# Enterprise-Level Indicators for Resource Productivity and Pollution Intensity

## A Primer for Small and Medium-Sized Enterprises

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

UNITED NATIONS
ENVIRONMENT PROGRAMME

Vienna, 2010

## TABLE OF CONTENTS

**ACKNOWLEDGEMENTS**

The indicator system presented in this Primer was developed and refined through a participatory and iterative process. A cornerstone of this process was the Networking Meeting on Resource Efficient and Cleaner Production (RECP) in Developing and Transition Countries, organized by the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Programme (UNEP), in Lucerne, Switzerland, 18-22 October 2009. The indicator system was developed by UNIDO in close cooperation with UNEP and the National Cleaner Production Centres (NCPCs) in Kenya, Macedonia, Peru and Sri Lanka, which applied and tested the indicator system.

The following contributors are specifically acknowledged: Heinz Leuenberger, René Van Berkel, Smail Alhilali and Vida Rozite (UNIDO); Desta Mebratu and Cristina Battaglino (UNEP); Permod Gupta (Chief Technical Adviser, NCPPs, Cambodia and Lao PDR); Jane O'Nyakango (NCPC, Kenya); Atanas Kochov (NCPC, Macedonia); Marcos Alegre (NCPC, Peru); Sena Peiris (NCPC, Sri Lanka); Vladimir Dobes (international expert/Czech Republic); Roberta De Palma (international expert/Italy); and Jan Stejfa (international expert/Czech Republic).

The preparation, pilot testing and publication of this Primer was made possible by funding from the State Secretariat for Economic Affairs (SECO), Government of Switzerland, under its support to UNIDO for the 2009 UNIDO-UNEP RECP Networking Meeting.

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs FDEA
**State Secretariat for Economic Affairs SECO**

# FOREWORD

The United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Programme (UNEP) cooperate closely to advance sustainable industrial development and sustainable consumption and production in developing and transition countries. Since 1994, UNIDO and UNEP have worked together to establish and support National Cleaner Production Centres (NCPCs), which are currently operational in over 45 countries. These centres provide services to businesses, governments and other stakeholders in their home countries for the promotion and implementation of Resource Efficient and Cleaner Production (RECP) methods, practices, technologies and policies. In 2009, UNIDO and UNEP agreed on a new Joint Programme on RECP, with the overall aim of expanding and scaling up the activities and impacts of the global network of NCPCs.

A key feature of the success of RECP initiatives is the monitoring of performance improvements in terms both of increased resource productivity, and of decreased pollution intensity. Performance indicators enable companies to monitor their use of energy, water and materials and the generation of waste and emissions. While absolute amounts are important from the point of view of protecting environmental quality, in particular at the local level, they do not necessarily provide an adequate measure of the successes of RECP initiatives. This Primer, therefore, places emphasis on linking resource use and pollution generation to product outputs, thereby creating relative indicators that can be tracked over time. The indicators selected are central to RECP and are relevant to the manufacturing, processing and service sectors. The indicator system provides a framework for initiating and focusing RECP activities, monitoring, setting targets, sustaining performance achievements and reporting progress.

This Primer on Enterprise-Level Indicators for Resource Productivity and Pollution Intensity is a joint UNIDO and UNEP publication under the RECP Programme. It has been developed in response to the need for a common and transparent framework for documenting enterprise-level RECP results that is widely applicable in small and medium-sized enterprises (SMEs) in developing and transition countries. The Primer provides a core set of indicators for enterprise-level resource productivity and pollution intensity, and explains how these indicators can be applied and how they can be used to initiate RECP and document its results. This Primer is supported by a set of success stories, which demonstrate how the indicators have been applied in different companies to measure the results of RECP. One is included as Annex A to this Primer. Further success stories cover companies in Kenya, Peru and Sri Lanka and are available as separate publications that can be obtained from UNIDO and UNEP.

It is expected that this Primer will be able to serve as a starting and reference point for SMEs in planning, structuring, initiating and further developing RECP activities, and thus will provide a basis for continuous efforts directed towards sustainable industrial development.

Heinz Leuenberger, Director
Environmental Management Branch
UNIDO

Arab Hoballah, Chief
Sustainable Consumption and Production Branch
UNEP

# 1 INTRODUCTION

The systematic depletion of natural resources that underlies our most pressing environmental concerns, including climate change, necessitates new approaches that make possible economic growth and at the same time decrease negative environmental impacts that stem from the production of goods and services.

Resource Efficient and Cleaner Production (RECP) is a preventive, enterprise-level approach to improving resource use, reducing environmental pollution and contributing to sustainable industrial development. It is based on the continuous application of an integrated preventive environmental strategy to processes, products and services in order to increase overall efficiency and to reduce risks to humans and the environment. RECP can be applied to the processes used in any industry, to products and to various services provided in society.

RECP acts as a catalyst to productivity by optimizing the use of natural resources by companies. It further promotes environmental management by preventing the generation of waste and emissions. RECP involves determining where waste and emissions are generated and where and how resources are used inefficiently. This then serves as a basis for deciding how to best address or eliminate the source or cause of these problems. Further background information on RECP methods, practices and technologies can be found, for example, in the Cleaner Production Toolkit (published by UNIDO) and the Resource Efficiency Toolkit for Small and Medium Enterprises (published by UNEP), and other sources included in the reference section.

The central element of RECP is the examination and re-evaluation of company processes. RECP is typically undertaken at a profit or is otherwise beneficial to companies, as money is saved in two ways: firstly, by converting valuable resources into useful products and services, and, secondly, by reducing the costs of clean-up, remediation, transport, treatment and disposal associated with wastes and emissions. Furthermore, RECP saves valuable natural resources, thus providing benefits for society and the environment.

The monitoring of improvements is central to the success of the RECP approach. Environmental performance indicators allow companies to quantify their resource productivity and pollution intensity at any point in time and to track the results of RECP over time. Indicators translate complex data into relevant knowledge that can be used to initiate, focus and sustain RECP activities. Indicators are also useful for target-setting and reporting.

This Primer has been developed specifically to promote and support the implementation of RECP practices and technologies in small and medium-sized enterprises (SMEs) in developing and transition countries. For National Cleaner Production Centers (NCPCs) and other RECP service providers, the Primer will provide a basis for quantifying the results of their RECP services to companies. The Primer may also serve as a basis for the development or enhancement of NCPC services that are offered to companies and can contribute to the promotion of RECP services.

This Primer enables companies to establish RECP profiles based on their use of resources and the pollution caused relative to the scale of production. The first-time application will result in a baseline which can be used to target RECP initiatives, and periodic reapplication will reveal improvements over time as a result of RECP initiatives. The Primer also contains suggestions on how achievements can be presented and reported.

The indicator system proposed in this Primer is based on absolute indicators that cover the main inputs and outputs of business operations, namely, resource inputs (use of materials, energy and water), pollution outputs (waste, carbon dioxide emissions, and waste water) and product outputs. The indicator system is then based on resource productivity and pollution intensity indicators that are relative indicators calculated on the basis of these absolute indicators. The main part of this Primer deals with these indicators, explaining why they are important, how they can be measured and/or calculated and how performance can be improved over time.

The Primer does not present a complete overview of all possible environmental indicators. More comprehensive indicator sets are available, for example, in the general and sector-specific reporting guidelines promoted by the Global Reporting Initiative (GRI) (www.globalreporting.org) and eco-efficiency management tools (www.wbcsd.org ), or from relevant international standards (in particular ISO 14021 and the new draft carbon accounting standard ISO 14067, available at www.iso.org ). While the collection and monitoring of a broad range of data on resource use and emissions to the environment can be exceedingly valuable and useful, the investments needed to implement complex indicator systems may act as a deterrent to SMEs. Based on the global experience of the National Cleaner Production Centres (NCPCs), the environmental performance indicators proposed here are key indicators that SMEs can effectively manage and improve through RECP. These indicators are equally relevant for a wide range of manufacturing, processing and service sectors. Their application will, therefore, provide a solid starting point for companies wishing to initiate the monitoring and management of resource use and pollution. The indicator system presented can be used as a basis for the successive inclusion of additional environmental performance indicators.

The indicator system presented in this Primer focuses on physical indicators. It is acknowledged that complementary monetary indicators are very useful for and relevant to RECP. They have at this stage not been included in the system, as the main intention of this Primer is to enable companies to establish functioning and robust systems and routines for measuring, monitoring and managing performance in relation to the physical inputs and outputs of their business activities. The indicator system can, however, be utilized to provide input for environmental management accounting (EMA), and companies can successively expand their indicator systems to include monetary indicators or indicators that combine monetary and physical data that are relevant to their area of business. Useful guidelines and tools on EMA are provided in section 2.7.

This Primer is divided into five sections designed to guide the reader through the process of understanding how indicators can be relevant and useful, how to set up an indicator system, how to collect and calculate data and how to use and present results.

**Section 2** provides step-by-step guidance on the actions needed to establish an indicator-based system for performance management.

**Section 3** comprises the main part of the Primer. It introduces the indicator system and presents each of the indicators, explaining why they are important, how they can be measured and/or calculated and how they can be improved over time. Examples from companies that have implemented RECP programmes and utilized the indicator system to track and report progress are provided to illustrate both the effectiveness of RECP measures and the usefulness of being able to quantify improvements.

**Section 4** explains the concepts of resource productivity and pollution intensity, provides guidance on how these can be calculated and introduces the RECP profile, which is a visual tool that can be used for monitoring and communication.

**Section 5** gives a brief introduction on how results can be communicated and reported, while **Section 6** provides an overview of possibilities for expanding the indicator system.

Suggestions on useful general resources to help companies start to monitor their progress and to enable them to adapt and further develop the indicator system to their specific needs are provided in the section on Resources and Tools, while suggestions on indicator-specific resources are given in **Section 3**.

**Appendix A** provides an example of a success story to illustrate how results can be reported; a reporting framework template is available at www.unido.org/cp . Further guidance on data management, calculations and reporting can also be found in the accompanying RECP indicator calculation tool. **Appendix B** illustrates how total resource use and pollution can be quantified.

The Excel-based **RECP indicator calculation tool** enables companies to track their performance, calculate results and present their RECP profiles. The tool is available at www.unido.org/cp . In this Primer, the term production is used to signify both the production of physical products and the provision and delivery of services. The term product output includes both physical products and services. The term site is used to describe the area of operation, which, depending on the type of business, could be a factory, production plant, shop, hotel, or office.

It is intended that the indicator system presented in this Primer can be directly put to use by SMEs and the further text of the Primer is addressed directly to this audience.

# 2 MANAGING PERFORMANCE

The activities of your company have both direct and indirect environmental impacts. Direct impacts are caused, for instance, by fumes from production processes, waste generated, and emissions from fuel combustion. Indirect impacts pertain to impacts that are associated with your business but are caused by activities outside your immediate control, for example, during the extraction of raw materials or when your products are used and discarded. The practices described here focus on the management and reduction of the causes of direct impacts.

You can only manage what you know and can measure! A set of key performance indicators is a must for any improvement programme, including RECP. There are numerous frameworks and tools that could be used to plan, implement and monitor RECP activities. However, a small set of key indicators is all you need to get started with managing and decreasing your company's resource use and pollution. The indicators proposed in this Primer are critical for the management of direct impacts emanating from any SME and, in most cases, cover the majority of the direct impacts that can be reduced directly by your company. The application of the indicator system will help you to identify which areas need to be targeted and will provide a good basis for starting, implementing, monitoring and continuing RECP. It will enable you to integrate environmental and resource-saving considerations into your business operations and to sustain RECP achievements. It will also supply you with relevant sets of data that you can use to present and report your achievements and inform your clients, the government, the municipality, employees and the community about your progress and thereby gain further support for your efforts.

The measurement and monitoring of indicators alone do not lead to improvements. You need to proactively manage your company's environmental performance. This is possible through the application of RECP methods, practices and technologies. RECP is based on identifying the root sources and causes of low efficiency in the use of materials, energy and water and of high levels of waste and emissions. RECP provides approaches for developing and implementing practical solutions designed to eliminate these causes, as further described, for example, in the UNIDO "Cleaner Production Toolkit", the UNEP "Cleaner Production Companion", the UNEP "Pre-SME Toolkit" and other resources included in the Resources and Tools section.

The implementation of RECP needs to be guided by data on resource use and pollution. The combination of monitoring and improvement programmes provides multiple benefits, in particular, higher productivity, decreased environmental burdens and better care for workers, consumers and communities.

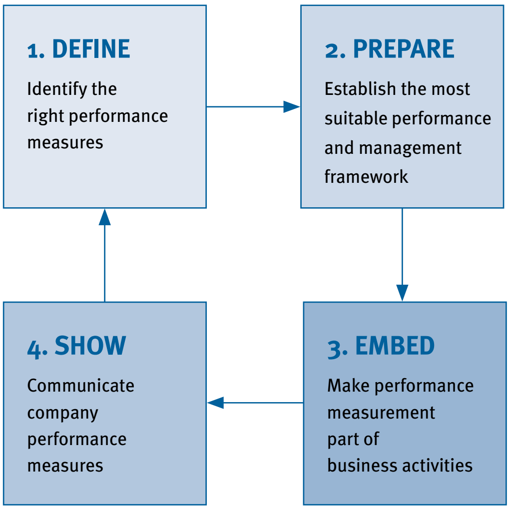
Monitoring and measuring performance will help you to:

- Compare resource productivity and environmental performance over time;
- Highlight improvement and optimization potentials;
- Identify and follow up on resource productivity and environmental targets;
- Discover market opportunities and cost-reduction potentials;
- Communicate your results to external stakeholders;
- Involve, educate and motivate staff;
- Promote organizational learning;
- Support decision-making by providing concise information about the current status and trends with regard to resource use and performance; and
- Implement environmental management systems or generate information needed for your current environmental management system.

## 2.1 Planning the System

Monitoring needs to be embedded in the way you run your business on a day-to-day basis. A practical approach for systematic performance monitoring and management includes the following four key steps[1]:

- Step 1: **Define** the right issues and performance measures.
- Step 2: **Prepare** by establishing the most suitable performance management and measurement framework. Make sure that you are using the most effective indicators. Develop robust processes for implementing your system.
- Step 3: **Embed** your performance measurement system into your business activities. Collect data from business units and third parties.
- Step 4: **Show** your internal and external stakeholders what you have been doing and what results you have achieved.




The level of effort you will need to implement the performance-monitoring system depends on how you design the system. Care should be taken to develop a system that is suited to your needs and available capabilities. It may initially be far more beneficial to design a simple robust system that is easy to integrate into your accounting routines, rather than to create a complex system that requires significant investments in the form of time, advanced measurement systems and comprehensive changes in accounting and information management procedures. That said, you can and should work continuously to improve your system, procedures and data quality.

This Primer is based on the experience of NCPCs working with SMEs in developing and transition countries. Their experience shows that the ability of companies to strive for improvements in a systematic way needs to be improved. This need has been addressed by ongoing capacity-building and technical assistance on RECP methods, practices and technologies. However, the full utilization of these RECP approaches and technologies requires effective monitoring systems. According to NCPC experience, companies also tend to lack the skills and equipment required for adequate measurement of inputs and outputs. This Primer sets out to address this issue and to provide a predefined set of key indicators for monitoring and improving performance.

In relation to the four steps of systematic performance monitoring and management described above, **Step 1**, namely, the identification of the right performance measures, has already been done for you. You may wish to revisit this step after you have successfully implemented your indicator system, and assess opportunities and possibilities for including additional indicators in your system. The remainder of this Section, as well as Sections 3 and 4 of this Primer, will help you to carry out **Steps 2** and **3**, that is, to establish the most suitable performance and management framework and to make performance measurement part of your business activities. Finally, Section 5 and Appendix A provide guidance for carrying out **Step 4** and offer suggestions on how to communicate your results.

1 Business in the Environment and Ernst & Young (2001). *A measure of progress. Guidelines on measuring environmental performance.*

## 2.2 Understanding Indicator Types

There are various types of indicators that can be utilized to measure and monitor change. At the outset of working with indicators, there are two different types that are of primary relevance:

**Absolute indicators** measure basic data in a given time frame, typically one year, for example:

- Tons of Carbon Dioxide ($CO_2$) emitted annually;
- Tons of wastes generated annually;
- Annual production.

Relative indicators, sometimes also called normalized indicators, are a measurement of absolute consumption or emission figures relative to reference data. In terms of environmental performance, productivity and intensity ratios are central relative indicators.

- **Productivity ratios** quantify the amount of product output per unit of resource use, e.g., the tons of product output per ton of materials used or the volume of services delivered per cubic metre of water used. Sustainability considerations require productivity ratios to INCREASE over time, leading to more production per unit of resources used.

