



Toolbox

An EMPA guidebook for environmental decision support concepts and tools

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1 OVERVIEW

1.1 CONTENTS

The toolbox consists of two elements: an overview and the description of different tools or concepts. The overview gives overall information on the toolbox e.g.: about goals or the choice of the tools and concepts.

The toolbox is mainly used as accompanying material for environmental trainings and will be continually built-up and adapted based on the experiences of and co-operation between CNPLM- and EMPA-collaborators. According to the specific topics of trainings the contents of the toolbox delivered may vary.

Most of the individual concept or tool will be described in the following way (see Table 1.1) – the description will also be supplemented and improved continually.

Table 1.1: Structure for the description of concepts or tools

Chapter	Contents
Introduction, aims	Summarizes what you should have learnt when you have studied the following chapters and gives the overall goal of the tool/concept.
Background, description	Description based on the common practice and knowledge mostly in industrialized countries is given. Where necessary, different variants of the tools or concepts are discussed and as far as possible a variant is recommended.
Implementation	Guidelines for the implementation of the tool are given. Advantages and disadvantages are discussed.
Case studies, examples	Here the application of the tool on the unified example is shown. Further different case studies and examples from own project experience or to be found in literature are given.
Review, questions	Gives you the possibility to test the knowledge you have gained after studying the preceding chapters.
Experience and application in Colombia	Specific topics and experiences related to the application of the tools or concepts in Colombia will be addressed. This chapter will be continually adapted according to the experiences made in ongoing projects of the CNPLM and EMPA.
Further documents, standards	Here important documents, e.g. standards, guidelines for the tool are given.
Literature, addresses, other sources	Where to find further information on the tool.
Presentations, overheads	The presentations of the training will be given.
Individual notes	Reserved for your individual notes.

For the selection of the instruments included, see Chaps. 3-7.

1.2 GOALS OF THE TOOLBOX

If we want to optimize processes in companies or products in order to increase eco-efficiency, we are confronted with a variety of different decision support tools which may help us better or less efficiently to fulfil the task.

This toolbox gives an overview of tools developed and implemented in OECD-countries in the last decade. It supports practitioners in choosing the appropriate environmental and financial decision support tools or concepts.

This support is given in form of a guidebook, which contains basic information on selected tools and concepts, examples and rough guidelines for their application and further useful information.

The idea of building-up such a toolbox originates from the need of a comprehensive and concise material for the training of and experience exchange with collaborators in the Environmental Technology Center in Colombia (CNPML). But also in general, there is a need for harmonized rough guidelines on different tools or concepts, which support practitioners in their work in Colombia and also in other projects.

The toolbox shall in first priority be used by CNPML or EMPA collaborators:

- As accompanying material in trainings with the aim to give a basic overview and knowledge on different tools and concepts to be used in consulting work especially in Colombia;
- As rough guideline for the selection and/or application of different tools and concepts for projects in Colombia;
- As base for the discussion of further needs related to the use of concepts and tools in Colombia.

Further it may be used in trainings and consulting work in Europe or countries in transition.

The toolbox will be continually improved and built-up according to the experiences made by its paying also regard to specialties in different countries of application, especially in Colombia (see table 1.1).

1.3 INITIAL SITUATION

In this chapter we give a brief overview of the development of environmental policy and decision support instruments mainly in industrialized countries.

In OECD countries environmental policy started in the sixties with the reactive end-of-pipe philosophy. In practice emissions were reduced by cleaning technologies on a technical level like air emission filters or wastewater treatment plants.

With the publication of the Brundtland report (1987) the philosophy of sustainable development has been introduced. Since then almost all countries have dedicated themselves to the goal of sustainable development (see Agenda 21, ICC-Charter). Putting sustainability into practice encompasses the optimization of all sectors of human activity towards reduced resource use and the avoidance of environmental impacts under

consideration of economic and social aspects. Further shifts of environmental problems from one sector of activity to another or one nation to another have to be avoided.

The implementation of environmental goals demands for comprehensive concepts and appropriate instruments or combination of instruments on different levels (like legislation, management, technology etc.) which allow analyzing, improving and controlling our activities. Since the start of environmental protection activities a variety of instruments have been developed. Ongoing with the shift from end of pipe towards sustainable development philosophy more comprehensive concepts have been introduced. The focus of the instruments and their application context changed too.

As an example in the last decade on a regulative level demand and control has been complemented by economic instruments giving a financial incentive for Industry to reduce emissions. In several European countries also voluntary agreements between the regulative bodies and Industry sectors have been introduced. For example, Switzerland has committed itself to the reduction of CO₂-emissions on the level of 1990 by 2010. This goal is planned to be reached by a voluntary reduction agreement with Industry. However if the goal is not achieved by 2004, the Swiss government will introduce a CO₂-tax.

Another example is the development of the Cleaner Production Concept. In the USA, in the nineties Pollution Prevention was developed in order to reduce toxic emissions. This concept was extended to the reduction of non-toxic waste. It encompasses on one hand cleaning technologies but also preventive clean technologies. Clean technologies focus on more eco-efficient product design and processes. Furthermore the introduction of Environmental Management Systems according to ISO 14'000:1996 or EMAS (1993) in the nineties aims towards self-responsibility and continual improvement of the eco-efficiency of enterprises.

However the instruments nowadays available have been designed for particular problems and different stakeholders almost independently from each other. They differ according to their application and origin (è chap. 4). Up to 1995 differences and compatibility of instruments have hardly been investigated. In 1995 the SETAC¹-Europe working group on: Life Cycle Assessment and Conceptually Related Programs started to compare the compatibility of different environmental decision support concepts and tools. Further activities followed by different research groups and researchers (è chap. 4). In 1998 Chainet a concerted action financed by the European community started research on the appropriate use of environmental decision-support tools. The focus is on instruments, which allow to take care of shift of environmental problems along material and energy chains. Goal of all these efforts is to provide appropriate decision-support instruments for practitioners, to be applied in an efficient way. One important topic of the next years will be how to apply different tools worldwide and how to provide the appropriate basis data for their application. This will also encompass the knowledge and experience exchange and co-operation between OECD and other countries.

¹ Society for Environmental Chemistry and Toxicology

1.4 OVERVIEW OF DESCRIBED CONCEPTS AND TOOLS, LINKING

1.4.1 Introduction

Putting sustainable development into practice encompasses the inclusion of environmental issues besides others in private or public decision making.

In the last decades, different decision support "instruments" have been developed and applied in OECD-countries mostly independently to each other. They differ according to the situation they are used in and in the particular environmental information they deliver. E.g. the improvement of the environmental friendliness of a certain product along its life-chain asks for another type of decision support than the overall reduction of air emissions in Switzerland according to Agenda 21.

In order to choose the appropriate instrument or combination of instruments for the environmental problem to be addressed, a structured overview on different instruments, their application fields and linking is helpful.

In the last five years different efforts have been made to compare and position the instruments to each other (Beck&Bosshart 1995, Cowell 1998, IVAM 1998, LCANET 1998, SETAC 1997). Research on this topic is still going on (Chainet 1998).

Here we will not discuss the differences of these comparisons but give you a practical oriented overview, which shall support you to orientate yourself better in the "jungle of instruments".

But first of all some basic definitions we are going to use throughout the toolbox:

When we talk in general about instruments for decision support this may mean more precisely concepts, tools or even elements.

- **Concepts** are ideas for achieving sustainability or other goals. They deliver frameworks and basic principles (SETAC 1997); e.g. the concept of continual improvement which is also used in Environmental Management Systems
- **Tools** are concrete techniques for deriving and combining information to be used in decision-making. Often used to support or concretize concepts (LCANET 1997, SETAC 1997). E.g.: the tool Life Cycle Assessment concretizes the concept of Life cycle thinking. It takes the whole life cycle of a product (from material extraction to disposal) into account.
- **Elements** are prescribed method of obtaining, processing and presenting information (LCANET 1997). They are used within tools. E.g.: an algorithm for averaging data or energy and mass balances like in Life Cycle Assessment.

As basis for the application of these instruments we need qualitative or quantitative data we can process (see also Figure 1.1).

