applicable): Multiply the value indicated in Column B by the conversion factor in Column D for each of your water sources. Place the results in **Column E**.

Step 6: Sum the values in Column E. Place the results in the box labelled "**Total water taken in**." This is the total water taken into your project boundary in cubic metres.

Calculating water intensity

As defined earlier, the core water intensity indicator is the amount of water taken into the project boundary per unit of product or service delivery.

Step 7: Calculate your core water intensity indicator using the calculation below:

$$\text{Core water intensity} = \frac{\text{Total water taken in}}{\text{Unit of production or service delivery}}$$

$$= \frac{\text{Total water taken in (Chapter 7, Table 7.4) } [m^3]}{\text{Denominator value [e.g., t, \$, \# of widgets]}}$$

$$= \frac{\_\_\_\_\_\_\_\_ [m^3]}{[\quad\quad]}$$

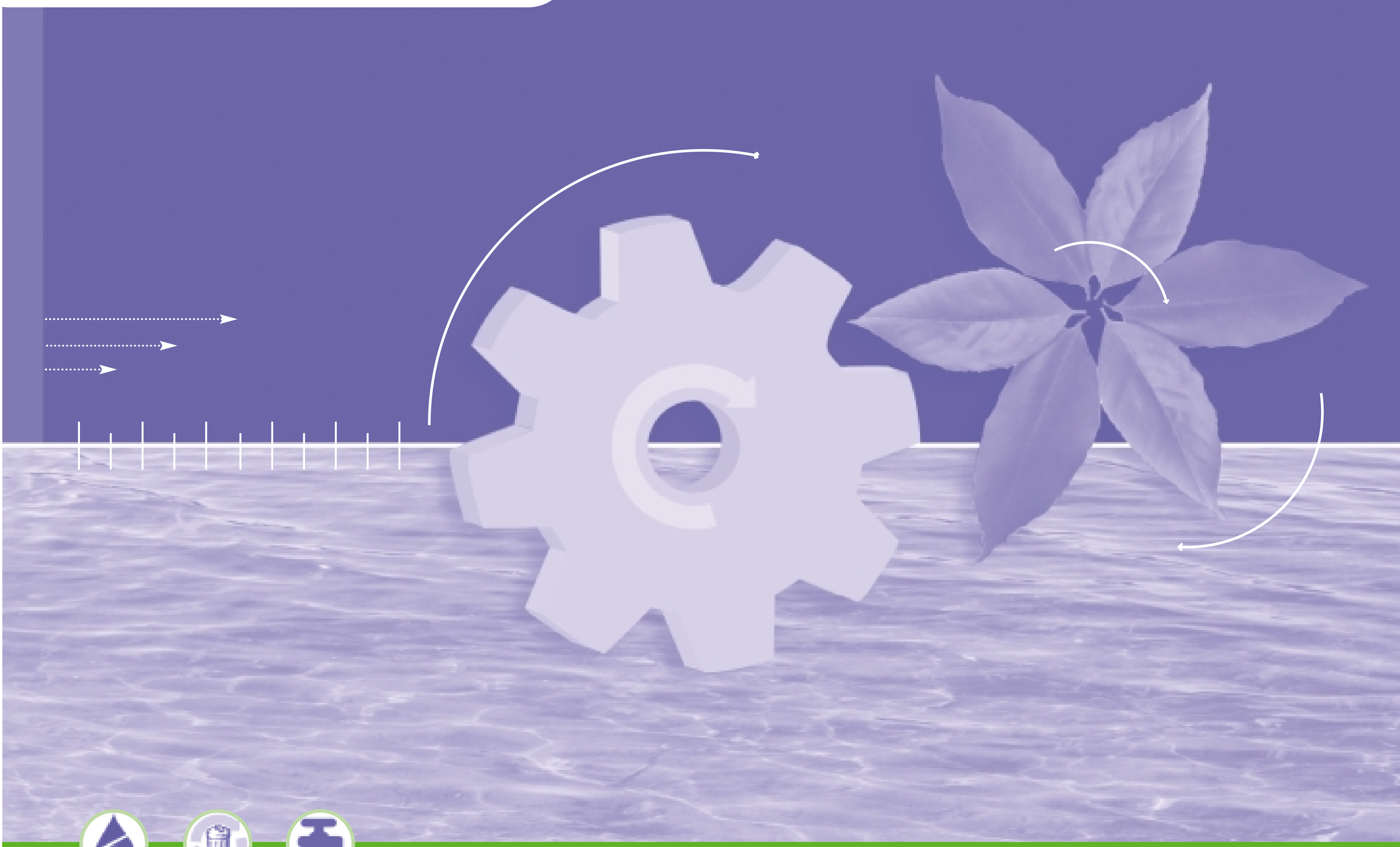
Core water intensity = ___________ [m³/]

Special cases

1. *What if I collect rainwater within the project boundary and use it as a source of cooling water in the manufacturing process?*

The quantity of rainwater collected should be measured and included in the calculation of water taken in. An explanatory note should be included with your indicator showing that rainwater is included in your calculation.