- **Intensity ratios** quantify the amount of resources used or the amount of emissions per unit of production, e.g., $CO_2$ emissions per unit of production or waste generated per unit of production. Sustainability considerations require intensity ratios to DECREASE over time, leading to less pollution per unit of production.

Relative indicators can also be used to tie physical and monetary data together, for instance, cost of waste-water treatment per unit of customer service. While the indicator system presented in this Primer focuses on physical indicators, Section 2.7 touches on how the indicator system can be linked to monetary values.

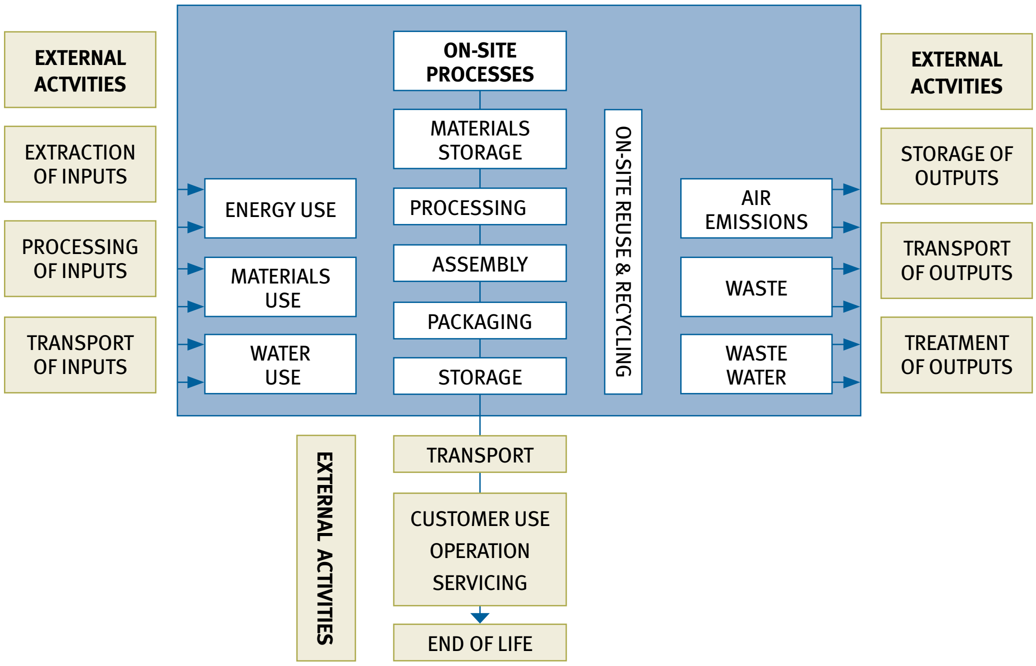
## 2.3 Setting the Boundaries

The first step in monitoring results is setting your system boundaries. Boundaries are the borders that are used to determine what is included and what is not included in your system. Boundaries can include the company site, individual processes or units within the site, the company site plus transportation of goods, or even the whole product chain. However, it can be challenging to access data for processes and systems that are outside the immediate control of your business. It is, therefore, recommended that you start with a system boundary that covers your site and the impacts that you can directly affect, i.e., gate-to-gate, where the first gate is the boundary for your inputs and the second gate is the boundary for your outputs. The resources (materials, energy and water) that you purchase, the resources that you generate or collect on the site and the outputs (waste, waste water, air emissions, and products or services) from your operations should be included.

Once you have established your system and have achieved and tracked your results, you can work on expanding your boundaries and extending your RECP work to further improve your environmental performance. If you decide, as a next step, to expand your boundaries to include indicators covering other areas, for example, energy in the form of transport fuels and emissions from transport, the first reassessment with the expanded system boundary will then in effect become the new baseline for future reference.

To compare performance at different points in time (time series within your company) and between different companies at the same time (benchmarking), you need to have the same boundaries. Within your company, this is relatively easy to manage, as you can set the boundaries and maintain these for future use. For benchmarking purposes, however, you should apply the same boundaries, measurement protocols and equipment as have been used in the other companies to which you would like to benchmark your company. Given the difficulties of ensuring comparable monitoring boundaries and protocols between companies, it is advisable to focus initially on monitoring time series within the boundaries of your own company.

GATE-TO-GATE BOUNDARY




## 2.4 Establishing your Baseline

A proper baseline assessment is the starting point for the effective implementation of your indicator system. It is basically the result of the first-time application of the indicator set, including the collection of data through measurement, estimation and calculation. It is used as your point of reference for tracking changes and improvements over time.

Your baseline should, ideally, be based on data for one complete year. Shorter periods of time can be subject to fluctuations owing to various circumstances, such as seasonal variations, and may not provide you with a sufficiently representative picture. A six-month period could be possible depending on the sector and type of business. All your consecutive measurements and calculations need to be for the same period as the baseline and the same units must be used.

**Good practice: Make frequent measurements**

The frequency for data collection and measurement is dependent on factors such as access to data, existing measurement equipment, complexity of making of measurements, costs of measurement and your needs (e.g., to compile reports for various stakeholders). A sufficient number of measurements should be made so that meaningful annual data can be compiled. However, there are clear benefits from more frequent measurements and calculations, since these give you greater control, provide more input for decision-making with regard to opportunities for optimization, and increase the probability of avoiding unnecessary waste. Develop a system that makes it easy for you to see the period of time for which each measurement has been made; this will also help you to compute the data into annual resource use, emissions and waste.

A good practice is to construct the baseline retrospectively, using the data from a suitable 12-month period immediately prior to the RECP initiative, most commonly the most recently completed financial year or calendar year. Even though the historical data may not be perfect, this practice allows you to start implementing improvement measures immediately. Once better data are available, you may then wish to re-establish the baseline. It is generally advisable to choose the same accounting period for the environmental monitoring as for the regular accounts, typically the fiscal year. However, using calendar years or production seasons might also be suitable.

## 2.5 Identifying Information Sources

An important step in implementing any indicator system is to determine where and how to obtain the data. While the data requirements for an indicator system may at first seem daunting, you will find that you probably already have most of the information and can compute the baseline by bringing together monitored data and tacit knowledge from different people and sources in your company. In some cases, the information may not yet have the desired level of detail and/or reliability. However, this is something that can be addressed over time, for example, by installing metering devices or improving procedures for data collection.

Possible sources include:

- Internal sources within the company (departments or persons in charge of accounting, sales, purchasing, production, maintenance, human resources, environment);
- Invoices from suppliers and public utilities;
- Industry-sector organizations;
- Local authorities;
- Government; and
- International organizations.

Review the type of measurements that you can make or access and determine and locate tools or conversion tables that are needed to standardize calculations. To ensure comparability, it is important that you use the same methods and tools for measurement and calculation. If, after a time, you wish to utilize a different method for measuring your indicators, you will have to review your baseline and make the necessary corrections or create a new baseline.

Different data sources lead to different types of values, including:

- *Metered (or gauged) value*: A value that is scaled by means of a balance or other instrument.
- *Estimated value*: A value based on common practice. The method and tools that you elect to use for making estimates should be disclosed when reporting your results
- *Calculated value*: A value based on (user-) defined algorithms. The inputs into the calculation can be values of different quality levels (e.g., metered, estimated) and/or defined conversion factors.
- *Empirical value*: A value based on empirical studies/research and scientific evidence.
- *Reference value*: A value used to normalize a dynamic development. Through normalization, results for different entities with different levels of activities and dynamics are transformed into the same unit, so they become comparable.
- *Conversion factor*: A consensus value based on generally accepted scientific standards, concepts or models.

You should be aware that the level of accuracy can vary significantly between different types of values. You should attempt to utilize the data sources that provide you with the most accurate values, taking into consideration the resources you have available, including access to data and equipment.

**Good practice: Be aware of the quality of data**

Owing to the nature of the data collected and calculations made, there will be a level of uncertainty stemming from the quality of the data you can access. It may not be possible to measure quantities with satisfactory precision and accuracy; conversion factors are typically based on averages; your suppliers may not have precise measurements; spills may go unreported; and other issues will have an impact on how completely your data correspond to actual quantities. However, it is important to emphasize that what you are interested in are trends and indications rather than getting a completely comprehensive overview of exact quantities. You will be comparing performance over time to see improvements from year to year. The trends will be visible despite slight variations in the quality of data.

Bearing this in mind, it is still important to check and recheck data and calculations. If some of the values seem unusually high or low, it is always a good idea to check, remeasure or recalculate. You should also make sure that your system is transparent and that you can provide information on the methods that you have used. This will help you deal with possible criticisms or doubts expressed by stakeholders.

The person or unit making the final calculations and reports should be aware of the quality of the measurements or estimated values. If different people or units are responsible for data collection and calculations, then the person or unit responsible for collection should make an assessment of the accuracy of measurements and estimations and pass this information on to the person or unit making the calculations.

Depending on your target audience, it may be a good idea to include a section on method and even a discussion of data quality when reporting results.

When reporting your data, ensure that you use a format that correlates to the accuracy of your data, for example, a quantity that was computed as 123,456 but is known to be accurate only to within a couple of hundred units is better stated as about 123,500. A good rule of thumb is to use the most exact numbers you can when making calculations, but to round off the results or totals when reporting.

## 2.6 Creating Guidelines

Clear guidelines and data-collection procedures will help you to save time and resources and ensure that the methods used for indicator construction, data collection and data processing are clear, transparent and replicable.

The following factors should be included in your data management process:

| | |
|---|---|
| **Accountability** | An individual or a function should be assigned the responsibility for managing the data-collection and calculation processes. |
| **Purpose** | The purpose and reasons for collecting the data should be made clear. |
| **Common understanding** | To create a common understanding, guidelines and protocols required to describe the requirements of the data-management process should be made clear. |
| **Approved methods** | Clearly defined procedures and tools for collecting and interpreting measured data are needed. These should include:<br>• Frequency of making measurements, calculations and estimates;<br>• Analytical methods (how to calculate or estimate values);<br>• Information on the proper calibration of instruments;<br>• Deadlines for supplying data. |
| **Learning** | Personnel should have an understanding of the benefits of collecting and processing data. In some situations training may be necessary. |
| **Auditability** | The data generated by a system should be sufficiently robust to withstand external scrutiny. |

**Good practice: Coordinate**
When establishing an environmental performance-monitoring system, it is important that information-collection activities be coordinated. To save time and resources, it is a good idea to make the collection of data on resource use and waste and emission generation part of routine business functions. For example, the person registering the costs and quantities of raw materials could also register the weight of raw materials and make sure that this information is labelled as information important for the indicator system and is made accessible to the person or persons responsible

## 2.7 Managing Environmental Costs

An integral part of RECP is the identification of potential financial benefits from improved environmental performance. By enhancing efficiency in the use of energy, water and materials, not only are environmental improvements (reduced resource use and reduced waste and emissions) achieved, but potentially significant financial savings are also made possible, since the costs for purchasing of materials and treatment of wastes decrease accordingly.

In some situations, it may even be preferable to express improvements in resource use and pollution intensity in monetary rather than in physical terms. For instance, managers who might not appreciate or react to information on the total volume of waste water generated annually (a physical environmental-performance indicator) may pay attention to an estimate of total annual waste-water treatment costs (a monetary environmental-performance indicator). However, bear in mind that changes in costs do not necessarily reflect actual improvements in environmental performance or resource use. For example, total waste or waste-water costs could still increase, even after volumes have been reduced, as a result of higher effluent or waste-disposal charges.

A further good practice consists in estimating the costs of non-product output (NPO) by adding the purchase value of raw materials or the potential sales value of intermediate or final product lost as waste or in waste water to the treatment and/or disposal costs incurred. For example, in a brewery, this could be done by adding the estimated sales value of the quantity of beer that ends up in the waste water due to spills and leaks in the bottling plant. Doing so would normally make managers realize that it might be expensive to clean up polluted water, but that it is even more expensive to pollute clean water in the first place. Various primers and guidelines are available to help you calculate the total costs of waste, emissions and non-productive use of resources. Such calculations are generally useful to motivate RECP initiatives, and provide valuable input for full cost-benefit analysis of proposed RECP initiatives. However, due to price and other fluctuations, they are less suitable for the ongoing monitoring of environmental performance at the enterprise level, which is the main focus of this Primer.

**Good practice**

A Paper mill in Eldoret (Kenya) that produces paperboards for box files, diaries and other paper products improved productivity and environmental performance by targeting NPO. Through an analysis of material flows, it was ascertained that NPO constituted 36% of the total annual cost of production. By changing procedures, fixing leaks, training personnel, carrying out maintenance of equipment and making minor equipment redesigns and modifications, the company improved the quality of their products and decreased NPO costs by 16%. These improvements led to decreased resource use, including lower energy and water consumption, and reduced emissions and waste.[2]

Environmental management accounting (EMA) links physical performance, such as the data that you are collecting through the indicator system proposed in this Primer, with financial performance. EMA is broadly defined as the identification, collection, analysis and use of two types of information for internal decision-making, namely, physical information on the use, flows and fates of energy, water and materials (including wastes) and monetary information on environment-related costs, earnings and savings.[3] The indicator system presented in this Primer will provide you with the physical data that you need as a basis for the assessment of environmental costs and savings. The assessment of environment-related costs can take place at many different levels. For instance, costs can be assessed with reference to the profit-and-loss account, or more detailed data can be collected for specific sites, cost centres, processes, materials, product lines, customer services or waste streams that are of particular interest.

Environmental costs include:

- **Materials costs of product outputs** (including the purchasing costs of resources such as energy, water and other materials that are converted into products, by-products and packaging);
- **Materials costs of non-product outputs** (including purchase and processing costs of energy, water and materials that are wasted or end up as waste);
- **Waste- and emission-control costs** (including costs for handling, treatment and disposal of waste and emissions; remediation and compensation costs related to environmental damage; and any control-related regulatory-compliance costs);
- **Prevention and other environmental-management costs** (including the costs of environmental-management activities, environmental planning and systems, environmental measurement, environmental communication and any other relevant activities);

2 PREMAnet (2001). *Application of Environment-Orientated Cost Management. Example 5.*

3 United Nations Division for Sustainable Development (2001). *Environmental Accounting Procedures and Principles*.

- **Research and development costs** (including costs for research and development projects related to environmental issues);
- **Less tangible costs** (including liability and risks, future regulations, productivity, company image, stakeholder relations and externalities).[4]

The collection, calculation and estimation of data on environmental costs may be challenging. Often, with traditional management accounting systems, environmental costs are not tracked or may be aggregated or hidden in overhead costs. A key principle is, therefore, to allocate environmental costs to business activities or products, just as other costs for such factors as labour and machines are allocated for purposes of traditional financial control. This is known as activity-based costing. For environmental costs, this requires insight into which processes or activities consume chemicals, energy and water and generate waste and emissions. This type of information results from materials- and energy-flow and -balance studies, which are typically performed as part of an RECP assessment. However, some costs may be difficult to assess, for instance, legal costs, damage to company image and environmental liabilities. The fact that environmental costs are not fully recorded often leads to distorted calculations of the costs and in particular of the benefits of improvement options.

It is important to bear in mind that environmental costs are not a separate type of cost; they are part of the integrated system of material and money flows in your company. A central element in EMA is the calculation of production costs on the basis of materials flows. Working with EMA does not necessarily mean that you need to implement a new system. Instead, you can improve your existing management accounting and make it more comprehensive by focusing on environmental costs and keeping an eye on potentially hidden costs. By implementing the indicator system proposed in this Primer and linking the data from your absolute indicators and resource-productivity and pollution-intensity indicators to monetary values, you will be well on your way towards starting to implement a system of EMA.

There are a wide variety of guidelines and tools that can be utilized to develop and improve your accounting system and to start working systematically with environmental costs.

| **Resources** | |
|---|---|
| International Federation of Accountants (2005). Guidance Document on EMA | www.ifac.org/members/DownLoads/IFAC_Guidance_doc_on_EMA_FINAL.pdf |
| The Institute for Environmental Management and Economics, e.g., Excel-scheme for cost assessment | www.ioew.at/ioew/en_ioew-set.html |
| Profitable Environmental Management (PREMAnet) | www.premanet.net/index.asp |
| UNCTAD (2002). Guidance manual. Accounting and Financial Reporting for Environmental Costs and Liabilities | www.unctad.org/en/docs/iteeds4_en.pdf |
| United Nations Division for Sustainable Development (2001). Environmental Accounting Procedures and Principles | www.un.org/esa/sustdev/publications/proceduresandprinciples.pdf |
| UNIDO (2010). Performing Environmental-Management (EMA) and Material-Flow Cost Accounting (MFCA) in SMEs | Being developed |
| UNIDO. Introducing Environmental Management Accounting (EMA) at Enterprise Level. Methodology and Case Studies from Central and Eastern Europe | www.unido.org/fileadmin/import/26160_EMAforewordexplnoteswithoutcoverimage.pdf |
| United States Environmental Protection Agency (1995). An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms | www.epa.gov/oppt/library/pubs/archive/acct-archive/pubs/busmgt.pdf |

4 IFAC (2005). *International Guidance Document: Environmental Management Accounting*.
United Nations Division for Sustainable Development (2001). Environmental Accounting Procedures and Principles.