1.4.2 Criteria for the choice of different concepts and tools

In chapter 1 we have already given an overview of the concepts and tools included in the toolbox. Here we will give you the selection criteria for their inclusion and further description criteria, which will help to position the variety of tools to each other.

1.4.2.1 Selection criteria

In the toolbox in first priority the instruments (concepts or tools) have been chosen which seem to be important for this work according to experiences in OECD countries. The focus is on instruments allowing the improvement of the eco-efficiency (overall environmental impact related to the overall costs) of enterprise related activities.

These are instruments:

- Which can be used in an enterprise on a technical or management level;
- Addressing environmental aspects or financial aspects;
- Which have already been used in practice thus they are "ready to use" and some experience is available;
- Which seem to be useful for the application in countries in transition and especially in Colombia in regard to information and resources available.

The financial tools have been limited to investment appraisal.

Furthermore general concepts and tools, not particularly focusing on environmental or financial aspects, have been included. They give a good basis for analyzing problems and improving situations. Information on other concept or tools will be limited to quality management.

1.4.2.2 Description criteria

The criteria given here help to describe and position the variety of instruments to each other and thus support to choose the appropriate instrument or even combination of instruments. As already mentioned there exist different ways of comparing and describing different instruments to each other.

The distinction chosen for the toolbox is reflected in its structure (è chap. 1). We distinguish between (see also Beck&Bosshart 1995, Chainet 1998, IVAM 1998, SETAC 1997):

- Concepts, tools and elements
- Aspects addressed by the instrument: environmental, financial or others (e.g. social, quality-related or general etc.)
- The **object** under study: enterprise, process, product/service, or others (e.g.: technologies, lifestyle-behavior)

This distinction gives you a rough overview on the instruments available (see Table 1.2). Examples for the application of the instruments will be given in the description of each individual instrument.

Further for the choice of an instrument the following information is helpful:

- The **type of information** needed for the instruments: qualitative versus quantitative (see Table 1.2).

This information is important in regard to the data and information available, the reproducibility and the accuracy of results demanded.

- ü Site specific: The instrument allows including site-specific information; e.g. the specific background concentration of toxic emissions on a production site.

- ü Site independent: The instrument does not particularly include site specific information and is site independent.

- **Spatial focus** which can be addressed:

Typical site-specific tools are Risk Assessment and Environmental Impact Assessment, which we do not address in the toolbox. A typical site independent tool is Life Cycle Assessment making no differentiation between information of different sites.

- **Time horizon, which** can be addressed:

- ü Retrospective: The instrument analyses on basis of existing information of preceding periods.

- ü Prospective: The instrument is directed towards future situations, scenarios.

For a combination of different instruments you have to decide which overall information for the decision should be given: Do you need information on energy or material flows or on the content of toxic releases within a product?

The compatibility of different tools is not sufficiently cleared up to now (Chainet 1998). Especially interfaces of tools have to be better defined. But nevertheless there are concepts and tools, which can be and are already used in combination (see Figure 1.1). E.g.: Life Cycle Assessment can be used within Environmental Management Systems for identifying important environmental aspects, controlling etc. Input-Output Analysis of energy and materials can be used in different tools as basis information.

Further the following more general points for the application of instruments should be considered.

- **Resource intensity of the application of an instrument:**

- ü Costs and time demand.

- ü Know how and skills requested.

- **State of the art:**

- ü Is the instrument available and ready to use?

- ü Or can it only be used with own development efforts?

- **Data, information availability:**

Are public or individual data, quantitative or qualitative information available?

- **Transparency, objectivity:**

- ü Is it possible to trace back, how the results are derived?

- ü Can different people come to the same result if they apply the instrument or not?

Beside the information given in 4.3 you will find information on the above mentioned topics in the descriptions of the individual instruments.

1.4.3 Overview and linking of described concepts and tools

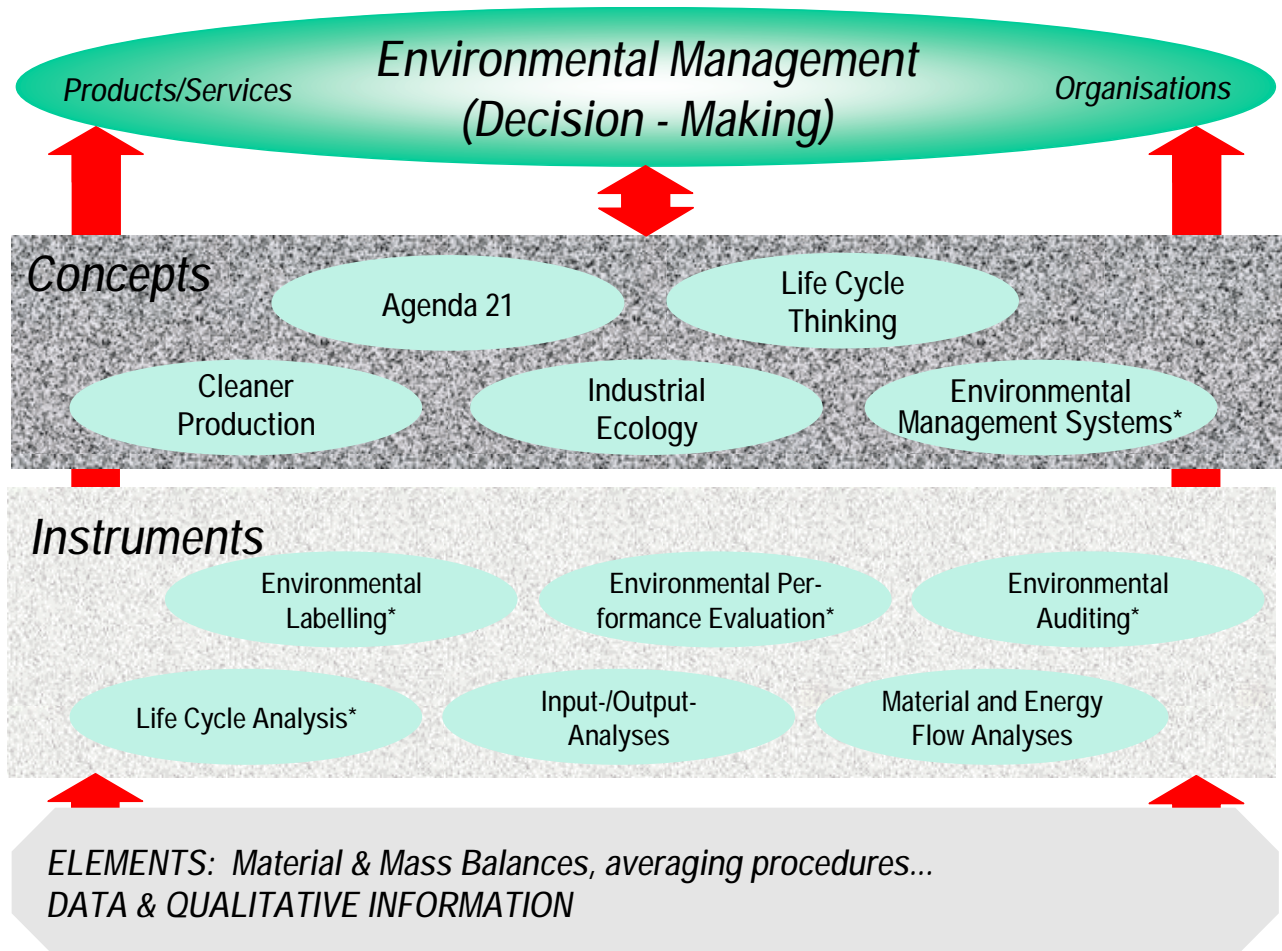


Figure 1.1: Relations between environmental tools, concepts and elements

* Included in the ISO 14000 series

Both concepts and tools can be subdivided in various ways (see Table 1.2):

- Into organization (enterprise/company) related, process related and product/service related tools;
- Into procedural and analytical tools;
- Following the type of information (qualitative/quantitative)
- Into environmental/financial/further aspects.