Chapter 7 *Resources and Tables*



Conversion factors for energy sources[10]

Fuel type	Natural unit	Conversion factor (MJ)
Petroleum products		
Heavy fuel oil	litres	41.73
Light fuel oil	litres	38.68
Diesel	litres	38.68
Kerosene	litres	37.68
Gasoline	litres	34.66
Petroleum coke	litres	42.38
Natural gas		
Natural gas	cubic metres	37.78
Propane	litres	25.53
Butane	litres	28.62
Coal		
Anthracite	kilograms	27.70
Imported bituminous	kilograms	29.00
Canadian bituminous		
Newfoundland	kilograms	28.50
P.E.I.	kilograms	28.50
Nova Scotia	kilograms	28.50
New Brunswick	kilograms	27.00
Quebec	kilograms	28.50
Ontario	kilograms	30.40
Manitoba	kilograms	30.40
Saskatchewan	kilograms	30.40
Alberta	kilograms	30.40
British Columbia	kilograms	30.50
Yukon & N.W.T.	kilograms	30.40
Sub-bituminous	kilograms	18.30
Lignite	kilograms	15.00
Coke	kilograms	28.83
Biomass		
Wood	kilograms	18.00
Hog fuel	kilograms	18.00
Black liquor	kilograms	14.00
Electricity	**kilowatt hours**	**3.60**

Table 7.1: Energy intensity indicator

	A	B	C		D	E	
Energy source	**Applicable to me?**	**Numerical value over reporting period**	**Units**	**Multiply**	**Conversion factor (to convert to MJ)**	**Converted value over reporting period**	**Units**
Electricity							
Electricity				x			MJ
Petroleum products							
Heavy fuel oil				x			MJ
Light fuel oil				x			MJ
Diesel				x			MJ
Kerosene				x			MJ
Gasoline				x			MJ
Petroleum coke				x			MJ
Other				x			MJ
Natural Gas							
Natural gas				x			MJ
Propane				x			MJ
Butane				x			MJ
Other				x			MJ
Coal							
Anthracite				x			MJ
Bituminous/sub.				x			MJ
Lignite				x			MJ
Coke				x			MJ
Other				x			MJ
Biomass							
Wood				x			MJ
Hog fuel				x			MJ
Black liquor				x			MJ
Other				x			MJ
Other							
Steam				x			MJ
Hot water				x			MJ
Inherent energy				x			MJ
Other				x			MJ
Total energy							
					Total energy =		MJ

Table 7.2: Waste intensity indicator (mass balance approach)

A	B	C		D	E	
Materials used	Numerical value over reporting period	Units	Multiply	Conversion factor (to convert to kg)	Converted value over reporting period	Units
Raw materials						
			x x x			kg kg kg
Packaging						
			x x x			kg kg kg
Office supplies						
			x x x			kg kg kg
Indirect materials						
			x x x x			kg kg kg kg
Total material taken in						
				Total material taken in =		kg

Table 7.2: Waste intensity indicator (mass balance approach) (cont'd)

A	B	C		D	E	
Amount of product and co-product	Numerical value over reporting period	Units	Multiply	Conversion factor (to convert to kg)	Converted value over reporting period	Units
Product						
			x x x x			kg kg kg kg
Co-product						
			x x x x x x x x			kg kg kg kg kg kg kg kg
Total amount of product and co-product						
				Total amount of product and co-product =		kg

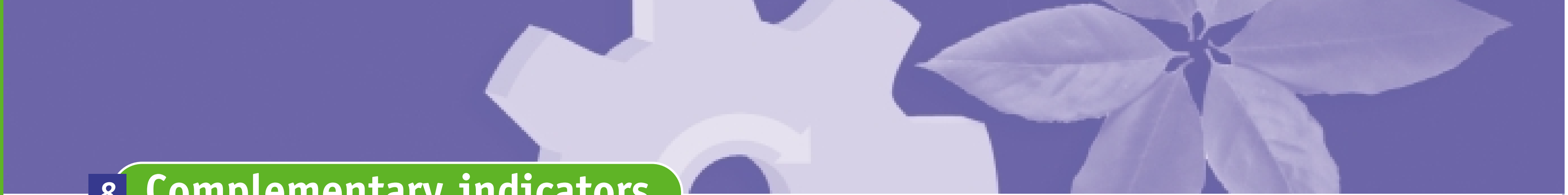
Table 7.3: Waste intensity indicator (waste output approach)