## 2.8 Making it Happen

To benefit from your indicator system, make sure that it is embedded in your business operations and ensure that your key staff members are aware of the process and involved in it. Throughout the process, you should check and control that your system is working and that the resources necessary for implementation are available.

Controlling data accuracy and procedures is crucial to making sure that your system functions well and that the results will be valid and useable. Basic balances can be used to check your inputs and outputs and alert you to the need for investigating possible discrepancies.

A key factor in the success of your system is reporting progress to both internal and external stakeholders. Section 4 deals specifically with practical ways for tracking and communicating results in a manner that facilitates continual improvement.

In order to retain relevance and effectiveness, the indicator system must be periodically reviewed to determine whether it is still adequate for measuring and improving your resource productivity and environmental performance.

Reviews should include an assessment of the following questions:

- Do the available indicators adequately reflect the company's environmental impacts?
- Can new or improved indicators be developed or used?
- Can the quality and reliability of data collection be increased?
- Are the indicator measurements frequent enough?

# 3 RECP INDICATOR SYSTEM

The indicator system proposed in this Primer comprises six absolute indicators, three for resource use (energy use, materials use and water use) and three for pollution (air emissions, waste water and waste) and one reference indicator (product output). These absolute indicators are used to calculate three resource-productivity indicators (product output per unit of resource consumption) and three pollution-intensity indicators (emissions or waste generation per unit of product output). These are central to managing and evaluating RECP implementation in enterprises.

The indicators have been selected on the basis that they collectively cover the most important environmental aspects of SME operation and that improvements in these areas generally provide maximum benefits for the environment and the business. Moreover, the data required for these absolute indicators should, at least in principle, be available or measurable by any company, resulting in a relatively low implementation cost in relation to the potential benefits.

The indicators referring to **resource use** are:

- **Energy use**: final energy use of your company, measured in megajoules or kilowatt hours, including energy content of fuels used (gas, oil, petrol, biomass, etc.) and electricity consumption;
- **Materials use**: total mass of materials used by your company, measured in tons, including raw materials, packaging and distribution materials, auxiliary materials, etc., but excluding the weight of fuels;
- **Water use**: total water consumption of your company, measured in kilolitres or cubic meters, including all sources (ground water, tap/drinking water, surface water) and all applications (process water, cooling water, sanitary water, etc.).

The indicators covering **pollution** are:

- **Air emissions**: covering all sources in the enterprise, but limited to greenhouse gas (GHG) emissions, measured in tons of equivalent emissions of the primary greenhouse gas, namely, carbon dioxide ($CO_2$). This includes on-site energy-related GHG emissions (use of fuels, gas etc.), off-site energy-related GHG emissions (in particular for electricity generation and distribution) and process-related GHG emissions (both $CO_2$ and non-$CO_2$, particularly $CH_4$ and $N_2O$);
- **Waste water**: the total volume of contaminated water leaving the company boundaries, measured in kilolitres or cubic meters, regardless of the final disposal method (sewer, surface water), excluding water streams discharged without chemical or biological load (thereby excluding cooling water);
- **Waste**: the total value of waste (solid or liquid) trucked or otherwise transported from the site or disposed and stored on the site, measured in tons, regardless of the respective disposal methods (e.g. incineration, landfill, recycling, etc.).

The absolute **production indicator** or reference indicator covers the product output or value created by the enterprise. It is preferably measured in a relevant physical unit (tons, kilolitres or units) of production or service of the enterprise. However, when different products or services are created, it might be acceptable to use the economic value (sales value) as proxy.

The indicators selected should be seen as a common set, since they are to varying degrees interrelated, as illustrated in the following figure. When productivity is not optimized, increased consumption of materials and water will typically lead to more waste and more waste water. If the energy used is based on fossil fuels, then increased consumption will lead to increased GHG emissions. Furthermore, if you use more materials, you will generally need more energy and sometimes more water to process these materials. Similarly, if you use more

Silk weaving workshop in Vietnam

Finishing of lacquerware handicrafts in Vietnam

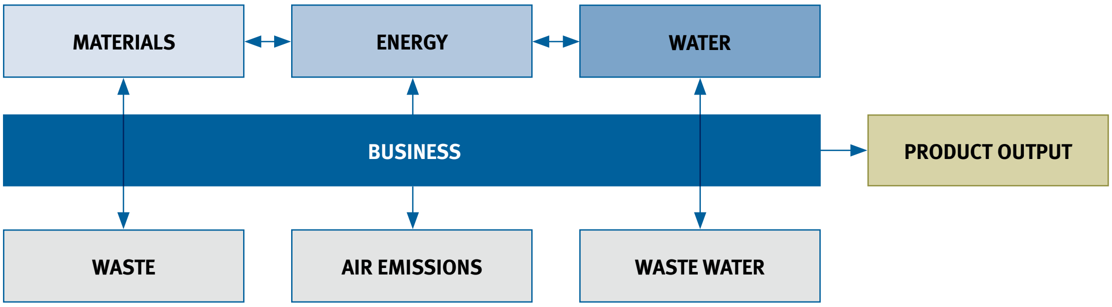
Shirt factory in Vietnam

Beamhouse of leather tannery in Indonesia


Coal boiler in India

water, you will most probably need more energy (for heating, cooling, pumping, etc.). Increased use of water could also lead to an increased consumption of materials owing to losses. Moreover, increased use of energy may also affect consumption of materials and water, since you may require more water or materials to contain or discharge waste heat. However, these correlations can also be used to your benefit. By targeting improvements at one part of the input-output system, you will generally also be able to simultaneously improve your performance in regard to other parts of the system.

RELATION BETWEEN THE ABSOLUTE INDICATORS




These absolute indicators are used to compute six relative indicators - three resource-productivity indicators and three pollution-intensity indicators (see also Section 2.2):

### Resource productivity

- Energy productivity (product output per unit of energy used);
- Materials productivity (product output per unit of material used);
- Water productivity (product output per unit of water used).

### Pollution intensity

- Carbon intensity (greenhouse gas emissions per unit of product output);
- Waste intensity (waste generation per unit of product output);
- Waste-water intensity (waste-water generation per unit of product output).

Jointly, these six relative indicators constitute your enterprise-level RECP profile. Increases in any of the three productivity ratios and decreases in any of the three intensity ratios over time are beneficial from the environmental and sustainability viewpoints and substantiate the successful implementation of RECP practices and technologies.

**Good practice**

Rathkerewwa Desiccated Coconut Mill in Sri Lanka realized that it was throwing away a valuable resource that could be utilized for the generation of energy. The company replaced furnace oil with coconut shells and not only decreased the quantity of waste and costs of waste disposal, but also decreased energy costs. Furthermore, since coconut shells are of plant origin, the carbon dioxide emissions from combustion can be excluded from greenhouse gas emission calculations, since they do not contribute to an anthropogenic dioxide emissions. The replacement led to annual savings of around USD 165,000 and reduced GHG emissions by more than 900 tons of $CO_2$ eq.

Hand paring process (waste reduced from 53 grams per nut to 45 grams per nut)

Reduced water consumption in the white meat cleaning process

## 3.1 Indicator 1: Energy Use

The consumption of energy from fossil fuels contributes to global warming, as well as regional and local air pollution. Further environmental impacts arise from the extraction, processing and transport of fossil fuels. Other sources of energy can also give rise to negative environmental impacts. For example, the unsustainable production and consumption of bioenergy is linked to deforestation, displacement of indigenous species, depletion of soil resources and local and regional air pollution. There are also considerable risks associated with the storage of waste from nuclear power generation. Both large-scale and small-scale hydropower can negatively affect the ecology of waterways. Wind turbines may have a negative effect on neighbouring communities and local birdlife. These negative impacts can be reduced by decreasing the amount of energy that you use.

The costs of energy include costs for the purchasing of fuel, electricity, heating and other forms of energy; for the operation, maintenance and depreciation of machinery; and for personnel. Energy costs can account for a significant share of company expenditure, and fuel prices are subject to fluctuations, so that increasing efficiency is a strategy for improving profitability.

| Energy indicators | Reference indicator | Conversion | | |
|---|---|---|---|---|
| • Total energy use, in MJ/yr or kWh/yr<br>• Energy productivity | Product output, in units/yr, tons/yr, kl/yr or USD/yr | 1 kWh<br>1 MJ | =<br>= | 3.6 MJ<br>0.278 kWh |

| Total energy use should include | Getting data |
|---|---|
| • Power generated on site (natural gas, fuel oil, coal, biofuels, waste, refined fuels, solar power, and power from wind turbines and small hydro units, etc.)<br>• District heating/cooling<br>• Imported electricity<br>• Imported steam | • Invoices from suppliers<br>• Receipts/bills<br>• Inventory |

**Possible challenges and solutions**

- **Different types of energy.** Various energy sources are typically calculated in different units (natural gas in cubic meters or BTU, fuel oil in litres or tons, coal in tons), and these have to be converted. If the actual net caloric value is known, these values should be used. Otherwise, country-specific or region-specific average values can be applied. When making time-series analyses, it is important that the same conversion factors be used.
- **On-site electricity generation.** Any electricity generated within your boundary from renewable sources (e.g., wind, solar, hydro) must be included in your calculation of total energy. If electricity, hot water or steam is generated from fossil fuels (coal, oil or gas) within your boundary, include the fuel entering your boundary, but do not include the energy value of the electricity, hot water or steam produced on site in your calculation of total energy. If you include both the energy value of the fuel and the energy value of the energy carrier produced, this will lead to double counting.
- **Biofuel conversion.** The energy value of biofuels you use has to be converted into kWh or MJ. Conversion factors for biomass vary depending on the type of biomass and the quality (particularly moisture and ash content) of the biomass. By default, the value as declared by the supplier of the energy commodity should be used. If the supplier cannot provide values, then there are standard values available, for example, from UNCTAD or the International Energy Agency (IEA).
- **Dealing with non-standard units.** In some cases, suppliers deliver fuels in non-standard units (e.g., truckloads of biofuel). You will then have to calculate the weight (or volume) of one unit and multiply this figure with the number of units you use to obtain the mass or volume. This figure should then be multiplied with a corresponding conversion factor.
- **Unreliable information.** If you suspect that the information, for example, from your electricity supplier is not reliable, install and monitor metering devices. This will also help you to avoid being overcharged by suppliers.

**Calculate energy use**

**Step 1:** Make a spreadsheet or use an available spreadsheet. Label your spreadsheet columns, for example: A (energy types), B (quantity), C (units), D (conversion factors), E (energy in kWh or MJ).

**Step 2:** List all types of energy that you use in column A.

**Step 3:** Collect usage data for each of the energy types in column A. Make sure that your data are applicable to your reporting period. Enter the quantities of energy in column B.

**Step 4:** Indicate in column C the units referring to the quantities provided in column B.
Step 5: Convert each of your energy inputs into a common unit of measurement (kWh or MJ). Enter appropriate conversion factors into column D. Multiply the value in column B by the conversion factor in D for each of your materials and enter the results in column E.

**Step 6:** Sum all the totals to get your total energy consumption.

For example, you use 1,000 litres of light fuel oil. You access a relevant conversion factor, in this example, 38.68 MJ per litre. Light fuel oil: 1000 litres x 38.68 = 36,680 MJ.

## Improving performance

**Use the right quality of energy for the right purpose and recover energy**
Review the types of energy you are using for different processes. Investigate opportunities for using waste heat rather than electricity for heating or drying purposes. Look into possibilities for using solar energy, e.g., for drying or for heating.

**Review layout**
Review the placement of your operations and equipment. Inefficiencies may occur, for instance, if processes requiring heating are placed next to processes that need cooling. Also, do not unnecessarily transport product flows repeatedly between different parts or floors of your premises.

**Maintain your equipment**
Schedule regular checks of your energy system. Install metering equipment and monitor it on a regular basis.

**Turn things off**
Go through your routines and production processes and ensure that only the equipment that needs to be turned on is turned on at any given time. Install smart sensor-based controls for switching on lights, ventilation, etc. only when needed.

**Redesign your processes**
Assess your production process to discover potential energy savings. Investigate the possibility of replacing processes requiring large amounts of energy, for example, applications using compressed air, with direct-driven or mechanical alternatives.

**Heating, cooling, lighting**
Avoid energy losses by insulating both buildings (windows, doors, ceilings, floors) and processes (pipes, equipment). Insulation of buildings may be valuable also in hot climates, especially if air conditioning is used.
Invest in efficient light bulbs. Take advantage of natural light.

**Look at pumps and engines**
Pumps and engines are frequently over-dimensioned, which leads to excessive use of energy. When purchasing new equipment, ensure that the equipment you purchase is specified to your needs or that it can be adjusted to fit your requirements (e.g., that it has variable-speed drives). In some cases, it might even be a worthwhile investment to replace existing equipment.

**Train and involve your staff**
Good procedures and routines will lead to energy savings. Educate and train your staff, and develop clear guidelines. Create possibilities and incentives for staff members to submit proposals on ways of saving energy.

**Decrease other resource use**
The amount of energy that you need is linked to the quantities of water and materials that you have to process. Look for opportunities to decrease the quantities of materials and water that you use, e.g., by means of efficiency measures, waste reduction and process or product design.

## Good practice

Pwani Oil Products Ltd., a manufacturer of edible oils and fats and laundry soaps in Kenya, achieved a 5% reduction in energy use by simple low-cost and no-cost measures. These included the installation of energy-saving lamps, installation of timers, replacement of old air compressors and other equipment, fixing of leaks and other maintenance measures.

Metalexacto, a small lead foundry in Peru, decreased its energy use by more than 15% by improving its furnace and combustion process. Improvements included putting a hood on the furnace and using residual heat to warm up fuel.

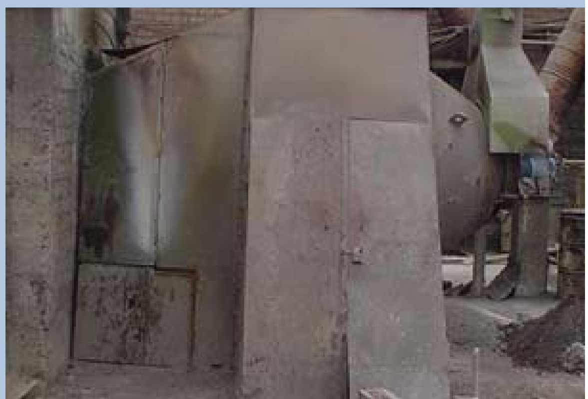
Chandaria Industries Ltd., a paper manufacturing and conversion company in Kenya, reduced its energy use by around 25% by installing submetering at key usage points, replacing oversized motors, introducing variable-speed drives where the motor speed can be regulated to match process demand, and monitoring boiler efficiencies.

UNIQUE S.A., a cosmetics producer in Peru, targeted energy consumption by improving boiler efficiency, recovering heat from the chimney flue gases, insulating the water tanks, decreasing the heat losses in the steam distribution line, reducing electricity consumption by regulating and maintaining the compressors, taking advantage of natural light and switching to more efficient light bulbs. They also reduced their electricity bill by changing the peaks of the company's usage to hours outside of the peak period of electricity demand.

HACO industries, a producer of  stationery products, shavers, personal-care and household-hygiene items in Kenya, decreased its energy use by more than 10% by installing internal meters to monitor the consumption trends in different user zones, increasing the awareness of staff by putting up ‚switch off the lights' stickers and replacing light bulbs. The company also conducted heat-loss measurements and insulated heaters. Further savings were achieved by increasing the use of natural light, by switching from electrical heating to steam heating in some areas and by using wind-driven cyclones instead of electric fans.

**Metalexacto**

Before



After

## Resources

| | |
|---|---|
| UNEP Energy Efficiency Guide for Industry in Asia | www.energyefficiencyasia.org |
| UNEP Guidelines for the Integration of Cleaner Production and Energy Efficiency | www.unep.fr/energy/activities/cpee/manual/htm |
| Energy unit conversion calculator | www.unit-conversion.info/energy.html |
| A Manual for the Preparers and Users of Eco-Efficiency Indicators, UNCTAD 2004 | www.unctad.org |

## 3.2 Indicator 2: Materials Use

Materials used in production can be from non-renewable or renewable resources, recycled or reused. All use of materials involves significant environmental impacts stemming from the extraction, mining or cultivation and harvesting phases, and the transport, use, and disposal of the material. Materials consumption contributes to the depletion of natural resources, and the pollution of air, water and soil. It can be associated with deforestation and disruption of ecosystems. The transport of materials gives rise to air pollution and emissions that contribute to global warming. The severity of environmental impacts from the production and use of materials is dependent on many factors that are not related to weight, e.g., toxicity, flammability, renewable or non-renewable origin, etc. None the less, it makes sense to consider the total volume of materials used in the production, as every ton of material has to be handled, and that requires energy and can give rise to emissions into the environment.