Table 1.2: Overview of concepts and tools

Name	Action = Analytical P = Procedural	Type of information		Aspects			Object			
		Qualitative	Quantitative	Environmental	Financial	Others	Organization	Process	Product/Service	Others
		C = Concept T = Tool E = Element								
Systems thinking	P	C				General				General
Continual Improvement/ Plan-Do-Check-Act	P	C				General				General
Agenda 21, ICC-Charter		C								General
Life cycle thinking	P	C								General
Cleaner Production (Pollution Prevention, Waste Minimization, Cleaner Technology)	P	C								
Industrial Ecology	P	C								Organizations, Material cycles
Input/Output, Material, Energy Flow Analyses	A		T/E							
Environmental Management Systems	P	C/(T)	(T)							
Life Cycle Assessment	A		T							
Environmental Labeling	P	T	T							
Environmental Performance Evaluation (Indicators, Bench Marking)	A/P		T/E							
Financial Tools (Pay Back Time, Internal Rate of Return, Net Present Value)	A		T							

Legend:

	Aspects and objects focused on
	Aspects and objects covered but not central focus
	Aspects and objects not covered

1.4.4 Short description of further tools

Excerpts from Chainet, Center of Environmental Science, Leiden University

1.4.4.1 Check-lists (CL)

Checklists are qualitative tools that may give guidance to design, environmental management, setting eco-labelling criteria, etc. The checklists used for a particular purpose, such as checklists for design, may be general or customized for a specific sector or company. Checklists consider various different aspects such as recyclability, minimizing harmful substances, and so on. They may be differentiated by underlying bases and principles, such as:

- Social perception of environmental risks,
- Compliance with environmental legislation,
- Common sense/expert judgement on environmental aspects,
- Environmental analysis.

However, checklists may often consider several principles at the same time. These principles can be used to characterize and compare checklists, and to draw conclusions with respect to their applicability to specific decision situations.

Relevant literature

Examples of checklists for design are given in:

Behrendt et al., 1997. Life Cycle Design - A manual for small and medium sized enterprises

Brezet H. and Hemel, C, 1997. Ecodesign: a promising approach to sustainable production and consumption. UNEP-Industry and Environment, ISBN 92-807-1631.

1.4.4.2 Cost-Benefit Analysis (CBA)

Cost-benefit analysis is an economic tool for supporting decisions on larger investments from a social, as opposed to a firm's, point of view. Its domain of application includes regulatory and technology choices. It has been developed as a tool to remediate a number of shortcomings of a purely market oriented analysis of costs and benefits. In a world with perfect markets, costs and benefits would indicate to any decision-maker everything relevant for economic welfare. Markets are not perfect. Cost-benefit analysis repairs some of the deficiencies caused by these market imperfections. Three types of correction take place:

- For transfer payments, that is taxes and subsidies, which shift purchasing power but do not indicate welfare changes for the community as a whole
- For price distortions, as created by monopolistic and oligopolistic markets
- For external effects and collective goods, which are not, or not adequately, expressed in market prices.

It is the latter type of effects, which is of interest for environmental analysis. Most environmental problems can be seen as **external effects** of economic activities, like the costs of emissions, which are not paid for to those damaged, or as **collective goods**, which

are not priced and hence overused, like fish from the oceans, wood from forests, and the beauty of a landscape.

In cost-benefit analysis, a first step is to specify the effects as related to the decision at hand. In the cost-benefit literature this step has not been worked out in much detail. Models may be restricted to more or less direct effects, may include indirect effects and may even take into account secondary effects involving macro-economic mechanisms.

Next to market related costs and benefits, a number of other effects are specified, including all relevant environmental effects. The main focus in the current development of cost-benefit analysis is on how to evaluate these unpriced effects. The dominant approach is based in Paretian welfare theory, where the individuals confronted with these external effects judge their importance. As in market choices, their preferences can be expressed in money terms. The overall evaluation then is in one single category: money, providing a comparable yardstick for the decision-maker.

Cost-benefit analysis, contrary to the other tools for environmental decision support, can take the time horizon of effects into account. By discounting future costs and benefits, the more future effects are the less important they become. Often, in cost-benefit analysis an equilibrium situation is specified, as mostly is the case in, e.g., LCA, and discounting then is not possible.

Cost-benefit analysis and LCA can be integrated, applying the analysis to a (broadly defined) unit of function and setting up the LCA characterization and evaluation in line with the Paretian approach: specifying damage functions and valuating the damages from the point of view of those concerned. Recent examples of integrating LCA and cost-benefit analysis are in assessing different options for energy production and for waste management.

Relevant literature

Ajit K. Dasgupta, D.W. Pearce, 1972. *Cost-Benefit Analysis: Theory and Practice*. The MacMillan Press Ltd., 270 pp, 1972. ISBN 333-11397-7.

Per-Olov Johansson, 1993. *Cost Benefit Analysis of Environmental Change*. Cambridge University Press, 232 pp, 1993. ISBN 0-521-44792 5.

Tevfik F. Nas, 1996. *Cost-Benefit Analysis, Theory and Application*. SAGE Publications Inc., 219 pp, 1996. ISBN 0-8039-7133-8.

E.J. Mishan, 1971. *Cost-Benefit Analysis, an informal introduction*. Unwin Brothers Limited 454 pp, 1971. ISBN 0-04-338080 8.

1.4.4.3 Cumulative Energy Requirements Analysis (CERA)

CERA is used to quantify the primary energy requirement for products and services in a life-cycle perspective. It had been developed to consider the upstream energy flows when optimizing production processes. The cumulative energy requirement indicates a basic environmental pressure associated with the use of energy. Similar to material intensity the energy intensity can not be used to quantify specific environmental pressures (e.g. ozone depletion) rather than a generic pressure.

The primary energy requirements are measured in Joules and aggregated into one number. Interpreting lower values as being associated with less environmental burden is only justified if the relative share of the energy carriers will not be changed towards more hazardous ones.

CERA can be used to:

- Quantify the energy intensity of products, services and national economies;
- Analyze options for energy savings in industry;
- Provide energy-input coefficients for base materials to support engineering and design of products.

Relevant literature:

Verein Deutscher Ingenieure (VDI) (Hrsg.) (1997): Kumulierter Energieaufwand - Begriffe, Definitionen, Berechnungsmethoden. Richtlinie VDI 4600, Beuth Verlag, Berlin

1.4.4.4 Environmental Impact Assessment (EIA)

Environmental Impact Assessment (EIA) is the **process** of identifying and evaluating the consequences of one economic activity on the environment and, when appropriate, mitigating those consequences. EIA is used as an aid to public decision making on larger projects, such as the construction of a highway, power plant or industrial production sites. Precise elements of this **process** and specific technical guidelines and legal requirements that pertain to it vary from nation to nation and, within one nation, vary with time. However, despite the diversity of techniques, the differences in emphasis, and the varied objectives that characterize impact assessment as practiced in different nations, four important aspects of environmental impact assessment are increasingly approaching consensus:

1. Consideration of impacts on both the physical and the social environment.
2. As a tool of decision making, the value of environmental impact assessment is more likely to be realized in the timely communication of information between individuals conducting the assessment and individuals planning a proposed project than in the writing of a massive technical document. Although written assessments, often called Environmental Impact Statements (EISs) or Environmental Impact Reports (EIRs), are required by legislative or executive mandates, the general understanding is that such documents tend to serve more as records of decision making than as active tools in decision making.
3. Many environmental components, processes, and attributes are amenable to currently available methods of quantification, but includes other which are not (e.g. sociological, political and psychological factors). By their nature these may never become quantifiable, regardless of the continuing development of new analytical paradigms. EIA should consider both quantifiable and non-quantifiable attributes.
4. Mitigation of significant impacts, which includes the minimization of undesirable impacts and the enhancement of desirable impacts, must be assessed for all possible impacts.

Relevant literature

Colombo, A.G. (ed.), 1992. Environmental Impact Assessment. Dordrecht, NL, Kluwer Academic Publishers.