A	B	C		D	E		F	G	
Wastes generated	Numerical value over reporting period	Units	Multiply	Conversion factor (to convert to kg)	Converted value over reporting period	Units	Waste used?	Quantity	Units
Waste end points									
Landfill			x			kg			kg
Incineration			x			kg			kg
Recycling			x			kg			kg
Reuse			x			kg			kg
On-site composting			x			kg			kg
On-site energy generation			x			kg			kg
Hazardous waste disposal			x			kg			Kg
Air			x			kg			kg
			x			kg			kg
			x			kg			kg
			x			kg			kg
			x			kg			kg
Water			x			kg			kg
			x			kg			kg
			x			kg			kg
			x			kg			kg
			x			kg			kg
Others			x			kg			kg
			x			kg			kg
Total wastes generated									
				Total wastes generated =		kg	Total wastes used =		kg

Table 7.4: Water intensity indicator

	A	B	C		D	E	
Water source	**Applicable to me?**	**Numerical value over reporting period**	**Units**	**Multiply**	**Conversion factor (to convert to m^3 if necessary)**	**Converted value over reporting period (if necessary)**	**Units**
Water body(ies)				x			m^3
Wells				x			m^3
Municipal supply				x			m^3
Other				x			m^3
Total water taken in							
					Total water taken in =		m^3

Chapter 8 *Complementary Indicators*



8 Complementary indicators

Several complementary indicators were developed during the testing program to accompany the core indicators. These indicators, when communicated in conjunction with the core indicators, often give a more complete picture of a company's energy, waste or water intensity. They can also be used as additional tools to help a company reduce its environmental burden and costs per unit of production or service delivery. This workbook does not provide detailed instructions for calculation of the complementary indicators. General guidance is provided below.

Complementary energy intensity indicators

The complementary indicators (life-cycle energy, excess energy, transportation energy of materials, and transportation energy of personnel) were chosen from the suite of complementary indicators defined because (a) they were tested by at least one of the companies that participated in the NRTEE indicator program and (b) their calculation is relatively straightforward.

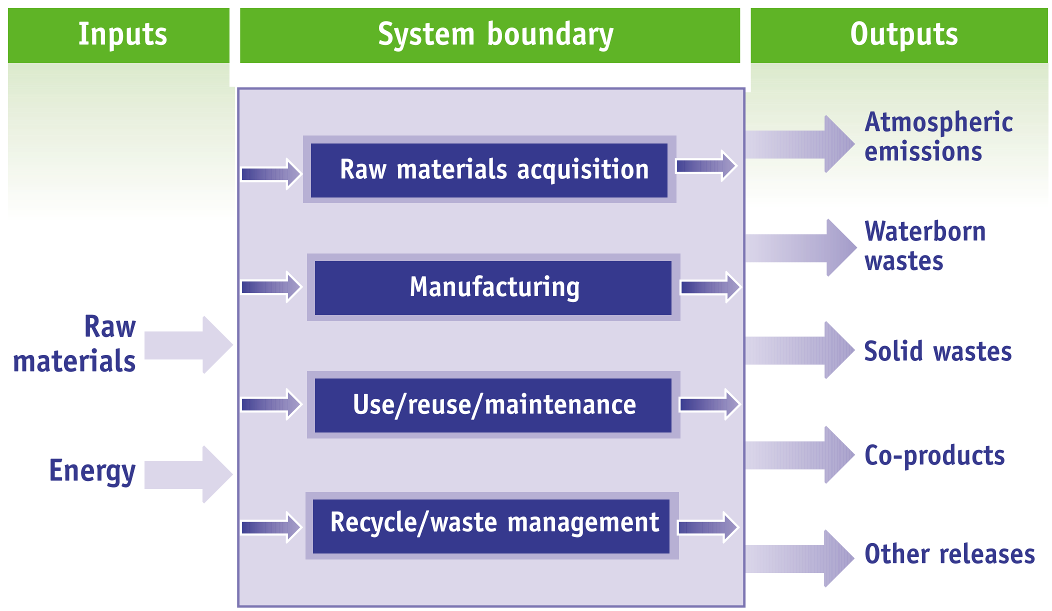
Life-cycle energy intensity indicator

"Life-cycle" refers to the consecutive and inter-linked stages of a product system, from raw material acquisition or generation of natural resources to final disposal.

The life-cycle energy intensity indicator is the sum of the energy consumed during all of the phases of the product or service life-cycle, from the extraction and processing of input materials and energy, through to the eventual disposal of the product.

It may be easiest when calculating your life-cycle indicator to limit the calculation to including one life-cycle step upstream and one downstream of the project boundary.