Materials efficiency through decreased use, recycling, and reuse will decrease negative environmental impacts throughout the life cycle of products and will increase your company's productivity.

| Materials indicators | Reference indicator | Conversion | | |
|---|---|---|---|---|
| • Total materials use, in t/yr<br>• Materials productivity | Product output, in units/yr, tons/yr, kl/yr or USD/yr | 1 ton<br>1 kton | =<br>= | 1,000 kg<br>1 million kg |

**Total materials use should include**

Materials purchased from external suppliers, materials from internal sources (extraction, harvesting), including:

- Raw materials
- Associated process materials (materials that are needed for production but are not part of the final product, e.g., lubricants for machinery)
- Semi-manufactured goods or parts that are part of the final product
- Materials for packaging purposes

**Getting data**

- Invoices from suppliers
- Weighbridge data
- Incoming goods records
- Receipts/bills
- Inventory

**Possible challenges and solutions**

- **Dealing with a large variety of materials.** Materials used often comprise a large number of different types of materials in varying quantities, and it may be a challenge to make the necessary measurements and calculations. An input-output balance sheet may be a useful tool to estimate consumption of materials. An option might be to exclude, for example, all types of materials used that constitute less than 0.1 or 0.5 % of the total materials used. Alternatively, non-process-related materials used could be excluded (e.g., office and laboratory requirements could be excluded to focus on materials efficiency in the main production processes).

- **Reuse of materials.** If you purchase recycled materials, then these should be included in your total. However, if you reuse materials on the site, then you should not include this quantity in your total, since you have already included it once. For example, chemicals recovered from waste water and reused in the production process should not be added to the total, since you already added them when they first entered your company.

- **Dealing with non-standard units.** To be able to compare input quantities, these need to be recorded in a standard unit measurement of tons. Inputs of materials sourced in non-standard units or volumes (e.g., bags of rice, bushels of wood, containers of detergent) will have to be weighed, then specific conversion rates can be developed for further use, e.g.:

| Material | Unit | weight of one unit (conversion factor) | Number of units per year | Total in tons |
|---|---|---|---|---|
| Rice | Bag | 0.01 tons | 42 | 0.42 |

**Calculate materials use**

**Step 1:** Make a spreadsheet or use an available spreadsheet. Label your spreadsheet columns, for example: A (inputs of materials), B (quantity),, C (units), D (conversion factors), E (materials in tons).

**Step 2:** List all direct and indirect materials that enter your boundary in column A. Inputs include materials directly incorporated in product, coproducts, indirect materials such as pump lubricants, and solvents. Exclude fuels.

**Step 3:** Collect usage data for each of the inputs of materials in column A. Your purchasing department should have the information in invoices or bills. Make sure that your data are applicable to your reporting period. Enter the quantities of materials in column B.

**Step 4:** Enter in column C the units referring to the quantities provided in column B.

**Step 5:** Convert each of your inputs of materials into a common unit of measurement (tons). Enter appropriate conversion factors in column D. Multiply the value in column B by the conversion factor in D for each of your materials and enter the results in column E.

**Step 6:** Sum all the weights of inputs into one number representing the total of materials entering your boundary.

**Improving performance**

**Review procedures**
Modifying existing procedures to prevent waste from spills or leaks will help to decrease the quantities of materials that you need to purchase and can also save money in clean-up costs.

**Train your staff**
Provide employees with information and incentives to minimize the wasting of materials in their daily duties. Train employees to use equipment and supplies properly.

**Keep an up-to-date inventory**
An inventory can help to ensure that materials are ordered when needed, and that materials are used ahead of their use-by date.

**Reuse materials**
Many of the materials that end up in waste water or as waste can be reclaimed and reused.

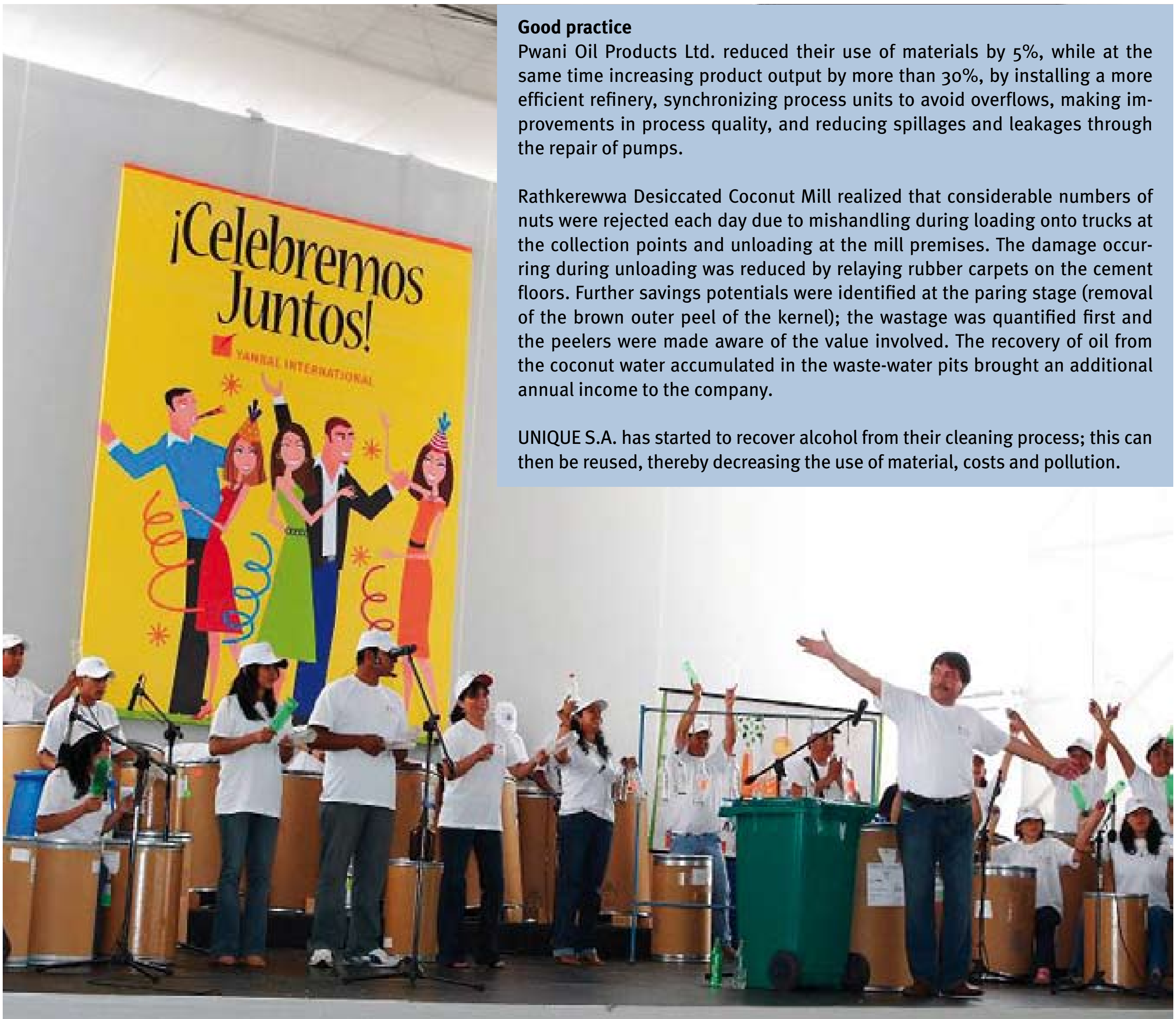
**Review control and storage of incoming goods**
Ensure that materials delivered correspond to the specification before allowing them to be offloaded and stored in your warehouse, in accordance with your procurement standards. Inventory techniques such as „first-in, first-out" or „just-in-time" delivery reduce waste and losses of materials or product from expiration or overstocking.

**Redesign products and packaging**
Review products and their packaging, and eliminate components that are not necessary for product performance and appearance. Smaller and lighter products may not only require less material, but can also lead to decreased transportation and storage costs. You can even go further and create services that produce the same benefit for customers and may replace physical products.

**Good practice**
Pwani Oil Products Ltd. reduced their use of materials by 5%, while at the same time increasing product output by more than 30%, by installing a more efficient refinery, synchronizing process units to avoid overflows, making improvements in process quality, and reducing spillages and leakages through the repair of pumps.

Rathkerewwa Desiccated Coconut Mill realized that considerable numbers of nuts were rejected each day due to mishandling during loading onto trucks at the collection points and unloading at the mill premises. The damage occurring during unloading was reduced by relaying rubber carpets on the cement floors. Further savings potentials were identified at the paring stage (removal of the brown outer peel of the kernel); the wastage was quantified first and the peelers were made aware of the value involved. The recovery of oil from the coconut water accumulated in the waste-water pits brought an additional annual income to the company.

UNIQUE S.A. has started to recover alcohol from their cleaning process; this can then be reused, thereby decreasing the use of material, costs and pollution.




Workers performing with recycled materials at the presentation of the RECP programme at UNIQUE in Peru

**Resources**

| | |
|---|---|
| Weight and mass unit conversion calculator | www.unit-conversion.info/weight.html |
| OECD (2008). A Study of Methodologies Relevant to the OECD Approach on Sustainable Materials Management. | www.olis.oecd.org/olis/2007doc.nsf/LinkTo/NT00008902/$FILE/JT03250103.PDF |

## 3.3 Indicator 3: Water Use

Water, in particular fresh water of potable quality, is a limited resource. Access to fresh water is central to the wellbeing of communities and ecosystems. Unnecessary water consumption means that there is less clean and safe water available for other purposes. Moreover, the provision of water to your premises gives rise to negative environmental impacts. Extraction may lower water tables; pumping requires energy; and treatment to suitable standards requires chemicals and energy. Water is often treated as an inexpensive and abundant resource, until all of a sudden it becomes scarce, which may pose a constraint for production. Moreover, the more water is used, the more water needs to be handled, pumped, heated, cooled, evaporated, all of which require energy, and may occasion more leaks, spills and other losses.

Decreasing water use, including by recycling and reuse, saves costs and decreases pressure on a limited resource. It can also protect the company from risks resulting from disruptions in supply, decreased availability and increased costs. In some areas, water-use patterns can influence relationships with neighbours and the local community.

| Water indicators | Reference indicator | Conversion | | |
|---|---|---|---|---|
| • Total water use, in kl/yr or m³/yr<br>• Water productivity | Product output, in units/yr, tons/yr, kl/yr or USD/yr | 1 kl<br>1 kl | =<br>= | 1 m³<br>1,000 l |

| Total water use should cover water sourced from | Getting data |
|---|---|
| • Municipal water supplies or other utilities<br>• Surface water (wetlands, rivers, lakes, oceans)<br>• Groundwater (including water from your own or external wells)<br>• Rainwater harvested and used<br>• Waste water from other organizations | • Invoices from suppliers<br>• Receipts/bills<br>• Measurements<br>• Meters<br>• Calculations<br>• Estimates |

**Possible challenges and solutions**

- **Recalculating other units into volume.** If invoices from utilities or suppliers do not provide volume, estimate the volume by taking measurements and multiplying by number of units (tanks, etc.) used, or install water-metering equipment.

- **Dealing with different sources.** If water is obtained from different sources (municipal water supply, harvesting of rainwater, own wells, etc.), measure or estimate the volume of water used from each source and add up the volumes.

- **Losses from leaks or accidental discharges.** Your water use includes water wasted through leaks or accidental discharges. Use a bucket and measure how long it takes to fill in order to estimate the volume of water lost. In addition, of course, repair your pipes, invest in new ones and improve your routines to avoid accidental damage to pipes.

- **On-site recycling and reuse.** In your total, do not include the water that you recycle and reuse on-site, since you have already counted this water when it first entered your company or when you extracted it.

- **Calculation of flows, discharge rates and evaporation.** You should focus on the level of detail that is suited to your needs and resources. If you need to make calculations at the process level, online calculators and conversion rates are available, for example, at www.gemi.org.

**Calculate water use**

**Step 1:** Make a spreadsheet or use an available spreadsheet. Label your spreadsheet columns, for example: A (water source), B (quantity), C (units), D (conversion factors), E (water, in kl or m³).

**Step 2:** Enter your water sources in column A.

**Step 3:** Collect usage data for each of the water sources in column A. Make sure that the data collected are relevant to the reporting period. Enter the quantity of water in column B.

**Step 4:** Enter in column C the units referring to the quantities entered in column B.

**Step 5:** If the information on the water entering your boundary is not in your selected unit of measurement (kilolitres or cubic metres), enter conversion factors in column D. Multiply the value in column B by the conversion factor in column D for each of your water sources. Enter these values in column E.

**Step 6:** Sum the values in column E to obtain the total water consumed in kl or m³.

**Improving performance**

**Use the right quality for the right purpose, recycle and reuse**
Significant water savings can be achieved by ensuring that the quality of water is suited to the purpose. For some processes, there is no need to use pure or very clean water. Instead, water recycled from another process can be utilized. For many rinsing or cleaning purposes, countercurrent or spray rinsing processes can be implemented.

The condensate from air conditioners, dehumidifiers, and refrigeration units can provide a steady supply of relatively pure water for many processes. Because condensate water is relatively free of minerals and other solids, it could be used for cooling towers, boiler makeup and reverse-osmosis feed water, or for drip-irrigation.

**Train your staff**
Provide employees with information and incentives to minimize water use in their daily duties. Train employees to use equipment and supplies properly.

**Maintain your equipment**
Schedule regular checks of your water system. Ensure that leaks in pipes, taps and other equipment are found and fixed. Install metering equipment and monitor it regularly.

**Switch to dry operations**
Avoid the use of water where possible, for example, use a broom instead of a hose to clean, and transport goods on a belt rather than in a water channel.

**Use the right amount**
Review processes that use water to verify that the quantity of water used is suited to the purpose. Water-saving taps and other fixtures require small investments, but can provide significant savings potentials. Try to find ways of eliminating unnecessary water use.

In equipment cooling, you can replace single-pass cooling systems, where water is circulated once through a piece of equipment and then discharged to a sewer, with a process or cooling loop.

**Run full loads**
Washers and other equipment use the same amount of water regardless of their load, so fill them up before running them to improve water productivity

**Redesign your processes**
Look for possibilities to redesign your processes so as to use less water or develop processes that do not require water. If water is needed, then operate the process at the highest possible intensity, since materials and energy can be more easily recovered at higher concentrations and temperatures.

**Good practice**
La Pisqueña, a tannery in Peru, decreased its water consumption through implementation of water timers that allow for measurement and control of the feed water.

Pwani Oil Products Ltd. achieved a 25% reduction in water use by fixing and sealing of leaks, on-site treatment and reuse of waste water, reuse of process water for flushing and cleaning, trapping of condensate and metering of all major water-consuming units.

Kandalama Hotel in Sri Lanka reduced water use by almost 10% by operating dishwashers at full capacity, operating laundry machines at full capacity, installing a dishwasher in the employees' kitchen, training employees and attending to housekeeping. The hotel also improved the quality of waste water by segregating and adding an extra filter. The water is recycled for urinals and gardening.

HACO industries Ltd. switched from cleaning vessels with running water hoses to cycle batch cleaning, where the company meters the amount of water going into the vessel, cleans, discharges the water, and rinses with a metered quantity of water, so that less water is used with better results. Similarly, new cleaning procedures have been established, whereby, instead of using running water hoses for cleaning, fixed-quantity cleaning with a mop and bucket is now used. Water meters have been installed at four major water-consumption points. Procedures have been improved, and now all tank outlets (except the fire tank) are closed at the end of the shift.

Scenic view of Heritance Kandalama Hotel with rich biodiversity

**Resources**

| | |
|---|---|
| Water for Business - Overview of water management tools | www.wbcsd.org |
| World Business Council for Sustainable Development - Global Water Tool | www.wbcsd.org |
| Global Environmental Management Initiative – Water Sustainability Planner | www.gemi.org/waterplanner |
| Global Environmental Management Initiative - Connecting the Drops | www.gemi.org/water/index.htm |
| The Corporate Water Gauge | www.sustainableinnovation.org |
| Liquid unit conversion calculator | www.unit-conversion.info/volume.html |

## 3.4 Indicator 4: Air Emissions

Business activities generally cause a diversity of air emissions, including flue gases from combustion of fuels on site and emissions from processes (e.g., solvents from cleaning and coating operations, dust from milling operations, etc.). Their impact on the environment and human health varies widely, and is dependent on the toxicity and nature of the emissions and factors, such as weather conditions, affecting distribution and dispersion in the receiving environment. The indicator system focuses on emissions of greenhouse gases (GHGs), as these are generated from all business activities. Other types of emissions are more dependent on the type of processes and activities of your company.