Erickson, P.A., 1994. A practical guide to environmental impact assessment. Academic Press, Inc. ISBN 0-12-241555-8

1.4.4.5 Environmental Risk Assessment (ERA)

Risk and risk assessment processes are both connected to the comprehensive evaluation of the potential, or rather the probability that damage or adverse effects will occur.

A full risk assessment for chemicals which are considered hazardous, is normally preceded by and based on a **Risk Characterization** involving the integration of three steps:

- A **hazard identification**, by which a relationship is studied between different levels of exposure and the *incidence and severity of (an) effect(s)*, normally including toxicological as well as ecotoxicological effects evaluation
- An **effects assessment**, which is dominated by the determination of the *PNEI, or PNEC for the effect(s)* defined via Hazard identification, *i.e. Predicted-No-Effect-Level/ of Concentrations*, and
- An **exposure assessment** in which *PEC, i.e. Predicted Exposure Concentration (or Total Daily Intake)* are determined by measurement and/or assessed, including description of nature and size of exposed targets, as well as magnitude and duration of exposure.

In regulatory risk evaluation, distinction is normally made between Environmental (including Ecological) Risk Assessment (ERA) and Human Health Risk Assessment (HRA). Both of these are mostly carried out stepwise following tiered process schemes and according to guidelines developed under international expert guidance, *cf.* OECD and EU Test and Risk assessment guidelines. The ERA comprises the risk assessments of substances on non-human species in complex systems. A highly significant **PEC/PNEC-ratio** is often taken to define a chemical's risk to the environment.

The most obvious difference between ERA and HRA is that ERA deals with millions of species rather than only one (man). Apart from this, differences in toxicological endpoints, spatial and temporal scales, complexity of exposure and several other parameters can be identified, explaining that variability in exposure and effects assessments is crucial for the ERA, necessitating an extreme use of simplifications of reality, *i.e.* via models. Considering these factors, the simplifications of ERA are far-reaching and only very few PEC's and PNEC's are actually determined.

Relevant literature

- *Overviews:*

EEA, European Environment Agency, 1998. Environmental Risk Assessment, Approaches, Experiences and Information Sources. Written by Robyn Fairman, Carl D. Mead & W. Peter Williams, MARC, King's college London for the EEA, Copenhagen.

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- *Instructive proceedings:*

M.I. Richardson (editor), 1986, Toxic Hazard Assessment of Chemicals. Comprised mostly by papers presented at meetings of the (British) Royal Society of Chemistry. Published by the Royal Society of Chemistry, Burlington House, London.

M.I. Richardson (editor), 1988, Risk Assessment of Chemicals in the Environment. Proceedings from the Third European Conference on Chemistry and the Environment held in Guildford on 11-14 July 1998. Published by the (British) Royal Society of Chemistry, Burlington House, London.

- *Technical Guideline documents:*

CEC/ECB, Commission of the European Communities/European Chemical Bureau, 1996. Technical Guidance Documents in support of the commission Directive 93/67/EEC on Risk Assessment for New Notified Substances and the Commission Regulation (EC) 1488/94 on Risk Assessment for Existing Substances. Published by the CEC, European Chemicals Bureau, Ispra, Italy.

OECD, 1995. Report of the EOCD Workshop on Environmental Hazard/risk Assessment, No. 94. Organization for Economic Co-operation and Development, Paris.

- *For further references, including industrial viewpoints, see:*

ECETOC/IRPTC, 1996. Inventory of Critical Reviews on Chemicals. Published by ECETOC, European Center for Ecotoxicology and Toxicology of Chemicals, Brussels, and IRPTC, International Register on Potentially Toxic Chemicals, Geneva.

1.4.4.6 Input-Output Analysis (IOA)

As part of the establishment of national accounts, input-output analysis was devised in the 1930s, and first implemented in the 1940s for the USA. Its founder was Wassily Leontief (1936), and his approach to national accounts was a disaggregated one, focusing on how industries trade with each other, and how such inter-industry trading influenced the overall demand for labor and capital within an economy.

The basic distinction that is made in input-output analysis is between the demand for goods and services sold to 'Final Demand' (households, governments, exports, investment), and the 'Total Demand' in the various sectors, resulting from the direct impact of final demand, and the indirect impacts resulting from inter-industry trading (intermediate demand). For instance, almost no iron and steel products are sold directly to domestic consumers (final demand), but a great deal is sold embodied in manufactured goods, such as cars and washing machines.

$$\text{Total demand} = \text{intermediate demand} + \text{final demand}$$

One of the main uses of input-output analysis is to display all flows of goods and services within an economy, simultaneously illustrating the connection between producers and consumers and the interdependence of industries. An advantage of input-output tables is that economic components, such as income, output and expenditure, are presented in a consistent framework reconciling the discrepancies between the estimates of these components.

Using linear algebra, input-output analysis allows all economic activity to be directly related to final demand. Of course, the final demand for the various producing sectors sums to Gross Domestic Product (GDP), one of the fundamental measures in national accounting. Input-output tables can be, and are being, used for various economic analyses within and outside Government. The use of input-output tables is particularly important for analyzing structural adjustment in industry. For a full description of input-output analysis, see Miller and Blair (1985), and its application to environmental issues, Proops et al. (1993).

Relevant literature

Leontief, W. (1936) Quantitative input-output relations in the economic systems of the United States. Review of Economics and Statistics, Vol. 18, pp.105-125.

Miller, R.E. and P.D. Blair (1985) Input-Output Analysis: Foundations and Extensions. Prentice-Hall, Englewood Cliffs, New Jersey.

Proops, J., Faber, M. and Wagenhals, G. (1993) Reducing CO₂ Emissions: A Comparative Input-Output Study for Germany and the UK, Springer-Verlag, Heidelberg.

1.4.4.7 Material Intensity Analysis (MAIA)

According to the concept of MIPS (Material Input per Service unit) MAIA is used to quantify the life-cycle-wide requirement of primary materials for products and services. Analogously to the quantification of the cumulative energy requirements MAIA provides information on basic environmental pressures associated with the magnitude of resource extraction and the subsequent material flows, which end up as waste or emission.

The input of primary raw materials (including energy carriers) is measured in physical units (kg) and aggregated to five main categories:

- Abiotic raw materials (non-regrowing inputs)
- Biotic raw materials (regrowing inputs)
- Soil removal
- Water
- Air (inputs for physico-chemical conversion, usually for combustion, therefore in most cases also strongly correlated with carbon dioxide emissions)

MAIA has been developed since 1992. It has been conceived as a screening step for LCA. It has been used to:

- Operationalise the concept of dematerialization and to contribute to the implementation of eco-efficiency (factor 4 to 10)
- Quantify the material intensity of products and services
- Elucidate options for material and energy savings in industry in order to increase resource productivity
- Provide material input coefficients for a variety of base materials to support sustainable product design
- Quantify the Total Material Requirements of regional and national economies (TMR).

Relevant literature:

Schmidt-Bleek, F. et al. (1998): Einführung in die Materialintensitäts-Analyse nach dem MIPS-Konzept. Wuppertal Texte, Birkhäuser Verlag, Berlin, Basel, Boston

Bringezu, S., Stiller, H., Schmidt-Bleek, F. (1996): Material Intensity Analysis - A Screening Step of LCA. Proceedings of the Second International Conference on EcoBalance, Nov. 18-20, 1996, Tsukuba, Japan, p.147-152

Liedtke, C., Orbach, T., Rohn, H. (1997): Towards a Sustainable Company: Resource Management at the „Kambium Furniture Workshop Inc.". In: Bringezu, S., Fischer-Kowalski, M., Kleijn, R., Palm, V.: Analysis for Action. Support for Policy towards Sustainability by Material Flow Accounting. Proceedings of the ConAccount Conference, 11-12 September 1997, Wuppertal, Wuppertal Special 6, pp. 163-174

MIPS-online: <http://www.wupperinst.org>

1.4.4.8 Multi-Criteria Analysis - MCA (After Paruccini et al., 1997)

Orthodox decision theory focuses on finding the best solution to any decision problem. In doing so, the theory employs analytical tools and specific theoretical language rooted in the paradigm of substantive rationality using constrained optimization. The optimizing approach

is based on the assumption that different objectives can be expressed with respect to a common denominator by means of trade-offs (complete commensurability) so that the loss in one objective can be evaluated against the gain in another. Thus the orthodox approach is firmly based on a single-criterion approach. However, most decision-makers would agree that the norm is decision making in situations where a single criterion is not sufficient – *i.e.* multiple criteria are needed. During the last two decades, further support has emerged for the view that a decision is a multidimensional concept (Bana e coste, 1990; Nijkamp et al., 1990; Paruccini, 1994).