Figure 8.1 **Life-cycle stages**[11]



Data beyond one step up and one step down are often difficult to obtain, are generally estimated and have high uncertainties.

Different industry sectors may have different decision rules around the steps to be included in this indicator. Some industries may find it useful to look only at upstream energies while some may only be interested in downstream energies.

Calculating the life-cycle energy intensity indicator

Step 1: Clearly define the number of upstream and downstream life-cycle steps that you wish to include in the life-cycle energy indicator. Issues to consider include:

- How easily accessible are data for upstream and downstream steps in my process?
- What is the quality of the upstream and downstream data?
- Are downstream steps more relevant to my industry sector than upstream steps? Or vice versa?
- How many upstream and downstream steps do I have the resources to address?

Step 2: Using Chapter 7, Table 7.1, calculate the total energy consumed within each life-cycle step being considered (e.g., if you are considering three life-cycle steps, you must use Chapter 7, Table 7.1, three separate times, calculating the total energy consumed for each individual step).

Step 3: Sum each of the total energies calculated in Step 2 and divide by your denominator value.

Excess energy intensity indicator

The excess energy intensity indicator measures the excess energy generated within a product or service entity that is not used within the facility but is used by or sold to others. The excess energy indicator applies to companies that produce energy as a co-product.

This complementary indicator reported together with the core energy intensity indicator can be used to illustrate a net energy benefit for a company.

Life-cycle energy intensity = Total energy (life-cycle step 1 + 2 + 3... life-cycle step n) / Denominator value [e.g., t, $, # of widgets]

= ______ [MJ] / [   ]

Life-cycle energy intensity = ______ [MJ/   ]

Calculating the excess energy intensity indicator

You will need to gather data on how much excess energy is generated within your project boundary that is either used by or sold to others.

Step 1: Collect the data for the excess energy generated within your project boundary. Possible sources for the information include direct metering (at the point where you produce the energy or at the point where you use the energy) and invoicing information to the purchasers of your excess energy.

Step 2: Indicate below the amount of excess energy generated within your project boundary. If you generate excess energy at more than one point in your process, sum all of the excess energy generated into one value. This will be the total excess energy generated within your project boundary.

Total excess energy generated = ______ [MWh]

Sources of excess energy include electricity generated (including by burning wastes), steam and hot water. You will need to use a conversion factor to determine your total excess energy generated in megawatt hours.

Step 3: Using the conversion factor below, convert the total excess energy generated within your project boundary (calculated in Step 2) into megajoules.

Total excess energy generated (MJ)	=	**Total excess energy generated [MWh] X 3600 [MJ/MWh]**
	=	**______ [MWh] X 3600 [MJ/MWh]**

Total excess energy generated	=	**______ [MJ]**

Transportation energy intensity indicator of materials

The indicator for transportation energy of materials addresses the energy needed to transport materials and/or energy between life-cycle steps per unit of service (i.e., between project boundaries; travel within the project boundary is already included in the core indicator). It should be noted that for businesses that transport either energy or materials, transportation may well be the core energy intensity indicator for that business. Examples where transportation energy is the core business include electricity transmission and distribution companies, gas pipeline companies and businesses that transport goods and services, such as trucking, bus or railway companies.

For some industries (e.g., energy and forestry), and assuming the project boundary is the corporate level, the transport of materials to and from the project boundary may represent a significant portion of total energy use.

Transportation energy intensity indicator of personnel

The indicator for transportation energy of personnel addresses the transportation energy per unit of product or service delivery for movement of personnel between life-cycle steps (i.e., between project boundaries). For example, companies that service their products may send technicians to the sites where their products are in the use phase of their life-cycle.

Transportation energy (personnel) is the energy required to transport personnel to and from the project boundary as normal business practice. This includes the travel of personnel to and from the project boundary on a daily basis and business travel.

Complementary waste intensity indicator

A complementary waste intensity indicator, the waste utilization indicator, was developed during the NRTEE extended indicator program.

Waste utilization

Most companies try to reduce the amount of waste sent to final disposal by finding uses for the materials that are “undesired” outputs of their manufacturing processes. Many of these companies track the amount of waste materials for which uses are found by measuring the amount of reused waste as a percentage of total waste as follows:

$$\text{Waste utilization} = \frac{\text{Waste utilized}}{\text{Total waste output}} \times 100$$

Calculating the waste utilization indicator

The waste utilization indicator is most easily calculated if the core waste intensity indicator is calculated using the waste output approach.

If you calculated your core waste intensity indicator using the mass balance approach, you will need to undertake Steps 1 to 6 under the waste output approach before continuing with calculating your waste utilization indicator. Steps 1 to 3 below refer to columns in Chapter 7, Table 7.3.