The combustion of fuels, chemical processing and other operations give rise to air emissions that contribute to global warming. Global warming is associated with large-scale, comprehensive threats to the global climate, with increased frequencies of extreme weather events, changing of precipitation patterns and on average an increase in temperatures. This poses significant risks to the environment (disturbance of natural environments, rising sea levels) and access to resources (water, food, etc.), with broad-ranging impacts on economic activity, settlements, human health, food security and well-being.

Carbon dioxide equivalent ($CO_2$ eq.) is a measure used to compare emissions from various greenhouse gases based on their global-warming potential (GWP). Carbon dioxide equivalent is derived by multiplying tons of gas by the associated GWP. In this manner, smaller emissions of highly potent GHGs (for example $CH_4$, $N_2O$ and CFCs) can be compared and added to larger volumes of emissions of less potent GHGs (mainly $CO_2$). Relevant GWPs are, for example, supplied by the Greenhouse Gas Protocol. It should be noted that the combustion of biofuels or biomass, for example wood or straw, does lead to $CO_2$ emissions (for the combustion of wood, the quantity of carbon dioxide emitted is around 0.18 kg/kWh). However, these emissions are non-anthropogenic and therefore excluded from GHG calculations, since it is assumed that the emissions are neutralized through carbon dioxide uptake during growth.

There is increased pressure on businesses to decrease their GHG emissions. In some countries, emissions-trading systems or carbon taxes have been established. By using a preventative approach, future costs can be avoided.

<table>
<tr><th>Air-emission indicators</th><th>Reference indicator</th><th colspan="3">Conversion (approx. values)<br>$CO_2$ emissions, in grams per kWh</th></tr>
<tr><td rowspan="3">• Greenhouse gas emissions, in tons of $CO_2$ eq./yr<br>• Carbon intensity</td><td rowspan="3">Product output, in units/yr, tons/yr, kl/yr or USD/yr</td><td>Natural gas</td><td>=</td><td>200</td></tr>
<tr><td>Fuel oil: light</td><td>=</td><td>260</td></tr>
<tr><td>Fuel oil: heavy</td><td>=</td><td>280</td></tr>
<tr><th colspan="2">Air emissions should include emissions from</th><th colspan="3">Getting data</th></tr>
<tr><td colspan="2">• Generation of electricity, heat, steam, including imported energy<br>• Combustion processes<br>• Physical or chemical processing<br>• Venting<br>• Fugitive emissions</td><td colspan="3">Mainly from calculations, with data derived from:<br>• Invoices from suppliers<br>• Receipts/bills<br>• Measurements<br>• Calculations<br>• Estimates/standardized emission factors for common processes<br>• Lists of conversion factors<br>• Lists of carbon content</td></tr>
<tr><th colspan="5">Possible challenges and solutions</th></tr>
<tr><td colspan="5">• Lack of information on energy mix. In some cases, electricity suppliers may not provide comprehensive information on the energy mix (types of fuels used, proportion of renewable energy, etc.) used to generate electricity. If you cannot access reliable information on how the electricity that you purchase is produced, use a generic country or regional conversion factor (available, for example, from www.unctad.org ).<br>• Difficulty finding specific carbon content of fuel used. To calculate the quantity of carbon dioxide emissions from fuel combustion, you need to know the carbon content. For most fuels, these data are readily available, but they may be difficult to find for some types of biofuels or waste. In such cases, use generic conversion factors or make estimates based on the composition of your fuel (just remember to utilize the same method for subsequent calculations).<br>• Difficulties quantifying GHG emissions in the production process. You may require additional measurement equipment or procedures for quantifying the GHG emissions from processes. You can start by using estimates or focus on $CO_2$ from energy consumption until you can implement systems for measuring or find a good method for making calculations (sector-specific guidelines could provide valuable suggestions).<br>• How to calculate $CO_2$ equivalent emissions. There are numerous guidelines for calculating $CO_2$ emissions (e.g., from UNCTAD, Greenhouse Gas Protocol). Below you will find a description of the steps involved in making calculations. The RECP indicator calculation tool includes a very basic GHG calculator that you can use.</td></tr>
</table>

**Calculate $CO_2$ emissions from energy consumption**

**Step 1:** Divide total energy sources into (a) fuels (energy combusted on site); (b) imported electricity; (c) imported steam and/or hot water; and (d) exported energy (for example, for district heating or cooling).

**Step 2:** Calculate $CO_2$ emissions from on-site combustion based on the type and quantity of fuel used. Use an equation or conversion factors.

To calculate $CO_2$ emissions using fuel-consumption and emission-factor data, the following equation can be used:

*$CO_2$ (tons) = volume, mass or heat content of fuel x carbon content of fuel on basis of volume, mass or heat x oxidation factor x (44/12).*

The oxidation factor provides the fraction of carbon in fuel that remains as soot or ash, i.e., if the oxidation factor is 98%, the remaining 2% of carbon remains as soot or ash and does not contribute to greenhouse gas emissions.
44/12 is the ratio of the molecular weight of $CO_2$ to that of carbon.

Alternatively, you can use generic, country or regional conversion factors.

**Step 3:** Calculate $CO_2$ emissions from imported electricity. You will need information on the fuel mix used by your power supplier or data on $CO_2$ emissions per energy unit, or you can use generic country or regional data, e.g., from municipalities, national authorities or UNCTAD.

**Step 4:** Calculate $CO_2$ emissions from district heating/cooling. You will need information on the fuel mix used by the district heating company or data on $CO_2$ emissions per heat energy unit, or you can use generic country or regional data, e.g., from municipalities or national authorities.

**Step 5:** Calculate $CO_2$ emissions from imported steam. You will need information on the fuel mix used by the steam supplier or data on $CO_2$ emissions per unit of steam.

**Step 6:** Aggregate your sums to obtain the total $CO_2$ from energy consumption.

In order to monitor performance, the same method and same sources of data have to be used for each successive measurement period to ensure that the information is comparable. If you change the method of calculation or measurement, you will need to revisit your previous values and make corresponding changes.

**Calculate $CO_2$ equivalent from other sources**

**Step 1:** Make an inventory of greenhouse gases that you use or emit. The main ones are carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$) and chlorofluorocarbons (CFCs).

**Step 2:** Calculate $CO_2$ equivalent by multiplying the quantity of gas with the global warming potential (GWP). GWP tables can be found from the Greenhouse Gas Protocol. For instance, methane has a GWP of 21; nitrous oxide has a GWP of 310.

**Step 3:** Add your total $CO_2$ equivalent from process sources to the total $CO_2$ from energy consumption.

For example, if you emit 100 tons of methane, you look up the GWP, which is 21. Your methane emissions are equivalent to 2,100 tons of $CO_2$.

**Improving performance**

**Decrease energy consumption**
A decrease in the use of fossil fuel will lead to a decrease in emissions.

**Target GHGs in your processes**
Improve process controls to reduce the generation and emission of GHGs. Investigate opportunities for substitution in processes that give rise to GHG emissions.

**Substitute**
Assess your energy sources to find options for switching to renewable fuels or other fuels with lower carbon content. Investigate possibilities for purchasing electricity or heat from power utilities or district heating companies that use renewable energy sources.

**Good practice**
Rathkerewwa Desiccated Coconut Mill switched from furnace oil to coconut shell in their boiler, thereby reducing their annual emissions of $CO_2$ by more than 900 tons.

Pwani Oil Products Ltd. switched to biofuel to run boilers and obviated the need for furnace oil combustion by installing new biomass boilers, thereby almost eliminating $CO_2$ emissions from combustion.

**Resources**

| | |
|---|---|
| The Greenhouse Gas Protocol Initiative | www.ghgprotocol.org |
| A Manual for the Preparers and Users of Eco-Efficiency Indicators, UNCTAD 2004 | www.unctad.org |
| Simple carbon calculator | www.nef.org.uk/greencompany/co2calculator.htm |
| UNEP GHG calculation tool for enterprises in Asia | www.energyefficiencyasia.org/docs/SimplifiedGHG-Calculator.xls |
| UNEP Guidelines for Calculating Greenhouse Gas Emissions for Businesses and Non-Commercial Organizations | www.unep.fr/energy/information/tools/ghg/ |
| CAMSAT - Carbon Management Self Assessment Tool | www.unep.fr/energy/information/tools/camsat/ |
| Global Environmental Management Initiative - Business and Climate Change | www.gemi.org/businessandclimate |

## 3.5 Indicator 5: Waste Water

The potential environmental impact from waste-water generation depends on the level or concentration and type of pollutant. Common pollutants include organic matter (typically measured in terms of its Chemical Oxygen Demand (COD) and/or Biological Oxygen Demand (BOD)); nutrients; metals, particularly heavy metals; and toxic substances. Thermal pollution (discharge of water that is hotter or colder than the body of water into which you discharge) can also cause adverse environmental effects. The actual occurrence of an environmental impact then depends on the type of treatment that is used and the characteristics of the receiving body of water. Untreated waste-water emissions can have a significant impact on the health of aquatic ecosystems and pose a threat to human health. However, even treated waste water may contain chemicals or biological matter that can have considerable negative impacts.

Waste-water costs are related to disposal and treatment. The total volume of waste water indicates the scale of your company's waste-water issues, and can be used as an indicator to monitor your performance in regard to quantity. However, you should note that the quantity of waste water does not give an adequate measurement of impacts on the environment and human health. Similarly, the costs of treatment and disposal are dependent not only on the quantity of water, but also on the quality of the water, i.e., pollution loads.

| Waste-water indicators | Reference indicator | Conversion | | |
|---|---|---|---|---|
| • Total waste water, in kl/yr or $m^3$/yr<br>• Waste-water intensity | Product output, in units/yr, tons/yr, kl/yr or USD/yr | 1 kl<br>1 kl | =<br>= | 1 $m^3$<br>1,000 l |

| Waste water should include | Getting data |
|---|---|
| • Waste water that leaves the company boundaries by pipes, tanks or other forms of removal<br>• Water from processes, sanitary uses, cleaning<br>• Unplanned discharges, providing that the volume can be measured/estimated<br>• Water seepage into groundwater | • Invoices from waste-water authority of effluent-treatment plant<br>• Receipts/bills<br>• Measurements<br>• Water-balance calculations<br>• Estimates based on emission factors and industry benchmarks |

**Possible challenges and solutions**

- **Quantification of volume on the basis of utility invoices.** In some cases, water utilities may not charge per volume of water discharged. If you do not have your own metering system and the utility charges are based on pollution load, use pollution load as the measurement unit. If you are charged a fixed fee, then you have to make your own measurements, calculations or estimates. It is a good idea to install water meters at discharge points (points where the water leaves the company boundary).

- **Exclusion of certain water flows.** Unpolluted water flows (e.g., cooling water) that that you use on the site and discharge do not need to be included in total waste water, provided that the quality (chemical and biological load) of water remains unchanged or has been improved. However, the quality of the water that you discharge directly into water bodies needs to be checked regularly.

- **Making of calculations and estimates.** If you have no water meters and no information from waste-water utilities, then you have to make calculations and estimates. Make a water balance, starting with your water consumption, minus the amount of water that is inside your products, minus the water stored on the site, and the remainder should roughly correspond to your waste-water volume.

- **Incomplete data from meters.** If you have water meters only at some discharge points, make calculations/estimates for the remaining quantities.

**Calculate waste water**

**Step 1:** Make a spreadsheet or use an available spreadsheet. Label your spreadsheet columns, for example: A (types of waste water), B (quantity), C (units), D (conversion factors), E (waste water, in kl or $m^3$).

**Step 2:** Make a list in column A of the types of waste water that leave your boundary.

**Step 3:** Collect the discharge data for each type of waste water in column A. Make sure that the data are relevant to the reporting period. Enter the quantity of each of the wastes in column B.

**Step 4:** Enter in column C the units referring to the waste quantities in column B.

**Step 5:** If the units differ from your indicator unit (kl or m3), enter conversion factors for each waste-water flow in column D. Multiply the value in column B by the conversion factor in column D for each of your waste-water types. Place the results in column E.

**Step 6:** Sum all the $m^3$ or kl of waste water into a total.

**Improving performance**

**Decrease water consumption**
A decrease in water consumption will reduce generation of waste water.

**Train your staff**
Provide employees with information and incentives to minimize waste-water generation in their daily duties. Train employees to practice proper and efficient use of equipment and supplies.

**Reuse water**
Water can be reused in many processes instead of being discharged directly.

**Invest in on-site treatment and reuse the water**
Partial treatment of water on the site can open up more opportunities for reuse. On-site treatment of water from specific processes could also let you collect and reuse valuable materials.

**Keep different types of water separated**
If water flows of different qualities (e.g., water from the final rinsing processes and highly polluted water from dyeing processes) are not mixed, it is easier to reuse, recycle and treat the waste water.

**Good practice**
By improving the quality of waste water by segregating and adding an extra filter, Kandalama Hotel in Sri Lanka is able to recycle its waste water for urinals and gardening and is thus reusing approximately 95% of it.

UNIQUE S.A. has decreased waste water by more than half by increasing the efficiency of water use for the cleaning and sanitation of equipment, reusing water from processes and reusing treated waste water.

Leather workshop in India

| **Resources** | |
|---|---|
| Water for Business - Overview of water management tools | www.wbcsd.org |
| WaterWorld | www.waterworld.com |
| India Water Portal - Water for industries - Case studies | www.indiawaterportal.org/channels/water-industry |

## 3.6 Indicator 6: Waste

The environmental impacts of waste generation depend on the type of waste generated and the type of disposal and/or treatment that it is sent to. Some waste is inert (demolition rubble, concrete) and poses little risk to the environment when disposed of, but inert waste may be contaminated by substances that are not inert (e.g., paint leftovers in construction waste). Wastes that are not inert give rise to leaching, often of polluting chemicals and metals, into the soil and groundwater reservoirs. Organic waste rots and produces methane, also known as landfill gas, which is a potent greenhouse gas. The combustion of waste gives rise to air emissions; non-intentional emissions of Persistent Organic Pollutants (POPs) (e.g. dioxins and furans) are of particular concern. The formation of dioxins and furans is dependent on the composition of waste and the operating conditions inside incinerators.

For your company, waste is the proportion of purchased materials that you have not been able to convert into a marketable product and that needs to be disposed of. Costs of waste include purchasing price or cultivation costs, labour hours, depreciation of machinery and operating materials.

| Waste indicators | Reference indicator | Conversion | | |
|---|---|---|---|---|
| • Total waste, in t/yr<br>• Waste intensity | Product output, in units/yr, tons/yr, kl/yr or USD/yr | 1 ton<br>1 kton | =<br>= | 1,000 kg<br>1 million kg |

| Total waste should include | Getting data |
|---|---|
| • Waste sent to landfill<br>• Waste incinerated<br>• Hazardous waste<br>• Municipal waste<br>• Garden waste<br>• Waste sent to recycling outside your site | • Invoices/bills from disposal utilities or companies<br>• Recordings of weighbridges (at factory or landfill)<br>• Calculations<br>• Estimates |

**Possible challenges and solutions**

- **Waste utility charges by volume.** If the waste utility does not charge by weight but by volume (truckload, container), the volume can be weighed and total weight can be calculated by using the conversion factor generated. For example, one container of the volume X weighs (minus the weight of the container) Y tons. Total waste in tons will then be Y tons multiplied by the number of containers sent to the disposal company each year. If there are significant variations in the weight of the waste at different times, it is a good idea to measure the weight of the waste container at several different times and calculate an average.

- **No data on waste disposal.** If you do not receive an invoice from a waste utility, e.g., you dump the waste at a landfill without incurring charges, then, in line with the example above, the weight of a typical quantity of waste should be measured and multiplied by the number of quantities disposed of each year.

- **Waste-utility fees not based on quantity.** If you pay a monthly fee rather than being charged by volume, then weigh a representative part of the waste and make calculations based on estimates of the quantity.

- **Calculation of quantities of different waste streams.** If your waste is collected by various companies (paper collection, municipal waste collection, hazardous waste, garden waste), then the weights reflected in the different bills or invoices should be added together, or alternatively, calculations should be made for each waste stream.

- **Waste incineration.** If you incinerate your waste or part of your waste to generate electricity or heat, then this quantity should not be included in your total waste, but in your total energy calculations. Remember to calculate $CO_2$ emissions. If you simply incinerate waste without recovering energy, then the quantity should be included in total waste.

- **On-site landfilling.** If you have a landfill on the site, you should include the quantity of waste sent to landfill on the site in the total waste calculations.

- **Special waste.** Waste from special untypical or irregular occurrences such as construction should be excluded from total waste calculations, since including it would distort results.

- **Waste sold.** Waste sold as a product to another company should not be included in total waste calculations.