From the point of view of the decision-maker, it is also clear that, the moment a decision has been made the multi-dimensional problem, with a large number of possible solutions, has in fact been reduced to one solution. The role for decision support systems is in facilitating the process of the necessary reductions. Thus the most important distinction between the different types of Decision Support Systems is whether they can handle single or multiple criteria: clearly multi-criteria systems offer several advantages for policy decisions, where conflicting interests have to be considered.

A large number of multi-criteria evaluation methods have been developed and applied for different policy purposes in different contexts. As a tool for conflict management, multi-criteria evaluation has demonstrated its usefulness particularly with regard to environmental management problems. In general, a multi-criteria model presents the following aspects:

- There is no solution optimizing all the criteria at the same time and therefore the decision-maker has to find compromise solutions.
- The relations of preference and indifference are not enough in this approach, because when an action is better than another one for some criteria, it is usually worse for others, so that many pairs of actions remain incomparable with respect to a dominance relation.

Thus the concept of 'decision process' has an essential importance. The final outcome is more like a 'creation' than a discovery. With a multiple criteria decision aid the principal aim is not to discover a solution, but to construct or create something which is viewed as useful to an actor taking part in a decision process (Roy, 1995).

Relevant literature

Bana e Costa C. A. (ed.), 1990. Readings in Multiple Criteria Decision Aid. Springer-verlag, Berlin.

Nijkamp, P. Rietveld P. and Voogt H., 1990. Multicriteria Evaluation in Physical Planning, North-Holland, Amsterdam.

Paruccini, M., 1994. Applying Multicriteria Aid for Decision to Environmental Management, Kluwer, Dordrecht.

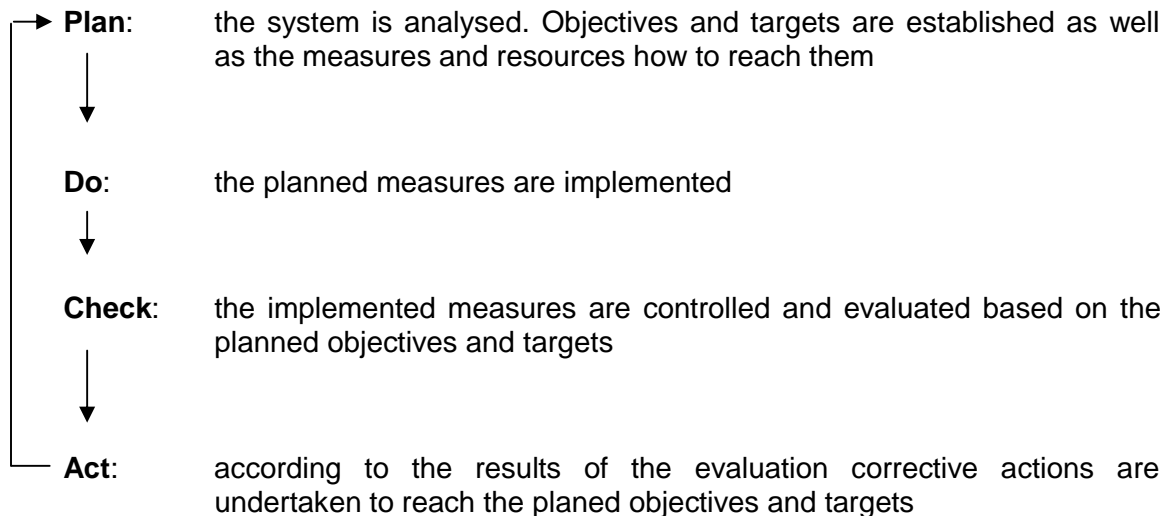
Paruccini, M., Haastруп, P. and Bain D., 1997. Decision support systems in the service of policy makers. The IPTS report ,14, May 1997, 28-35.

2 SOME CONCEPTS AND TOOLS

2.1 GENERAL CONCEPTS: CONTINUAL IMPROVEMENT / PLAN-DO-CHECK-ACT

Continual improvement is one of the inherent concepts of market economy, which is based on continual quantitative (and qualitative) growth. The competitive structure of the marked economy and the western culture implies continuous search for a "better", "cheaper", "faster", "easier" solution for little every-day-things as well as for industrial production and problems on a global scale.

The most important mechanism how to reach Continual Improvement, is by the PDCA-("plan-do-check-act")-circle.



This systematic approach acknowledges that you need to understand (plan – check) a process before you can improve it (do – act).

All management tools – like Life cycle assessment, Auditing, Project management, System engineering - can be assigned to one or several steps of the "plan-do-check-act"-circle.

2.1.1 Example: Environmental Management Systems

Environmental Management Systems according to ISO 14'001 have incorporated "Continual improvement" and the "plan-do-check-act"-circle as the main principles on an over all scale and on various sublevels of the system.

According to ISO 14001:1996 (chapter 3.1), "Continual improvement" is a process of enhancing the environmental management system to achieve improvements in overall environmental performance in line with the organisation's environmental policy.

The over all circle aiming at "Continual Improvement" is shown in Figure 2.1.

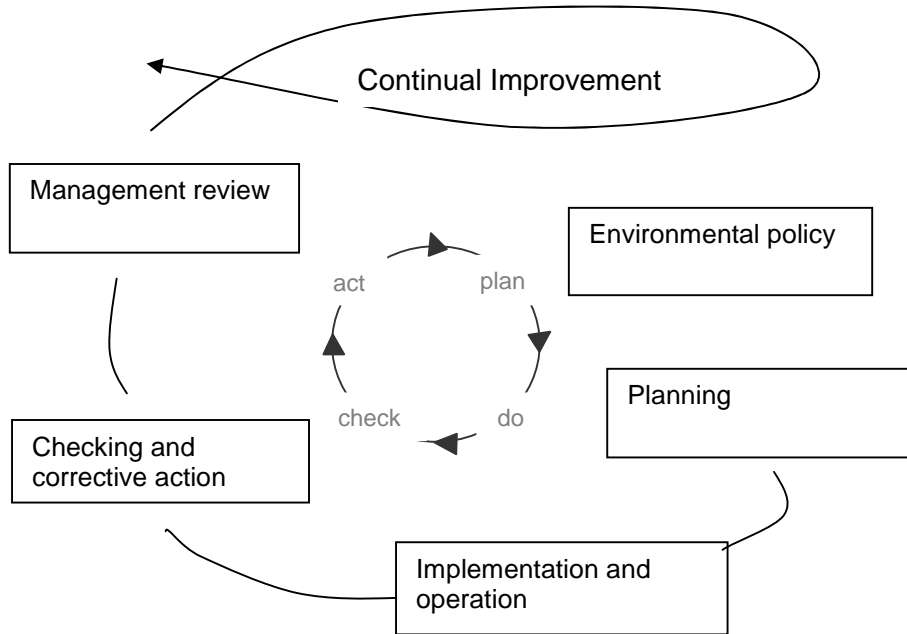


Figure 2.1.: Continual Improvement and "plan-do-check-act" as a general principle of Environmental Management Systems (according to ISO 14'001)

Not only on a general level but also as an inherent principle the "plan-do-check-act"-scheme is realised between the normative, the strategic and the operational level of the management system (Figure 2.2).