Gathering waste utilization data

Step 1: Using the data and information you gathered to calculate the core waste intensity indicator, determine which of your wastes are used in some way. These wastes may be reclaimed by their suppliers, recycled, sold or given away for other uses (e.g., steel slag for cement, food wastes for fertilizer). Anything that does not end up in landfill or as emissions to air or water are wastes that are used in some way and should be included. Put a check mark in **Column F** for each waste that is utilized.

Step 2: Copy the value from Column E (value of waste over the reporting period in kilograms) into **Column G** for each of the wastes that you checked in Step 1.

Step 3: Sum all of the values in Column G. Place the result in the box labelled "**Total wastes used**."

Calculating waste utilization

As defined earlier, the waste utilization indicator is the percentage of the wastes produced for which uses are found.

Step 4: Calculate your waste utilization using the calculation below.

$$\text{Waste utilization} = \frac{\text{Waste utilized}}{\text{Total waste output}} \times 100$$

$$= \frac{\text{Total wastes used (Chapter 7, Table 7.3) [kg]}}{\text{Total wastes generated (Chapter 7, Table 7.3) [kg]}} \times 100$$

$$= \frac{\_\_\_\_\_\_ \text{[kg]}}{\_\_\_\_\_\_ \text{[kg]}} \times 100$$

Waste utilization = ________[%]

Complementary water intensity indicator

A complementary water indicator, water discharge, was also developed during the NRTEE indicator program.

Water discharge intensity indicator

Water discharged per unit of production is the complementary indicator that accompanies the core water intensity indicator. The water discharge indicator is defined as:

$$\text{Water discharge intensity} = \frac{\text{Water discharged}}{\text{Unit of production or service delivery}}$$

Water consumed can be easily calculated using the core water intensity indicator and the complementary water discharge indicator.

Calculating the water discharge intensity indicator

You will need to gather data for each of the discharge points for water that leaves your project boundary over the chosen reporting period. Water discharge points include discharges to water bodies, to groundwater and to the municipal system. Water discharge points do not include water discharged as water in solid waste, as atmospheric releases such as evaporation from cooling towers and steam, or as storm water. Steps 1 to 6 below refer to columns in Table 8.1 below.

Step 1: Check off each water discharge point that is applicable to your project boundary in **Column A** of Table 8.1.

Gathering data

Step 2: Collect the data for each of the water discharge points that you have checked off in Column A. It is most likely that due to regulations and permitting requirements, the water that leaves your project boundary is accurately metered. Make sure that the data you collect are applicable to the reporting period that you have chosen. Enter the value of discharge for each of the water discharge points leaving your boundary in **Column B**.

Step 3: Clearly indicate in **Column C** the units in which your water discharges are being reported in Column B.

Calculating water discharge

Step 4: If the water discharge information that you have collected is not in units of cubic metres, enter a conversion factor to convert the quantities of water to cubic metres for each water source in **Column D**.

Step 5: Multiply the value indicated in Column B by the conversion factor in Column D for each of your water discharge points. Place the results in **Column E**.

Step 6: Sum the values in Column E. Place the results in the box labelled "**Total water discharged**." This is the total water discharged from your project boundary in cubic metres.

Calculating water discharge intensity

As defined earlier, the water discharge indicator is the amount of water discharged from the project boundary per unit of product or service delivery.

Step 7: Calculate your water discharge indicator using the calculation below:

$$\text{Water discharge intensity} = \frac{\text{Total water discharged}}{\text{Unit of production or service delivery}}$$

$$= \frac{\text{Total water discharged (Table 8.1) [m}^3\text{]}}{\text{Denominator value [e.g., t, \$, \# of widgets]}}$$