**Calculate waste**

**Step 1:** Make a spreadsheet or use an available spreadsheet. Label your spreadsheet columns, for example: A (types of waste), B (quantity), C (units), D (conversion factors), E (waste in tons).

**Step 2:** Make a list in column A of the types of waste that leave your boundary.

**Step 3:** Collect for each waste-water stream the amount of waste generation and enter these amounts in column A. Make sure that the data refer to the reporting period. Enter the quantity of each of the wastes in column B.

### Calculate waste

**Step 4:** Enter in column C the units referring to the waste quantities.

**Step 5:** If the units differ from your indicator unit (tons), enter conversion factors for each waste in column D.
Multiply the value 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 the tons of waste into a total.

### Improving performance

**Good housekeeping**
Establish routines to minimize waste from spills and accidents. Look at how your process can be improved to decrease unnecessary waste of materials.

**Train your staff**
Provide employees with information and incentives to minimize waste generation in their daily duties. Train employees to practice proper and efficient use of equipment and supplies.

**Reuse**
Investigate possibilities for reusing left-over materials such as cut-offs. It might be possible to develop new products using materials or parts of semi-processed products previously discarded.

**Reuse packaging**
Purchasing materials in reusable containers or packaging will decrease waste. Find suppliers that use less packaging for the products and materials that you purchase.

**Replace**
Substitute existing raw materials with other materials that give rise to less waste.

**Separate and segregate your wastes**
If you avoid mixing different types of wastes, then it will be easier to reuse and recycle.

**Compost organic waste**
Organic waste is a valuable resource, and composting systems are cheap and easy to establish. Compost can be used for your cultivation or gardens, or can be sold to local gardens or farms.

**Generate electricity from waste**
Waste can be incinerated to generate electricity and heat. Waste can be fermented into biogas that can be used to operate processes and for cooking.

**Sell or share your waste**
Your waste may be usable by other companies as input material, and can either be sold to generate income or given away to decrease waste and waste-related costs.


Elephant dung incorporated in the paper recycling plant

**Good practice**
Kandalama Hotel segregates its solid wastes into 16 different categories; biodegradable waste is composted and the compost is used in the garden to grow organic vegetables.

The hotel intends to generate biogas in 2010 to use in the employee kitchen. Most of the containers and packaging are being reused or returned to suppliers. Some wastes are being given out to micro-industries in the villages.

### Resources

| | |
|---|---|
| European Topic Centre on Sustainable Consumption and Production | http://scp.eionet.europa.eu/themes/waste |
| UNEP. Waste Minimization | www.unep.fr/scp/waste/minimization.htm |
| UNEP (2009). Converting Waste Plastics into a Resource. Compendium of Technologies. | www.unep.or.jp/Ietc/Publications/spc/WastePlasticsEST_Compendium.pdf |
| UNEP (2009). Converting Waste Agricultural Biomass into a Resource. Compendium of Technologies. | www.unep.or.jp/Ietc/Publications/spc/WasteAgriculturalBiomassEST_Compendium.pdf |

## 3.7 Reference indicator: Production

Product output is a measurement of the products or services that your company produces. In principle it should be measured in physical units, for example, weight, volume or units (e.g., hospital days, containers). Only when physical units of different products or services cannot meaningfully be summed, can their monetary value be taken as a substitute. In this case, it might be useful to express the indicator in terms of local currency and an international reference currency, for example, USD.

| Production indicators | Reference unit | Conversion |
|---|---|---|
| • Product output, in units/yr, tons/yr, kl/yr or USD/yr | n/a | n/a |
| **Product output** | | **Getting data** |
| • The core product-output indicator covers the economic output of the enterprise. It can either be measured in terms of physical units (tons, kl, units or otherwise) of production or service, or in terms of the economic value of products or services (sales value). | | • Sales figures<br>• Inventory<br>• Measurement<br>• Calculations<br>• Estimates |

**Possible challenges and solutions**

- **Difficulties in choosing the right unit.** Physical units are generally to be preferred, but fail to take into consideration improvements in product quality (and hence sales price). However, sales values can also be influenced by other factors such as inflation and other price fluctuations and may not necessarily provide a reflection of quality enhancement. For service providers, relevant units could be service units (e.g., number of hotel-guest nights/yr, number of patients treated/year) or sales figures.

- **Chosen unit does not reflect improvements.** If you have used the unit tons/yr in your baseline, but have since made product improvements and have decreased the weight of your products, and you consider that further use of the unit tons/yr will not provide a good measurement of your performance, then establish a new baseline (this can be done retroactively) using a different unit.

**Improving performance**

**Innovate**
RECP is a powerful tool for driving innovation. Look at your routines, processes, products and packaging to find ways of making more out of less. Eco-innovation is basically about changing the way you use materials, and adapting your processes and distribution methods so that you produce more goods or services with less energy and fewer resources. Eco-efficient businesses get more value out of their raw materials, while producing less waste and less pollution.

**Add value**
Investigate possibilities for adding value to products, for instance, by means of further processing. If you are now selling untreated wood at a relatively low price, investigate the profitability of investing in processing and selling, for example, sawn wood, wood products, etc., that will fetch a higher price.

**Develop new products**
Product output can be increased by extending your product line, for example, by utilizing waste resources in the production of new products.

**Good practice**
Makss is a manufacturer of cardboard packaging materials in Kampala, Uganda. Makss was producing boxes that were outdated in regard to transportation and customer requirements and that were resource-intensive. With the assistance of the Ugandan National Centre for Cleaner Production, the company created new products that were cheaper to produce and resulted in less waste. Reducing the weight of the product meant that less materials were required for production. The company improved their production process; the production of the box involves one production process fewer, since the new box is a one-piece box. Off-cuts are used for making pads for other boxes. The box is sold at a cheaper price to the customer; cargo charges are lower, since it is lighter. Functionality and customer satisfaction have been improved, since the stability and ventilation are better; the new easy-locking system saves handling time; and a one-piece box is easier to handle, since less space is needed for packing[5].

| Resources | |
|---|---|
| ECODESIGN Information Platform | www.ecodesign.at/methodik/index.en.html |
| UNIDO CP Toolkit, Volume 5 | www.unido.org/index.php?id=086205 |
| UNEP Cleaner Production Companion | www.uneptie.org/scp/publications/details.asp?id=DTI/0579/PA |
| The Efficient Entrepreneur: A Calendar for Small and Medium-Sized Enterprises. | www.unep.fr/scp/publications/details.asp?id=WEB/0050/PA |
| OECD (2009), Eco-Innovation in Industry: Enabling Green Growth. | http://browse.oecdbookshop.org/oecd/pdfs/browseit/9209061E.PDF |

5 UNIDO (no date - a).

# 4 RESOURCE PRODUCTIVITY AND POLLUTION INTENSITY

In order to track your progress in reducing the use of materials, energy and water and decreasing waste and emissions, measurements should be repeated at regular intervals. This will help you to identify trends and track progress from one year to the next. It can also provide you with incentives to continue to work on RECP, as well as helping you to assess the effectiveness of measures.

The baseline comprises data that define the situation before RECP measures have been implemented, and is normally established using the latest set of historical data available immediately before the start of the RECP initiative. The following measurements would then typically be made after the implementation of the first set of RECP opportunities, and thereafter at fixed time intervals. Remember that you can make measurements as often as is practical for you, but in order to make it possible to compare data, you must always use the same time period, so you will have to compute your measurements to correspond to the time period used for your baseline values.

The difference between the baseline and subsequent data is then calculated as a percentage. For example, you measure your materials use to be 1,000 tons each year prior to implementing RECP. This represents your baseline (B). After making an assessment and implementing RECP options, you make another measurement, which shows that your materials use amounts to 900 tons annually. This represents your first follow-up value (A). To understand how this new value relates to the baseline, you then calculate the change (C). To calculate the change in per cent, use the following equation:

Change (C) = 100* (A-B)/B
For this example, Change (C) = 100*(900-1000)/1000 = -10%. This means that materials use has decreased by 10%.

This percentage shows the results in terms of your absolute indicators, i.e., it shows whether resource use or pollution has increased or decreased and by how much. The absolute indicators provide a measurement of your environmental impact in terms of the amount of resources you use and how much pollution you generate.

A time-series comparison of absolute indicators does not take into consideration changes in your business operations. Considering only decreases or increases in the consumption of resources without considering the quantity of production as a reference may lead to incorrect interpretations.

For example, when your product output increases, this will typically lead to increased resource use and usually also increased quantities of pollution. If you only track absolute indicators and, as you are implementing RECP, your production also increases, it might seem as though you are not getting results. Your resource use in absolute terms may have increased, but you may be producing more product output per unit of resource use, which means that you have increased your resource productivity. Similarly, a decrease in product output would typically also involve a decrease in the use of resources (including materials, water and energy). When it is only reported that resource use has decreased, it remains unclear whether this has indeed been achieved through greater productivity. When product output has also decreased, however, the same or even more resources might have been used per unit of production. Therefore, you need a more suitable way of tracking your progress.

It is important to understand and track resource productivity and pollution intensity, since they provide a measurement of the results of RECP in relation to your product output. Through a time-series comparison of productivity and intensity, you will be able to track the results of your efforts to decrease the quantity of inputs you need to produce products or services and decrease the quantity of pollution that you generate per unit of product or service that you produce.

## 4.1 Resource Productivity

Product output refers to the volume, value or quantity of goods and services that you produce (see section 3.7). Productivity, on the other hand, is a measurement that shows how much product you produce per unit of resource used. It is important to note that increases in production do not necessarily result in increased productivity. If an increase in production is brought about with an increase in resource use (materials, water and energy), production will have increased, but productivity will have remained constant or may even have decreased.

Resource productivity, whether in respect of water, energy, or materials, can be measured by dividing the product output by the amount of the respective resource used. Resource productivity is a measure of how productively resources are being used to produce the desired products and/or services. It improves as less water, energy, and materials are used per unit of product output of the company.

By dividing your product output by resource use, you will obtain a value that represents your resource productivity. For example, if you produce 1,000 tons of product and use 1,300 tons of materials, your materials-productivity ratio = 1,000/1,300 = 0.77. This value shows you how much product you produce per unit of resource input. From the point of view of sustainability, as well as from the economic perspective, the more product output you produce per unit of input resource, the better you are doing.

To track your progress, you need to compare the productivity ratios that you have achieved after implementing RECP with your baseline ratios. For example, if in your baseline you produced 900 tons of product using 1,050 tons of material, and after implementing RECP, you increased product output to 1,000 tons while using 1,050 tons of material, you succeeded in increasing your resource productivity by 10%.

| **Baseline** | **Baseline (B) productivity ratio** (product output/ resource use) | **Follow-up** | **Follow-up (A) productivity ratio** (product output/ resource use) | **Change (C)** (C= 100* (A-B)/B) |
|---|---|---|---|---|
| Product output: 900 tons | 900/1,050 = 0.86 | Product output: 1,000 tons | 1,000/1,050 = 0.95 | C=100* (0.95-0.86)/0.86 = 10% |
| Materials use: 1,050 tons | | Materials use: 1,050 tons | | |

In your baseline, you produced 900 tons of product using 1,050 tons of materials. After implementing RECP, you decreased your use of materials to 1,000 tons, while product output remained at 900 tons. You succeeded in increasing your resource productivity by 5%.

| **Baseline** | **Baseline (B) productivity ratio** (product output/ resource use) | **Follow-up** | **Follow-up (A) productivity ratio** (product output/ resource use) | **Change (C)** (C= 100* (A-B)/B) |
|---|---|---|---|---|
| Product output: 900 tons | 900/1,050 = 0.86 | Product output: 900 tons | 900/1,000 = 0.9 | C=100* (0.9-0.86)/0.86 = 5% |
| Materials use: 1,050 tons | | Materials use: 1,000 tons | | |

These calculations are performed automatically by the RECP indicator calculation tool that accompanies this Indicator Primer (available from www.unido.org/cp ). You enter the baseline data for the absolute indicators and the data for the absolute indicators after implementation and follow-up of RECP. The tool then calculates and reports the resource-productivity indicators.

## 4.2 Pollution intensity

Pollution refers to the volume or quantity of pollution that you generate, while pollution intensity is a measurement of how much pollution you generate per unit of product output. In measuring pollution intensity, waste and emissions are seen in relation to production. A decrease, for example, in waste intensity means that you have decreased the quantity of waste generated per unit of product output. Progress in decreasing environmental burdens can be monitored by comparing pollution-intensity levels over time.

Division of pollution generation by product output provides an indicator for pollution intensity. For example, you produce 1,000 tons of product output and generate 300 tons of waste. Your waste intensity ratio = 300/1,000 = 0.3. This value shows how much pollution you generate per unit of product output. From the point of view of sustainability, the less pollution per unit of product output you are generating, the better you are doing. This is generally also the case from the economic point of view, since typically you have to pay for the disposal and treatment of waste and emissions, either through direct fees to utilities or through environmental taxes. The pollution-intensity indicators can be calculated for each of the three core pollution indicators, i.e., greenhouse-gas emissions, air emissions and effluent generation.

To track your progress, you need to compare the intensity ratios that you have achieved after implementing RECP with your baseline ratios. For example, if in your baseline you produced 900 tons of product output and generated 150 tons of waste, and after implementing RECP, you produced 1,000 tons of product output and generated 150 tons of waste, you succeeded in decreasing your pollution intensity by 12%.

| **Baseline** | **Baseline (B) productivity ratio** (pollution/product output) | **Follow-up** | **Follow-up (A) productivity ratio** (pollution/product output) | **Change (C)** (C= 100* (A-B)/B) |
|---|---|---|---|---|
| Product output: 900 tons | 150/900 = 0.17 | Product output: 1,000 tons | 150/1,000= 0.15 | C=100* (0.15-0.17)/0.17 = -12% |
| Waste: 150 tons | | Waste: 150 tons | | |

In your baseline, you produced 900 tons of product and 150 tons of waste. If, after implementing RECP, you produced 900 tons of product output and generated 75 tons of waste, you succeeded in decreasing your pollution intensity by 50%.

| **Baseline** | **Baseline (B) productivity ratio** (pollution/product output) | **Follow-up** | **Follow-up (A) productivity ratio** (pollution/product output) | **Change (C)** (C= 100* (A-B)/B) |
|---|---|---|---|---|
| Product output: 900 tons | 150/900 = 0.17 | Product output: 900 tons | 75/900= 0.08 | C=100* (0.08-0.17)/0.17 = -50% |
| Waste: 150 tons | | Waste: 75 tons | | |

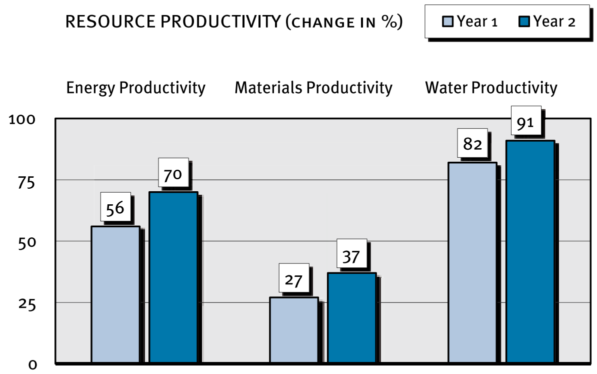
These calculations are performed automatically by the RECP indicator calculation tool that accompanies this Indicator Primer (available from www.unido.org/cp ). You enter the baseline data for the absolute indicators and the data for the absolute indicators after implementation and follow-up of RECP. The tool then calculates and reports the pollution-intensity indicators.

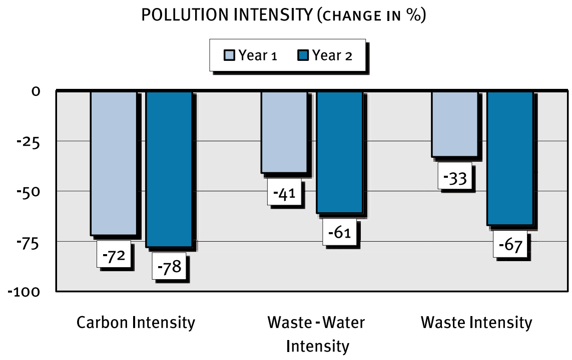
## 4.3 RECP Profile

Changes in the three resource-productivity indicators and the three pollution-intensity indicators can be collectively presented in an RECP profile. This visualizes your company's progress in improving the key resource-productivity and pollution-intensity indicators over time. The RECP indicator calculation tool automatically creates your RECP profile on the basis of the data that you enter. Your RECP profile will consist of two graphs, one for resource productivity and one for pollution intensity. Your RECP results will be shown as the change in percentage compared to the baseline. Your baseline has the value of zero on the x-axis. Increases are shown as positive percentages and decreases are shown as negative percentages.