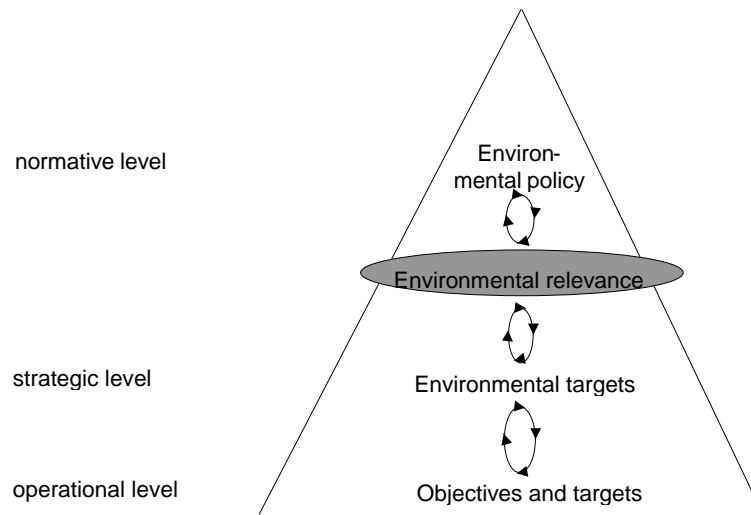


Figure 2.2: The "plan-do-check-act"-cycle as inherent concept between normative, strategic and operational level of a management system

This structure allows a co-ordinated procedure to plan, implement, control and review the state and adequacy of the management system in order to continually improve it, and – as a direct consequence – to improve the company's environmental performance (Figure 2.3).

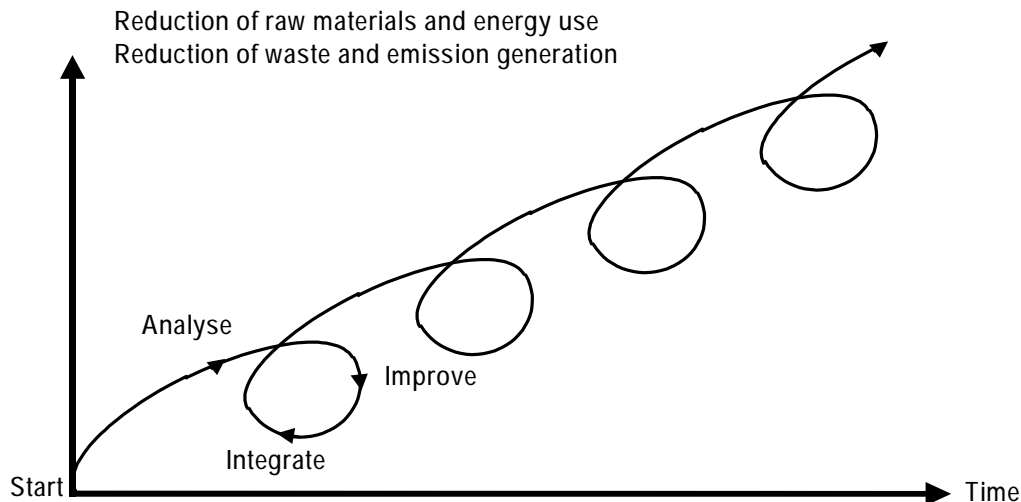


Figure 2.3: Continual improvement in environmental management systems

2.1.2 References

- ISO 14001:1996 Environmental management systems – Specifications with guidance for use
 ISO 14004:1996 Environmental management systems – General guidelines on principles, systems and supporting techniques. Draft.

2.2 INDUSTRIAL ECOLOGY

2.2.1 An integrated view of industrial systems

Industrial ecology provides an integrated view of industrial systems. It is a systems orientation that balances industrial development with the sustainable use of natural resources. Industrial ecology is based on an analogy of industrial systems to natural ecological systems. (1)

The concept of industrial ecology is comprehensive and the underlying idea can guide corporate approach to sustainability, business strategy and operational practice. However, the application of this concept in practice is mainly associated with eco-parks, industrial symbiosis or industrial clustering.

The concept of industrial ecology promotes a moving away from open linear systems towards systems similar to those found in Nature, where unit processes and industries are interacting systems rather than isolated components. (1)

Key elements of the industrial ecology perspective:

- “It is a systematic, comprehensive, integrated view of all the components of the industrial economy and their relations with the Biosphere.
- It emphasises the biophysical substratum of human activities, i.e. the complex patterns of material flows within and outside the industrial system, in contrast with current approaches

which mostly consider the economy in terms of abstract monetary units, or alternatively on energy flows.

- It considers technological dynamics, i.e. the long term evolution (technological trajectories) of clusters of key technologies as a crucial (but not exclusive) element for the transition from the actual unsustainable industrial system to a viable industrial ecosystem." (3)

As one author describes it, "industrial ecology is a way for corporations to better exploit their products and resources more efficiently, and therefore more profitably" (3)

2.2.2 Industrial Symbiosis or Clustering

Industrial symbiosis or clustering is a method based on the principles of industrial ecology. Industrial symbiosis internalises environmental costs within production and consumption processes. Industrial clusters or eco-industrial parks take advantage of the outputs of co-located operations, exchanging wastes for 'raw' materials.

To implement industrial symbiosis in practice, companies create complex networks of material flows developing sets of linkages throughout their operations to increase the efficiency of material and energy throughput (2). These linkages enable companies to capture emissions and wastes and recycle them back into processes as inputs.

One of the first applications of the industrial symbiosis concept is found in Kalundborg, Denmark. At Kalundborg, industry has tried to emulate natural ecosystems on an industrial estate where neighbours exist in symbiosis with each other, by developing a web of materials and energy exchanges among companies (4). Similar projects are under development in other European countries, Asia and the United States.

Figure 2.4 illustrates a possible industrial symbiosis network showing the material, finance and information flows.

2.2.3 Case study: Kalundborg - Industrial Symbiosis in Denmark

One of the best-known examples of industrial symbiosis can be found in a small industrial zone, 75 miles west of Copenhagen in Kalundborg, Denmark. This unplanned industrial park evolved from one power plant into a group of companies that rely on each other for material inputs. The project started in 1972, and by 1994, 16 contracts had been negotiated and total investments amounted to approximately US \$60 million. The extent of the material and energy exchanges in 1995 was about 3 million tons per year (5). Estimated savings totalled "US \$10 millions annually giving an average pay-back time of six years". (4)

The core participants in this system are (4):

- a power station - Asnaes, Denmark's largest coal-fired power station;
- an oil refinery - Statoil Refinery A/S, with an annual capacity of 5.2 million metric tons of crude oil;
- a pharmaceutical/biotechnology company - Novo Nordisk A/S, its largest site is the production facility in Kalundborg;

- a plasterboard manufacturer - Gyproc A/S, Scandinavia's largest plasterboard manufacturer;
- the Municipality of Kalundborg, which distributes water, electricity and district heating in this rural area with about 20,000 inhabitants.

The system is known locally as industrial symbiosis and it has grown over the years to include partners from other districts, farmers and other stakeholders in the region.