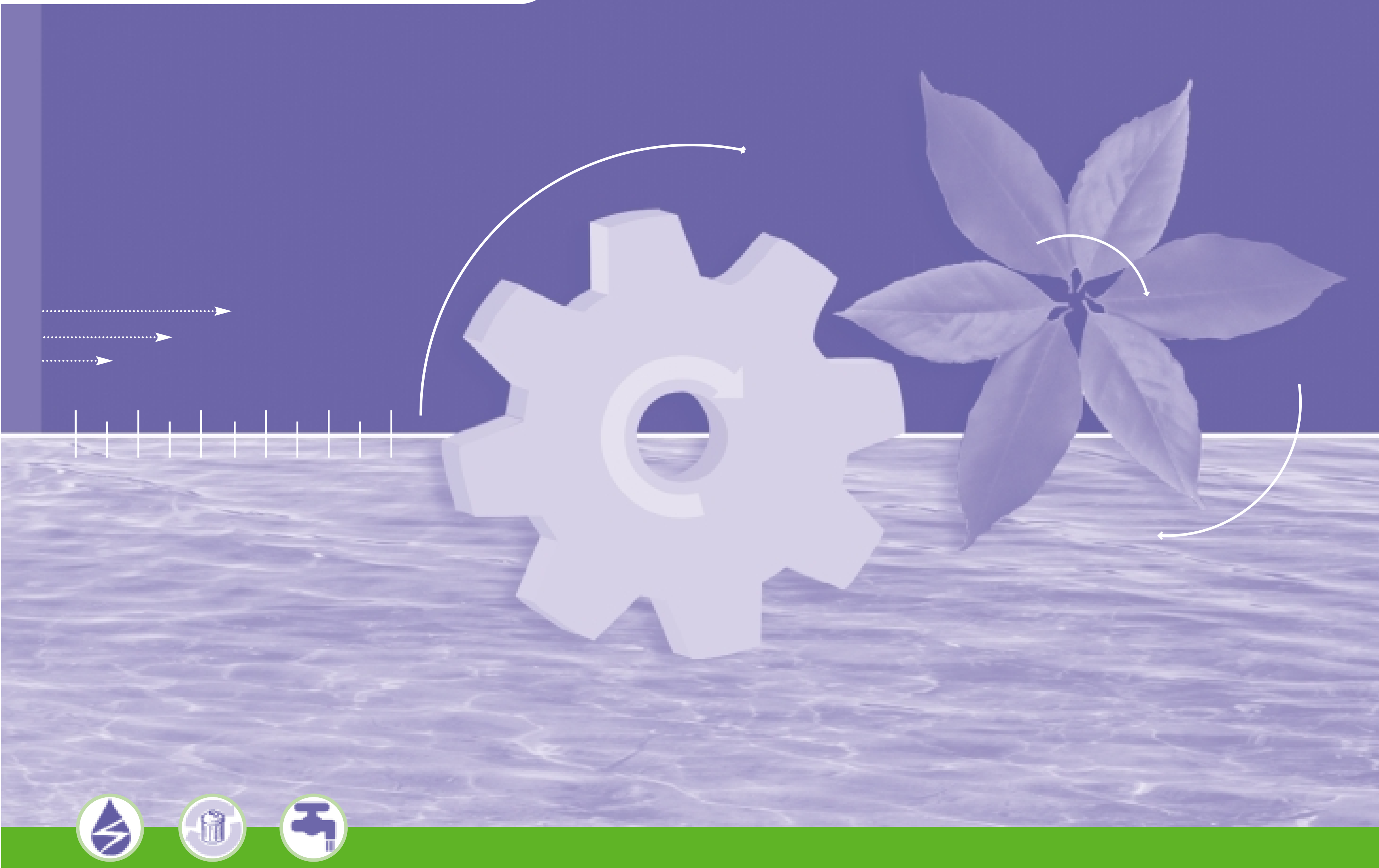
$$= \frac{\_\_\_\_\_\_\_\_\ [\text{m}^3]}{[\qquad\quad]}$$

Water discharge intensity = __________ [m³/]

Table 8.1 **Water discharge intensity indicator**

	A	B	C		D	E	
Water discharge point	**Applicable to me?**	**Numerical value over reporting period**	**Units**	**Multiply**	**Conversion factor (to convert to m^3 if necessary)**	**Converted value over reporting period (if necessary)**	**Units**
Water body(ies)				x			m^3
Ground water				x			m^3
Municipal system				x			m^3
Other				x			m^3
Total water discharged							
					Total water discharged =		m^3

Chapter 9 *Working Examples*



9 Working examples

Examples of indicator calculations from a food plant and a coal-fired electricity generation plant are provided in the sections below (Food plant, Coal-fired power plant).

Food plant

Project boundary . . . . .One facility (food plant)
Reporting period . . . . .2 months
Project denominator . . . . . . .3,400 tonnes of production

Core energy intensity indicator

	A	B	C		D	E	
Energy source	**Applicable to me?**	**Numerical value over reporting period**	**Units**	**Multiply**	**Conversion factor (to convert to MJ)**	**Converted value over reporting period**	**Units**
Electricity							
Electricity	Yes	1,700,000	kWh	x	3.6 MJ/kWh	6,120,000	MJ
Natural gas							
Natural gas	Yes	220,000	m^3	x	37.78 MJ/m^3	8,311,600	MJ
Total energy							
					Total energy =	14,431,600	MJ

$$\text{Core energy intensity} = \frac{\text{Total energy consumed within the project boundary from all sources}}{\text{Unit of production or service delivery}}$$

$$= \frac{\text{Total energy (from Chapter 7, Table 7.1) [MJ]}}{\text{Denominator value [e.g., t, \$, \# of widgets]}}$$

$$= \frac{14{,}431{,}600\ \text{[MJ]}}{3{,}400\ \text{[t]}}$$

Core energy intensity = 4,245 [MJ/t of production]

Note: The product is reported on a wet rather than dry basis because water is an integral component of the food product.