To sustain progress in respect of RECP, the objective is to increase resource productivity and decrease pollution intensity. In the resource-productivity graph, when you reach the upper limits of the scale, you need to increase the scale and continue to improve your productivity by reducing materials use, innovating, redesigning your products or developing product services. There are no set limitations on how much you can increase your resource productivity. In the pollution-intensity graph, the goal is to reach -100% (minus one hundred per cent), which corresponds to a decrease in pollution intensity of 100% compared to your baseline. While reaching -100% is a cause for celebration, it does not mean that your RECP work is done; it means that you should expand your boundaries and work on decreasing the environmental burdens of your company along the whole value chain. Section 6 provides some suggestions on how you can do this. There is, of course, no need to wait. Start to expand your indicator system and your boundaries as soon as you have established smoothly functioning routines for implementing RECP and tracking progress.

## RECP Profile



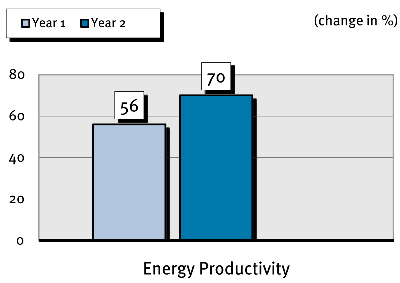



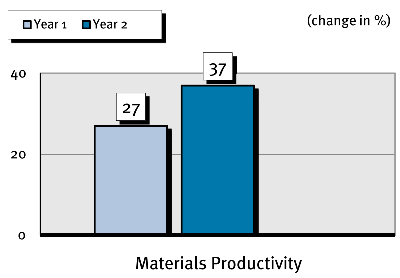

In this example, RECP has been implemented through two consecutive periods, and in addition to the baseline, two follow-up measurements have been made. For energy productivity, the first follow-up measurement showed a 56% increase in productivity, i.e., the company was producing 56% more product output per energy unit. The second follow-up measurement showed a 70% increase in productivity, again compared to the baseline. This means that the company had increased its productivity by 14% during the period between the first follow-up measurement and the second follow-up measurement.

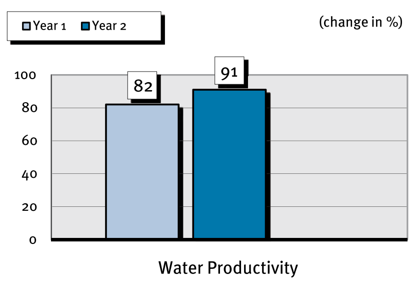
When tracking progress internally and when reporting results, it may be beneficial to review or present progress in a certain area. For this purpose, the RECP indicator calculation tool provides you with a set of six complementary graphs that can either be presented together as a set or individually, depending on what you wish to communicate or review.

## RECP Profile - extended

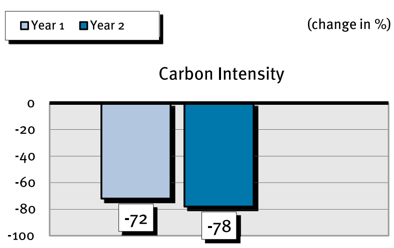
**RESOURCE PRODUCTIVITY**

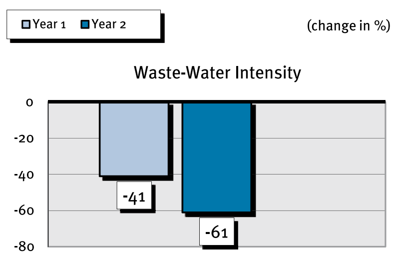


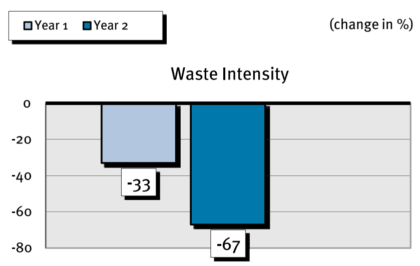




**POLLUTION INTENSITY**




These graphs are based on the same data as were presented in the previous figure.

Setting targets is an important part of RECP and can help you to steadily improve your performance. You can use the RECP indicator calculation tool and RECP profile for setting targets and tracking your performance. How to do this is explained in the tool.

# 5 COMMUNICATING AND REPORTING RESULTS

After you have collected and processed your data, you have valuable information in hand that you can present to your stakeholders. Relevant stakeholders that you may wish to inform are:

| Stakeholder/target audience | Your objectives |
|---|---|
| Company personnel | Share results and achievements. Inform, explain, motivate and engage in further RECP work. |
| Shareholders | Show results and improvements. Justify expenditures and make a case for further investments in RECP. |
| Municipality | Show that you are actively working with environmental issues. Address concerns over local pollution. Respond to reporting demands. |
| Local community | Show that you are working to decrease your environmental impact. Create goodwill. |
| Existing and new clients and consumers | Marketing. Gain a competitive edge over other suppliers. Reach a new client/customer base. |
| Media | Marketing. Disseminate information to a wider target audience. |

You will, of course, need to adapt the type and content of your reporting to the different stakeholder groups, based both on the message that you wish to convey and on the information needs, background knowledge and technical literacy of your target audience.

RECP results can be presented in the form of a success story or as a case study. RECP success stories focus on economic, environmental and other benefits achieved by a company as a result of implementation of RECP options, while an RECP case study is a description of an RECP assessment. Success stories can be used to promote and sell RECP and company achievements, while case studies show what is involved to identify, evaluate and implement RECP options.

**Comparison of success stories and case studies**

| Element | RECP Success Story | RECP Case Study |
|---|---|---|
| Aim | Promote and advocate RECP concepts and methods; generate interest and raise awareness of industry executives, government and other organizations | Illustrate how RECP can be successfully implemented through a systematic assessment |
| Structure | Result: appraisal of total impact of the RECP initiative on the performance of the business | Procedural: description of the steps taken and opportunities identified, evaluated and implemented |
| Indicators | Principally enterprise-level indicators, as achieved after implementation of RECP options | Primarily option-level indicators, as determined/calculated during the RECP assessment |
| Target group | Industry executives, government decision-makers, community leaders | Technical experts (industry staff, consultants, trainers, etc.) |

Appendix A provides an example of an RECP success story, following an appropriate standardized framework. You can also use the information you have collected through your indicator system for RECP assessments, more technical case studies and other types of reports and presentations.

# 6 EXPANDING AND REFINING INDICATOR SYSTEMS

Once you have started working with the indicator system and implementing RECP, you may find that, while the system provides you with valuable information, you need more specific data in regard to some of the indicators, or you may need completely new sets of indicators. The indicators presented will show general RECP progress, but may not reflect all the improvements that you have made. For example, you may wish to monitor and highlight achievements made in decreasing the amount of packaging that you use for your products, or you may wish to show how much of your waste is being recycled. You can then expand your indicator system to include relative indicators that describe the sub-section of a measure in relation to the whole measure, e.g., the proportion of the total waste output accounted for by packaging waste. You may also find that the indicator system does not sufficiently reflect improvements you have made in reducing the use, for instance, of hazardous substances. You can then expand your system to include indicators that will help you to monitor and manage the quantity of hazardous substances used.

Another reason for expanding your indicator system would be that you might be faced with new demands from authorities or customers to demonstrate your efforts to decrease your impacts on the environment. You can then, using the same tools and methods that you have learned to use through this Primer, design an indicator set that corresponds to these new demands.

Other reasons for developing your indicator system may be purely economic. You may realize that you could achieve substantial savings by being more efficient in your use of certain input materials. You can then design indicators to monitor the quantities of these materials used and the proportion of waste or waste water accounted for by these materials.

You may also decide that it is time to implement an environmental management system, which may necessitate an expansion of your indicator system; your existing indicator system will enable you to do this much more efficiently, since you will already have many of the necessary routines and approaches in place.

You can use your experience and routines to construct additional sets of indicators that provide you with more specific information. You can retrospectively construct a baseline for these new indicators that uses the same time frame as your current baseline, provided that you can access the necessary data. You can also start a new series of measurements with a baseline from a different year.

Sector-specific manuals on indicators will provide you with valuable guidance about indicators that are of specific relevance to your business.

As mentioned in Section 2.2 and explained in Section 2.7, you may also wish to complement the physical indictors with cost data (e.g., total cost of waste-water treatment per year) or cross-cutting indicators that include physical and financial data (cost of waste-water treatment per unit of product output per year). While financial indicators provide relevant information that determines the performance and profitability of your business, you need to bear in mind that the financial indicators are influenced by factors that have no bearing on the way your company manages resources and emissions into the environment. Most notable among these factors are prices. For example, changes in world market prices for raw materials influence financial indicators for resource use without any change in your company's physical-resource productivity.

Indicators that may be of interest:

| Inputs | Outputs |
|---|---|
| **Energy**<br>• Proportion of renewable energy<br>• Proportion of energy from waste<br>• Quantity of fuel used for transportation | **Air emissions**<br>• Non-greenhouse gas emissions (depending on type of business, for example, Volatile Organic Compounds, nitrogen oxides and sulphur dioxide)<br>• Emissions from transportation |
| **Water**<br>• Proportion of water from harvested rainwater<br>• Proportion of reused water | **Waste-water**<br>• Proportion of treated waste-water<br>• Pollution load of waste-water (measured in, for example, BOD, COD, nutrient and/or metal load)<br>• Quantity of certain materials in waste-water |
| **Materials**<br>• Proportion of recycled materials used<br>• Quantity of hazardous materials<br>• Proportion of hazardous materials | **Waste**<br>• Proportion of waste recycled<br>• Proportion of hazardous waste<br>• Proportion of packaging waste<br>• Quantity of hazardous waste<br>• Quantity of certain materials in waste |
| **Other areas** | **Cost-related** |
| • Land disturbance and or/use<br>• Quantity of packaging per production unit | • Cost of waste treatment per unit of production<br>• Cost of waste-water treatment per unit of production<br>• Revenues from sale of waste<br>• Cost of energy per unit of product<br>• Quantity of product per USD 1,000 of energy costs |

You can even design indicators that are very specific to your business, for example, number of towels washed per hotel guest per night. Indicators like these can help you monitor your progress with regard to a specific environmental issue that you have selected to target.

You can also expand your boundaries and include, for instance, parts of your supply chain or emissions from the transport of materials or transport of goods or other areas.

For some new indicators, you may have to invest in an additional system for measurement. This can range from assigning responsibility to a person to count certain units, e.g., number of towels washed, to installing metering devices. However, the fact of already having an indicator system, and well established routines and procedures means that most of what will be needed will already be in place.

# RESOURCES AND TOOLS

## GENERAL RESOURCES ON ENVIRONMENTAL INDICATORS


Business in the Environment and Ernst & Young (2001). **A measure of progress. Guidelines on measuring environmental performance.**
[http://www.bitc.org.uk/resources/publications/key_publications/index.html]

Global Reporting Initiative (2006). **Indicator Protocols Set Environment** (EN). Version 3.0.
[http://www.globalreporting.org/NR/rdonlyres/F9BECDB8-95BE-4636-9F63-F8D9121900D4/0/G3_IP_Environment.pdf]

Federal Environment Ministry, Federal Environmental Agency (1997). **A Guide to Corporate Environmental Indicators.** Bonn/Berlin, Germany. [http://www.akzente.de/public_downloads/Guideline_Environmental-Performance-Indicators.pdf]

Global Reporting Initiative (2005). **GRI Boundary Protocol.**
http://www.globalreporting.org/Home

National Round Table on the Environment and the Economy (2001). **Calculating Eco-Efficiency Indicators: A Workbook for Industry**, Canada.
[http://www.nrtee-trnee.com/eng/publications/ecoefficiency-workbook/NRTEE-Ecoefficiency-Workbook.php]

UNCTAD (2004). **A Manual for the Preparers and Users of Eco-efficiency Indicators.**
[http://www.unctad.org/en/docs/iteipc20037_en.pdf]

WBCSD (1999). **Measuring Eco-Efficiency: A Guide to Reporting Company Performance** [http://www.wbcsd.org/web/publications/measuring_eco_efficiency.pdf]


## RECP TOOLS


UNEP, CSCP and WI (2006). **Efficient entrepreneur family of tools.**
[http://www.efficient-entrepreneur.net/]

UNEP (2004). **Cleaner Production Companion**
[http://www.uneptie.org/scp/publications/details.asp?id=DTI/0579/PA]

UNEP (2010). **Pre-SME Toolkit**
[http://www.unep.fr/scp/cp/activities.htm]

UNIDO **Cleaner Production Toolkit**
[http://www.unido.org/index.php?id=086205]

Profitable Environmental Management - PREMAnet
[http://www.premanet.net/index.asp]


## SECTOR-SPECIFIC TOOLS


European Integrated Pollution Prevention and Control (IPPC) Bureau – **Sector-Specific Best Available Technologies**
[http://eippcb.jrc.es/reference/]

# REFERENCES


Business in the Environment and Ernst & Young (2001). *A measure of progress. Guidelines on measuring environmental performance.*
[www.bitc.org.uk/resources/publications/key_publications/index.html]

European Environment Agency (1998). *Environmental Management Tools for SMEs - A Handbook.*
[www.eea.europa.eu/publications/GH-14-98-065-EN-C]

Federal Environment Ministry, Federal Environmental Agency (1997). *A Guide to Corporate Environmental Indicators. Bonn/Berlin.*
[www.akzente.de/public_downloads/Guideline_Environmental-Performance-Indicators.pdf]

Global Reporting Initiative (2005). *GRI Boundary Protocol.*
[www.globalreporting.org/Home]

Global Reporting Initiative (2006). *Indicator Protocols Set Environment* (EN). Version 3.0.
[www.globalreporting.org/NR/rdonlyres/F9BECDB8-95BE-4636-9F63-F8D9121900D4/0/G3_IP_Environment.pdf]

The Greenhouse Gas Protocol Initiative (2004). *A Corporate Accounting and Reporting Standard*.
[www.ghgprotocol.org/]

The Greenhouse Gas Protocol Initiative (2007). *Designing a Customized GHG Calculation Tool.*
[www.ghgprotocol.org/]

The Greenhouse Gas Protocol Initiative (2007). *Measuring to Manage: A Guide to Designing GHG Accounting and Reporting Programs.*
[www.ghgprotocol.org/]

IFAC (2005). *International Guidance Document: Environmental Management Accounting*. [http://web.ifac.org/publications/professional-accountants-in-business-committee/other-publications-1#international-guidance-docu-1]

Jasch, C. (2000). *Environmental performance evaluation and indicators*. Notes from the field. Journal of Cleaner Production 8 (2000), 79-88.

Jasch, C. (2009). *"Environmental Performance Indicators" in Environmental and Material Flow Cost Accounting: Principles and Procedures (Chapter 4)*. Published in: Eco-Efficiency in Industry and Science.

Lutter, S. et al (2009). *Measuring Performance towards Sustainable Consumption and Production. Types of Indicators and Indicator Sets.* A Guide for Civil Society Organisations. Sustainable Europe Research Institute.

National Round Table on the Environment and the Economy (2001). *Calculating Eco-Efficiency Indicators: A Workbook for Industry.* Canada.
[www.nrtee-trnee.com/eng/publications/ecoefficiency-workbook/NRTEE-Ecoefficiency-Workbook.php]

OECD (2008). *A Study of Methodologies Relevant to the OECD Approach on Sustainable Materials Management.*
[www.olis.oecd.org/olis/2007doc.nsf/LinkTo/NT00008902/$FILE/JT03250103.PDF]

OECD (2009). *Eco-innovation in Industry. Enabling Green Growth.*
[www.oecdbookshop.org/oecd/pdfs/browseit/9209061E.PDF]

Olsthoorn et al (2001). *Environmental indicators for business: a review of the literature and standardisation methods.* Journal of Cleaner Production 9, 453-463.

PREMAnet (2001). *Application of Environment-Orientated Cost Management*. Example 5. [www.premanet.net/index.asp]

Rao, P. et al (2006). *Environmental indicators for small and medium enterprises in the Philippines: An empirical research.* Journal of Cleaner Production 14 (2006) 505-515.