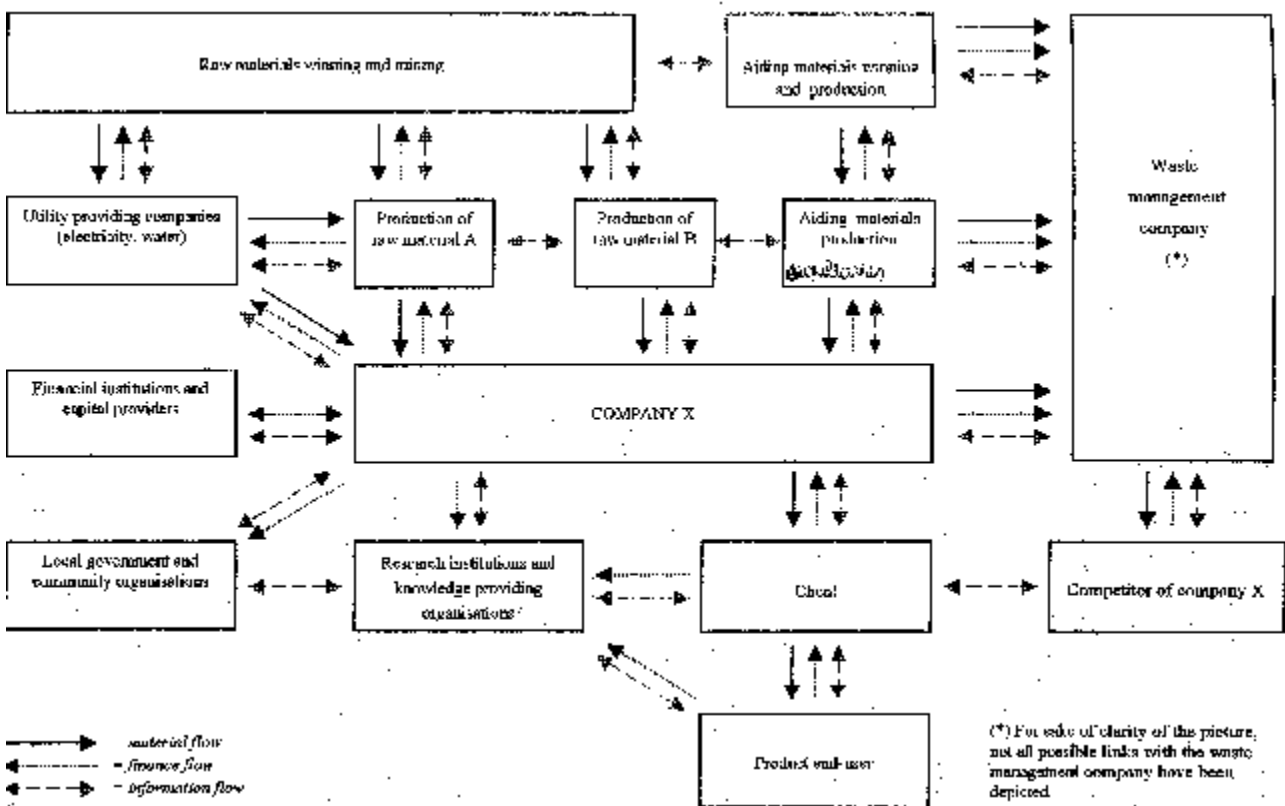


Figure 2.4: Example of an industrial symbiosis network

How does it work?

The participants in this symbiotic relationship exchange materials and energy for mutual benefit, realising that by-products from one business can be used as low cost inputs by the others businesses and stakeholders.

For example, treated wastewater from the Statoil Refinery is used by the Asnaes power station to obtain some of the cooling water Asnaes requires. On the other hand, Statoil and Novo Nordisk buy around 400,000 metric tons of "waste" process steam from the power station for their operations. The power station surplus heat is used for household heating in the local community. In addition, surplus heat from the power station is used to warm water for a fish farm (4).

The power station produces other valuable "wastes" including 170,000 metric tons of fly ash a year used to make cement and road. A cement company, Gyproc, uses the power plant's

desulfurised fly ash to obtain gypsum (a by-product from the desulfurisation of stack emissions). Gyproc buys about 80,000 metric tons of this material each year satisfying almost 2/3 of its needs for the input substance (5).

Surplus gas from the Statoil Refinery, which used to be burned off in the flare, is now delivered to the power station and Gyproc. Gyproc had seen Statoil's flares and recognised that this burning gas was a potential low-cost fuel source. Local farmers use Novo Nordisk's by-products as fertilisers. "At Novo Nordisk's factory, industrial enzymes and insulin are produced by fermentation using selected strains of micro-organisms. The residue from fermentation is rich in nutrients including nitrogen and phosphorus. After lime and heat treatment, this biomass makes an excellent fertiliser and about 1.5 million cubic meters a year are delivered to local farmers free of charge (4)."

Figure 2.5 shows a schematic diagram of the Kalundborg Industrial Ecopark.

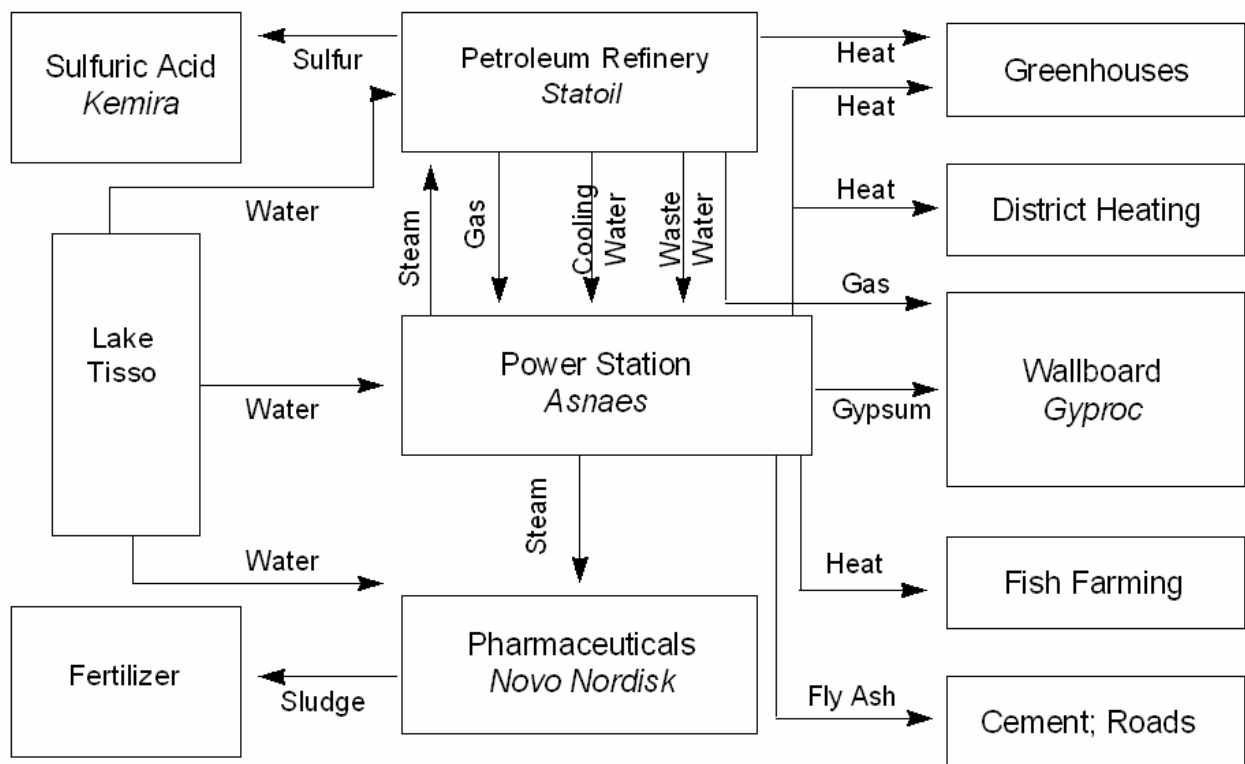


Figure 2.5: A schematic diagram of the industrial Ecopark located in Kalundborg, Denmark. The figure shows the industrial concerns that occupy the park, the materials and energy flows between them, and the nature and fate of outgoing material and energy streams. After Allenby, B.R. and Graedel, T.E., 1994, *Defining the Environmentally Responsible Facility*, AT&T, Murray Hill, NJ.

Benefits

"Originally, the motivation behind most of the exchanges was to reduce costs by seeking income-producing uses for "waste" products. Gradually, the managers and town residents realised they were generating environmental benefits as well, through their transactions (7)."

This project has enabled each of the participants to realise savings, improve resource efficiency, and protect the environment. Gyproc records 90-95% savings in oil consumption due to the gas supply obtained from the refinery (6). There is an annual reduction in resource consumption of 19,000 metric tons of oil, 30,000 metric tons of coal and 1.4 million metric tons of water. Annual reductions in air emissions amount to 200,000 metric tons of carbon dioxide and 1,000 metric tons of sulphur dioxide.

In addition to these reductions, the use of the excess heat from Asnaes for household heating reduces pollution in the community by eliminating the need for about 3,500 independent oil-burning domestic heating systems.