Core waste intensity indicator

A	B	C		D	E		F	G	
Wastes generated	Numerical value over reporting period	Units	Multiply	Conversion factor (to convert to kg)	Converted value over reporting period	Units	Waste used?	Quantity	Units
Wastes									
To landfill	150,000	kg	x	n/a	150,000	kg	no	0	kg
To recycling:									
Cans	25,000	kg	x	n/a	25,000	kg	yes	25,000	kg
Cardboard	48,000	kg	x	n/a	48,000	kg	yes	48,000	kg
Wood	33,500	kg	x	n/a	33,500	kg	yes	33,500	kg
Plastic	250	kg	x	n/a	250	kg	yes	250	kg
Total wastes generated									
				Total wastes generated =	256,750	kg	Total wastes used =	106,750	kg

$$\text{Core waste intensity} = \frac{\text{Total waste leaving the project boundary}}{\text{Unit of production or service delivery}}$$

$$= \frac{\text{Total wastes generated (Chapter 7, Table 7.3) [kg]}}{\text{Denominator value [e.g., t, \$, \# of widgets]}}$$

$$= \frac{256{,}750\ [\text{kg}]}{3{,}400\ [\text{t}]}$$

Core waste intensity = 75 [kg/t of production]

Waste utilization indicator

$$\text{Waste utilization} = \frac{\text{Waste utilized}}{\text{Total waste output}} \times 100$$

$$= \frac{\text{Total wastes used (Chapter 7, Table 7.3) [kg]}}{\text{Total wastes generated (Chapter 7, Table 7.3) [kg]}}$$

$$= \frac{106{,}750\ \text{[kg]}}{256{,}750\ \text{[kg]}} \times 100$$

$$\text{Waste utilization} = 41.5[\%]$$

Note: Weight is reported on a wet basis because water is an integral part of the food product and because it is difficult to estimate the waste quantities on a dry weight basis.

The weights of releases to air and water have not been included in the waste indicators because they are reported separately and because facility operators are focusing on reducing quantities of solid waste produced.

Core water intensity indicator

	A	B	C		D	E	
Water source	Applicable to me?	Numerical value over reporting period	Units	Multiply	Conversion factor (to convert to m^3 if necessary)	Converted value over reporting period (if necessary)	Units
Water body(ies)	no			x			m^3
Wells	no			x			m^3
Municipal supply	yes	900,000	ft^3	x	0.02832784 m^3/ft^3	25,495	m^3
Other	no			x			m^3
Total water taken in							
					Total water taken in =	25,495	m^3

$$\text{Core water intensity} = \frac{\text{Total water taken in}}{\text{Unit of production or service delivery}}$$

$$= \frac{\text{Total water taken in (Chapter 7, Table 7.4) } [m^3]}{\text{Denominator value [e.g., t, \$, \# of widgets]}}$$

$$= \frac{25{,}495\ [m^3]}{3{,}400\ [t]}$$

$$\text{Core water intensity} = 7.5\ [m^3/t]$$

Note: Water received as storm water on the plant site is not included in the calculation of the water indicator. This is consistent with the decision rules on calculating and reporting the water indicator.

Coal-fired power plant

Project boundary ....One facility (coal-fired power plant)
Reporting period ....12 months
Project denominator .....7,975,709 MWh of net generation

Core energy intensity indicator

	A	B	C		D	E	
Energy source	Applicable to me?	Numerical value over reporting period	Units	Multiply	Conversion factor (to convert to MJ)	Converted value over reporting period	Units
Petroleum products							
Gasoline	yes	63,099	L	x	35 MJ/L	2,187,000	MJ
Natural gas							
Natural gas	yes	693,963	GJ	x	1,000 GJ/MJ	693,963,000	MJ
Coal							
Bituminous/sub.	yes	6,270,019	t	x	18,300 MJ/t	114,906,049,000	MJ
Total energy							
					Total energy =	115,602,199,000	MJ

$$\text{Core energy intensity} = \frac{\text{Total energy consumed within the project boundary from all sources}}{\text{Unit of production or service delivery}}$$

$$= \frac{\text{Total energy (from Chapter 7, Table 7.1) [MJ]}}{\text{Denominator value [e.g., t, \$, \# of widgets]}}$$

$$= \frac{115{,}602{,}199{,}000\ [\text{MJ}]}{7{,}975{,}709\ [\text{MWh}]}$$

Core energy intensity = 14,490 [MJ/MWh]