UNCTAD (2002). *Guidance Manual. Accounting and Financial Reporting for Environmental Costs and Liabilities*. [www.unctad.org/en/docs/iteeds4_en.pdf]

UNCTAD (2004). *A Manual for the Preparers and Users of Eco-efficiency Indicators.* [www.unctad.org/en/docs/iteipc20037_en.pdf]

UNEP (2000). T*he GHG Indicator: UNEP Guidelines for Calculating Greenhouse Gas Emissions for Businesses and Non-Commercial Organizations.* [www.unepie.org/energy/information/tools/ghg/pdf/GHG_Indicator.pdf]

UNEP (2000). *GHG Calculation tool.* [www.unep.fr/energy/information/tools/ghg/pdf/GHG_Indicator.pdf]

UNEP (2004). *Cleaner Production Companion.* [www.uneptie.org/scp/publications/details.asp?id=DTI/0579/PA]

UNEP (2009). *Converting Waste Plastics into a Resource. Compendium of technologies.* [www.unep.or.jp/Ietc/Publications/spc/WastePlasticsEST_Compendium.pdf]

UNEP (2009). *Converting Waste Agricultural Biomass into a Resource. Compendium of technologies.* [www.unep.or.jp/Ietc/Publications/spc/WasteAgriculturalBiomassEST_Compendium.pdf]

UNIDO (no date - a). *Introducing Environmental Management Accounting (EMA) at Enterprise Level. Methodology and Case Studies from Central and Eastern Europe.* [www.unido.org/fileadmin/import/26160_EMAforewordexplnoteswithoutcoverimage.pdf] [www.unido.org/fileadmin/import/26164_EMApartIcropped.5.pdf]

UNIDO (no date - b). *Eco-design in MAKSS Packaging Industries Ltd. in Kampala, Uganda*. [www.unido.org/fileadmin/import/9790_MAKSSboxesEcoDesignUganda.pdf]

UNIDO (2010). *Performing Environmental Management (EMA) and Material Flow Cost Accounting (MFCA) in SMEs*. [to be published]

United Nations Division for Sustainable Development (2001). *Environmental Accounting Procedures and Principles.* [www.un.org/esa/sustdev/publications/proceduresandprinciples.pdf]

United States Environmental Protection Agency (1995). *An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts And Terms.* [www.epa.gov/oppt/library/pubs/archive/acct-archive/pubs/busmgt.pdf]

Verfaillie, H. A., Bidwell, R. (2000). *Measuring Eco-efficiency. A guide to reporting company performance.* World Business Council for Sustainable Development.

World Business Council for Sustainable Development (WBCSD) (1999a). *Measuring Eco-Efficiency: A Guide to Reporting Company Performance. Geneva.* [www.wbcsd.org/web/publications/measuring_eco_efficiency.pdf]

WBCSD (1999b). *Eco-Efficiency: Creating More Value with Less Impact*, Geneva.

Young, C.W. (1996). *Environmental performance indicators for business*. Eco-Management and Auditing, Vol. 3, 113-125.

# APPENDIX A: RECP SUCCESS STORY

## CHANDARIA INDUSTRIES LTD., AN RECP SUCCESS STORY [6]

### Overview

Chandaria Industries Ltd (CIL) is a leading Nairobi-based paper manufacturing and conversion company located at Baba Dogo in Nairobi, Kenya. The company's core business is manufacturing of tissue paper by recycling of waste paper; blending of virgin pulp with waste paper to produce hygiene grades of paper products that include toilet tissues, tissue napkins, paper towels and facial tissues; and recycling of cotton fibres into absorbent cotton wool.

### Benefits

The Resource Efficient and Cleaner Production (RECP) audit started in 2005, and monitoring has been going on since then. As a tool, cleaner production keeps on reminding CIL that improvements meant to achieve these goals need to be constantly enhanced. This has generally improved their operation through cost reduction, efficient resource use, improved environmental performance, and subsequently, their contribution towards sustainable development. The company makes annual savings of USD 633,600. RECP implementation also made it easier for the firm to obtain ISO 9000:2001 certification in quality management systems. In addition, CIL is a top award-winning firm, and was the recipient, among others, of Cleaner Production Awards in the years 2007 to 2009 and Company of the Year Awards (COYA) in Creativity and Innovation.

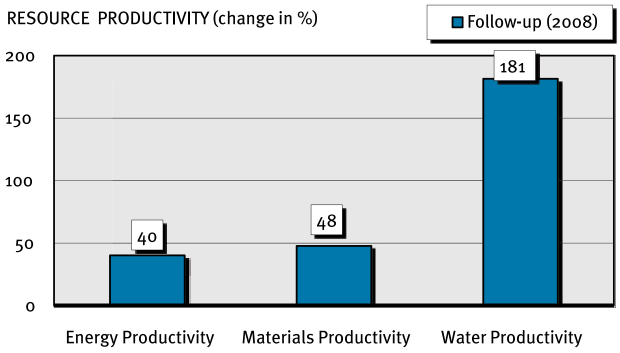
TABLE 1: RESULTS AT A GLANCE

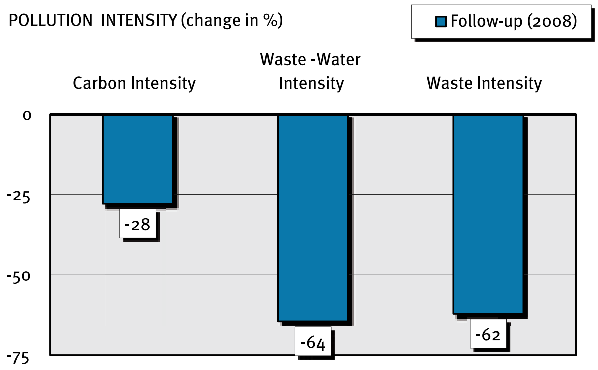
| Absolute Indicator | Change (%) | Relative Indicator | Change (%) |
|---|---|---|---|
| Resource use | | Resource productivity | |
| Energy use | -25 | Energy productivity | 40 |
| Materials use | -29 | Materials productivity | 48 |
| Water use | -63 | Water productivity | 181 |
| Pollution generated | | Pollution intensity | |
| Air emissions (global warming, $CO_2$ eq.) | -24 | Carbon intensity | -28 |
| Waste-water | -63 | Waste-water intensity | -64 |
| Waste | -60 | Waste intensity | -62 |
| Production output | 6 | | |

**Note:** The absolute indicators provide a measurement of the extent to which resource use/pollution output has changed in absolute terms, e.g., in units of energy used or tons of waste generated. A negative percentage indicates a decrease and a positive percentage indicates an increase. The relative indicators provide a measurement of changes in resource use/pollution in relation to production output. Resource productivity provides a measurement of how much product output can be produced per unit of resource used; from the point of view of sustainability, productivity should increase. Pollution intensity provides a measurement of how much pollution is generated per unit of production output; from the point of view of sustainability, intensity should decrease.

6 Further success stories, along with a common reporting framework, can be found online at www.unido.org/cp .

## CIL RECP Profile




**Note:** The RECP profile provides a visual overview of resource productivity and pollution intensity shown as the percentage change, compared to the baseline values. Environmental performance is improved when resource productivity increases and when pollution intensity decreases.

### Areas of improvement

The factory is powered by electricity, which is mainly utilized in the paper mill, and the conversion and cotton-milling plants. Consumption of electrical energy had averaged 416,000 kWh/per annum, but was reduced by 15% after RECP. Thermal-energy use characterized by high consumption of furnace oil was attributed to the running of the boiler for paper-milling operations. The highest water-consumption intensity is in the paper mill and cotton-milling plant. Water use has been reduced by more than 60%, equivalent to 150,000 m3 annually. Previously, all water used was discharged as effluent directly into the sewer system, but there has since been a reduction of up to 150,000 m3 of waste water annually. A reduction in biological oxygen demand (BOD) from 750 mg/l to 380 mg/l has been achieved through effluent treatment and waste-water recovery and recycling. Solid waste generated after improvements consists mainly of sludge, estimated at 600 tons per annum.

RECP has been and continues to be achieved by application of know-how from regular training, improvement of technologies, better process control and technology change. Comprehensive training and awareness sessions were conducted, which led to the formation of an in-house RECP team. Operational improvements and good-housekeeping options have been implemented at no cost. The strategy includes the following measures: monitoring of water consumption and waste-water generation through metering and submetering of all usage and discharge points; development of key performance indicators and monitoring of productivity levels; improvement of operation of the DAF (Krofta) system through optimization; monitoring of efficiency; and establishment of a preventive maintenance programme to control leakages, spills and overflows.

Various “low-investment-cost” options of better process control and equipment modification have been implemented, including: process monitoring; first-pass-retention and ash-content tests from which data generated was used in control of pulping time and refining loads; installation of inclined screens to avoid overflow losses; and installation of water-saving devices such as borehole pump timers, effluent control pumps and level transmitters. The introduction of new process chemistries involving the use of ionized polymers for improved flocculation that improved stock dewatering and hence improved first-pass retention is a high-investment-cost option that was adopted, leading to multiple resource-use benefits.

Energy efficiency has been achieved by implementing submetering of electricity at key usage points; data analysis for monitoring of trends and development of key performance indicators; retiring of oversized motors; introduction of variable speed drives; motor downsizing; introduction of interlock systems of pumps and agitators; steam-pipe lagging; and infrared heat analysis for heat losses in the boiler house. This has reduced energy use by an estimated 5,367,429 kWh per annum.

As a water conservation measure, the company practices harvesting of rainwater and recovery of steam condensate. To reduce effluent, waste water is treated through the DAF system and clarified water is recycled for reuse in production dilutions and improved shop-floor cleaning. Best practices in waste management entail waste segregation at source, quantification of generation levels, recycling of sludge for production of egg trays and successful practice and promotion of green procurement and the 3R system.

**Before: Housekeeping lapse** – poor storage of equipment


**After: Housekeeping benefits** – secured and well organized storage area

TABLE 2: OPTIONS IMPLEMENTED

| **Principal options implemented** | **Benefits** | | | |
|---|---|---|---|---|
| | **Economic** | | **Resource use** | **Pollution generated** |
| | Investment [USD] | Cost-savings [USD/yr] | Reductions in energy use, water use and/or materials use (per annum) | Reductions in waste water, air emissions and/or waste generation (per annum) |
| **Option 1: Energy management**<br>• Sub-metering of electricity at key usage points<br>• Retiring of oversized motors, introduction of variable-speed drives (VSDs)<br>• Introduction of interlock systems of pumps and agitators<br>• Data analysis, trending and development of key performance indicators<br>• Monitoring of boiler efficiency and infrared heat analysis | USD 4,802 | KES 19,240,000 (USD 260,000) | Reduction in energy use: 5,367,429 kWh | Reduction in air emissions: 1,456 t $CO_2$ eq. |
| **Option 2: Water management**<br>• Metering and submetering of all points of water use/discharge and setting of performance indicators<br>• Preventive routine maintenance of machinery and fixing of all leak points<br>• Recycling of clarified water<br>• Reduction of washing cycles of waste paper due to the procurement of high-quality waste paper<br>• Use of polyelectrolytes for waste-water treatment<br>• Recycling of clarified waste water<br>• Reuse of clean water in paper washings | | KES 1,598,400 ( USD 216,000) | Reductions in water use 150,000 $m^3$ | Reductions in waste water: 150,000 $m^3$<br><br>Reduced pollution load to sewer: BOD from 750 mg/l to 380 mg/l |
| **Option 3: Materials management**<br>• Process monitoring, first-pass -retention and ash-content tests. Data used to control pulping time and refining loads<br>• Introduction of new process chemistries; ionized polymers for improved flocculation that improved stock dewatering and hence improved first-pass retention<br>• Installation of inclined screens to avoid overflow losses<br>• Procurement of high-quality waste paper resulting in reduced washing cycles | | KES 6,048,000 (USD 352,000) | Reductions in materials use: 3,200 tons<br><br>Better quality raw material | Reductions in waste generation: 900 tons<br><br>Reduced sludge disposal |
| **Total of ALL implemented options** ([7]) | | **KES 46,886,400 (USD 633,600)** | | |

7 Note that the total of ALL options can be greater than that of some of the three to five key options detailed in table 2.

### Approach adopted

CIL commenced the programme, which is still in progress,, in 2005. However, this success story presents audit and monitoring results up to the year 2008. RECP was implemented following the initiation of the Cleaner Enterprise Programme undertaken by the Kenya National Cleaner Production Centre, and the company has played a leadership role by assisting other companies such as Madhu Paper (Kenya) and Kenya Paper Mills to embrace cleaner production and related best practices. RECP has been achieved by applying know-how; improving technology; and changing attitudes through regular audits, training and awareness-raising activities for capacity-building. The company began by implementing no-cost and low-cost investment options such as submetering of electricity and water consumption, process monitoring, preventive maintenance programmes, waste-water treatment and recycling. CIL has so far achieved great economic benefits from cost-cutting measures, in addition to ensuring compliance with the national legislative framework governing environmental management. Through their experience, they have learned that commitment by top management is critical to the successful implementation of RECP and that, since the process is an on-going one, the savings gained from no-cost options adopted can be ploughed back as investment for ‘low- and high-hanging fruits.

> *“As a company, we have realized that adoption of (RE)CP provided us with interesting and challenging opportunities to rethink and improve on our operations for better resource use, improved market competitiveness through cost reduction, improved environmental performance and sustainable growth.”*
> Mr. Linus Muchenya, EHS Manager

### Business case

CIL has gained recognition and, thus, access to a larger market share. As a result of the successful implementation of RECP, the company has become the sole supplier of an array of hygiene-tissue products to the UN agencies, as well as to several multinationals doing business in the country. The company has also realized that CP certification, as proof of environmental best practices and eco-friendly products, has increasingly come to be required by a range of clientele/customers who promote the ideals of sustainable consumption and production.

# APPENDIX B: CALCULATING TOTALS

There are various approaches that you can use to calculate totals. Section 3 of the Primer provides guidance on making calculations for each of the absolute indicators and dealing with various types of units. You can add extra sheets to the RECP indicator calculation tool and create tables that automatically calculate your totals. Remember to enter conversion factors if you are dealing with inputs or outputs in different units. Make one table for each measurement period. Start with a table for the baseline. You can link the totals calculated to the corresponding cells in the indicator calculation sheets so that the indicator calculations are done automatically on the basis of your calculated totals. You can also adapt your existing spreadsheets for collecting data and calculating totals.

The level of detail that you use in the tables depends on your needs and access to information. The more detailed your tables are, the greater the possibility to track certain flows. This will also provide more possibilities for spotting RECP opportunities. In the example provided, different types of resources and outputs have been entered; however, if you can access data, you can also organize your data according to processes, e.g., electricity and fuels used in process 1, electricity and fuels used in process 2, etc.

## INPUTS

### ENERGY

| Type | Quantity | Unit | Conversion | kWh or MJ |
|---|---|---|---|---|
| Imported | | | | |
| Electricity | | | | |
| District heating/cooling | | | | |
| Steam | | | | |
| On-site combustion | | | | |
| Petroleum products | | | | |
| - Light fuel oil | | | | |
| Gas | | | | |
| - Natural gas | | | | |
| - Propane | | | | |
| Coal products | | | | |
| - Coke | | | | |
| Biofuels | | | | |
| - Wood | | | | |
| - Pellets | | | | |
| etc... | | | | |
| Total in kWh or MJ | | | | |

### MATERIALS

| Type | Quantity | Unit | Conversion | Tons |
|---|---|---|---|---|
| Raw materials | | | | |
| - Aluminium | | | | |
| Auxiliary materials | | | | |
| Operating materials | | | | |
| Packaging | | | | |
| - Plastic | | | | |
| Merchandise | | | | |
| etc... | | | | |
| Total in tons | | | | |

### WATER

| Type | Quantity | Unit | Conversion | $m^3$ or kl |
|---|---|---|---|---|
| From utility | | | | |
| Harvested rainwater | | | | |
| From external well | | | | |
| From own well | | | | |
| Surface water | | | | |
| etc... | | | | |
| Total in $m^3$ or kl | | | | |

## OUTPUTS

### $CO_2$ eq.

| Type | Quantity | Unit | Conversion | $CO_2$ eq. |
|---|---|---|---|---|
| Imported | | | | |
| From electricity | | | | |
| From district heating/cooling | | | | |
| From steam | | | | |
| On-site combustion | | | | |
| Petroleum products | | | | |
| Coal | | | | |
| Natural gas | | | | |
| From processes | | | | |
| Methane | | | | |
| Nitrous oxides | | | | |
| CFCs | | | | |
| etc... | | | | |
| | | | | |
| | | | | |
| | | | | |
| Total in tons | | | | |

### WASTE

| Type | Quantity | Unit | Conversion | Tons |
|---|---|---|---|---|
| Solid waste | | | | |
| - Sludge | | | | |
| Municipal waste | | | | |
| Hazardous waste | | | | |
| Packaging | | | | |
| Organic waste | | | | |
| - Coconut shells | | | | |
| etc.. | | | | |
| Total in tons | | | | |

### WASTE WATER

| Type | Quantity | Unit | Conversion | $m^3$ or kl |
|---|---|---|---|---|
| From processes | | | | |
| - process 1 | | | | |
| - process 2 | | | | |
| Cleaning water | | | | |
| Sewage | | | | |
| etc... | | | | |
| Total in $m^3$ or kl | | | | |

### PRODUCT OUTPUT

| Type | Quantity | Unit | Conversion | tons (or $m^3$, kl, USD, units) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| Total in tons (or $m^3$, kl, USD, units) | | | | |