Core waste intensity indicator

A	B	C		D	E		F	G	
Wastes generated	Numerical value over reporting period	Units	Multiply	Conversion factor (to convert to kg)	Converted value over reporting period	Units	Waste used?	Quantity	Units
Wastes									
Fly ash (sold)	101,720	t	x	1,000 kg/t	101,720,000	kg	yes	101,720,000	kg
Bottom ash (sold)	101,759	t	x	1,000 kg/t	101,759,000	kg	yes	101,759,000	kg
Fly ash (stored)	589,265	t	x	1,000 kg/t	589,265,000	kg	no		kg
Bottom ash (stored)	932,743	t	x	1,000 kg/t	932,743,000	kg	no		kg
Paper (recycled)	19	t	x	1,000 kg/t	19,000	kg	yes	19,000	kg
Material to landfill	349	t	x	1,000 kg/t	349,000	kg	no		kg
Hazardous waste disposed of	36	t	x	1,000 kg/t	36,000	kg	no		kg
Total wastes generated									
				Total wastes generated =	1,725,891,000	kg	Total wastes used =	203,498,000	kg

$$\text{Core waste intensity} = \frac{\text{Total waste leaving the project boundary}}{\text{Unit of production or service delivery}}$$

$$= \frac{\text{Total wastes generated (Chapter 7, Table 7.3) [kg]}}{\text{Denominator value [e.g., t, \$, \# of widgets]}}$$

$$= \frac{1{,}725{,}891{,}000 \text{ [kg]}}{7{,}975{,}709 \text{ [MWh]}}$$

$$\text{Core waste intensity} = 216 \text{ [kg/MWh]}$$

Waste utilization indicator

$$\text{Waste utilization} = \frac{\text{Waste utilized}}{\text{Total waste output}} \times 100$$

$$= \frac{\text{Total wastes used [kg]}}{\text{Total wastes generated [kg]}} \times 100$$

$$= \frac{203{,}498{,}000 \text{ [kg]}}{1{,}725{,}891{,}000 \text{ [kg]}} \times 100$$

Waste utilization = 12 [%]

Core water intensity indicator

	A	B	C		D	E	
	Applicable to me?	Numerical Value over reporting period	Units	Multiply	Conversion factor (to convert to m^3 if necessary)	Converted value over reporting period (if necessary)	Units
Water source							
Lake	yes	218,208,962	m^3	x	n/a	218,208,962	m^3
River	yes	17,677,752	m^3	x	n/a	17,677,752	m^3
Purchased	yes	67	m^3	x	n/a	67	m^3
Total water taken in							
					Total water taken in =	235,886,781	m^3
Water discharge point							
Ash lagoon	yes	2,566,460	m^3	x	n/a	2,566,460	m^3
Other	yes	204,070,283	m^3	x	n/a	204,070,283	m^3
Total water discharged							
					Total water discharged =	206,636,743	m^3

$$\text{Core water intensity} = \frac{\text{Total water taken in}}{\text{Unit of production or service delivery}}$$

$$= \frac{\text{Total water taken in (Chapter 7, Table 7.4) [m}^3\text{]}}{\text{Denominator value [e.g., t, \$, \# of widgets]}}$$

$$= \frac{235{,}886{,}781\ [\text{m}^3]}{7{,}975{,}709\ [\text{MWh}]}$$

$$\text{Core water intensity} = 29.6\ [\text{m}^3/\text{MWh}]$$

Water discharge indicator

$$\text{Water discharge} = \frac{\text{Total water discharged}}{\text{Unit of production or service delivery}}$$

$$= \frac{\text{Total water discharged (Chapter 8, Table 8.1) [m}^3\text{]}}{\text{Denominator value [e.g., t, \$, \# of widgets]}}$$

$$= \frac{206{,}636{,}743\ [\text{m}^3]}{7{,}975{,}709\ [\text{MWh}]}$$

$$\text{Water discharge} = 25.9\ [\text{m}^3/\text{MWh}]$$

Water consumption indicator

$$\text{Water consumption} = \frac{\text{Water consumption}}{\text{Unit of production or service delivery}}$$

$$= \frac{\text{Water consumption (intake – discharge) } [m^3]}{\text{Denominator value [e.g., t, \$, \# of widgets]}}$$

$$= \frac{29{,}250{,}038 [m^3]}{7{,}975{,}709 \text{ [MWh]}}$$

$$\text{Water consumption} = 3.67 \ [m^3/\text{MWh}]$$

Endnotes

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

4 World Commission on Environment and Development (WCED), *Our Common Future* (Oxford: Oxford University Press, 1987).

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8 NRTEE, *Measuring Eco-efficiency in Business: Feasibility of a Core Set of Indicators* (Ottawa, 1999).

9 Ontario Securities Commission, *Companion Policy 51-101.*

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