2.2.4 Resources

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5. Indigo Development, Industrial Ecology: Case Histories
6. Industrial ecology - a holistic view. International Institute of Sustainable Development (IISD)

Related Links

- J.H. Ausubel, I.K. Wernick: Industrial ecology: some directions for research. Program for the Human Environment, The Rockefeller University, New York
http://phe.rockefeller.edu/ie_agenda/
- Center of excellence of sustainable development (U.S. Department of Energy, with lot of informations and links): <http://www.sustainable.doe.gov/business/parkintro.htm>
- Centre for Environment and Development (CED), Norwegian University of Science and Technology (NTNU), Trondheim <http://www.smu.ntnu.no>
with lectures: <http://www.smu.ntnu.no/PROG/STIE/LectureSlides/>
link page: <http://www.smu.ntnu.no/PROG/STIE/Links/>
- Eco-Industrial Development: About Eco-Industrial Parks:
<http://www.cfe.cornell.edu/wei/eid.html>
The Work and Environment Initiative is a program of the Cornell Center for the Environment. Drawing substantially on the Cornell School of Industrial and Labor Relations (ILR), WEI combines expertise in labor-management relations, human resource management and industrial hygiene.

- Ehrenfeld, John and Nicholas Gertler. "Industrial Ecology in Practice: The Evolution of Interdependence at Kalundborg". *Journal of Industrial Ecology* 1 (1: 1997): 67-79.
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- Industrial Ecology Case Studies: <http://indigodev.com/index.html>
Indigo Development is a Center in the Sustainable Development Division of RPP International, California. This site includes descriptions of the industries in the Kalundborg industrial park in Denmark.
- International Institute of Sustainable Development (IISD): <http://iisd1.iisd.ca/business>
IISD is a non-profit organisation in Winnipeg, Canada. IISD's mission is to promote sustainable development in decision making internationally.
- Journal of Industrial Ecology: <http://www.yale.edu/jie>
The site presents articles from the *Journal of Industrial Ecology*, an international, multi-disciplinary quarterly journal published by MIT Press. The journal is designed to foster both understanding and practice in the emerging field of industrial ecology.
<http://mitpress.mit.edu/journals.tcl>
- The Burnside Industrial Park as an Ecosystem:
<http://www.mgmt.dal.ca/sres/BURN/home.html>
The Burnside Industrial Park in Atlantic Canada is a research project of Dalhousie University, Canada. Researchers and businesses are examining how cleaner production and industrial ecology may offer new opportunities.

2.3 AGENDA 21 (AND ICC-CHARTER)

Rio de Janeiro, Brazil, June 1992: The largest-ever meeting of world leaders makes critical decisions about how we can run our economies secure our future. What 179 countries agreed to is nothing less than a blueprint on how to make the future development of our world economically, socially and environmentally sound and sustainable. The Earth Summit's Agenda for Change explains in clear terms what was decided in Rio. This may be the most important book you will read, because the Rio decisions have the potential to change the way you will live and work from now into the next century.

2.3.1 The Road to Rio

During the last two decades, people began to realise that we cannot have a healthy society or economy in a world with so much poverty and environmental degradation. Economic development cannot stop, but it must change course to become less ecologically destructive. The challenge of the 1990s is to put this understanding into action, and make the transition to sustainable forms of development and lifestyles. From the farm field to the boardroom, from the shopping cart to the national budget, we will have to make major changes.

A road map to sustainable development is now taking shape. Agenda 21 is a guide for business and government policies and for personal choices into the next century. It was

endorsed by the 1992 Earth Summit in Rio de Janeiro, Brazil, the largest-ever meeting of world leaders. This meeting took place during the United Nations Conference on Environment and Development, which brought together the heads or senior officials of 179 governments. They were joined by hundreds of officials from United Nations organisations, municipal governments, business, scientific, non-government and other groups. Nearby, the '92 Global Forum held a series of meetings, lectures, seminars and exhibits on environment and development issues for the public. This drew 18,000 participants from 166 countries, as well as 400,000 visitors. There were 8,000 journalists covering the Rio meetings, and the results were seen, heard and read about around the world.

The foundations for the Rio process were laid in 1972, when 113 nations gathered for the Stockholm Conference on the Human Environment, the first global environmental meeting. In 1983, the United Nations created the World Commission on Environment and Development. Four years later its landmark report, *Our Common Future*, warned that people had to change many of the ways they did business and lived or the world would face unacceptable levels of human suffering and environmental damage.

The commission said that the global economy had to meet people's needs and legitimate desires, but growth had to fit within the planet's ecological limits. The commission, known as the Brundtland Commission after its chairman, called for "a new era of environmentally sound economic development". It said that: "Humanity has the ability to make development sustainable - to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs."

In 1989, the United Nations began planning a Conference on Environment and Development to spell out how to achieve sustainable development. For two years, experts from around the world hammered out difficult agreements along the road to Rio. The international negotiating system was opened up as never before. Thousands of people from non-governmental organisations, businesses, education, women's groups, indigenous groups and others contributed to the Rio process.

2.3.2 The Five Rio Documents

Rio produced two international agreements, two statements of principles and a major action agenda on worldwide sustainable development. The five are:

- The **Rio Declaration on Environment and Development**. Its 27 principles define the rights and responsibilities of nations as they pursue human development and well-being.
- **Agenda 21**, a blueprint on how make development socially, economically and environmentally sustainable.
- A **statement of principles** to guide the management, conservation and sustainable development of all types **of forests**, which are essential to economic development and the maintenance of all forms of life.
- Two major international Conventions were negotiated separately from but parallel to preparations for the Earth Summit and were signed by most governments meeting at Rio.
- The aim of the **United Nations Framework Convention On Climate Change** is to stabilise greenhouse gases in the atmosphere at levels that will not dangerously upset the

global climate system. This will require a reduction in our emissions of such gases as carbon dioxide, a by-product of the use of burning fuels for energy.

- The **Convention on Biological Diversity** requires that countries adopt ways and means to conserve the variety of living species, and ensure that the benefits from using biological diversity are equitably shared.

2.3.2.1 Agenda 21

Agenda 21 explains that population, consumption and technology are the primary driving forces of environmental change. It lays out what needs to be done to reduce wasteful and inefficient consumption patterns in some parts of the world while encouraging increased but sustainable development in others. It offers policies and programmes to achieve a sustainable balance between consumption, population and the Earth's life-supporting capacity. It describes some of technologies and techniques that need to be developed to provide for human needs while carefully managing natural resources.

Agenda 21 provides options for combating degradation of the land, air and water, conserving forests and the diversity of species of life. It deals with poverty and excessive consumption, health and education, cities and farmers. There are roles for everyone: governments, business people, trade unions, scientists, teachers, indigenous people, women, youth and children. Agenda 21 does not shun business. It says that sustainable development is the way to reverse both poverty and environmental destruction.

We currently gauge the success of economic development mainly by the amount of money it produces. Accounting systems that measure the wealth of nations also need to count the full value of natural resources and the full cost of environmental degradation. The polluter should, in principle, bear the costs of pollution. To reduce the risk of causing damage, environmental assessment should be carried out before starting projects that carry the risk of adverse impacts. Governments should reduce or eliminate subsidies that are not consistent with sustainable development.

A major theme of Agenda 21 is the need to eradicate poverty by giving poor people more access to the resources they need to live sustainably. By adopting Agenda 21, industrialised countries recognised that they have a greater role in cleaning up the environment than poor nations, who produce relatively less pollution. The richer nations also promised more funding to help other nations develop in ways that have lower environmental impacts. Beyond funding, nations need help in building the expertise - the capacity - to plan and carry out sustainable development decisions. This will require the transfer of information and skills.

Agenda 21 calls on governments to adopt national strategies for sustainable development. These should be developed with wide participation, including non-government organisations and the public. Agenda 21 puts most of the responsibility for leading change on national governments, but says they need to work in a broad series of partnerships with international organisations, business, regional, state, provincial and local governments, non-governmental and citizens' groups.

As Agenda 21 says, only a global partnership will ensure that all nations will have a safer and more prosperous future.

2.3.2.2 Rio Declaration on Environment and Development

Recognising the integral and interdependent nature of the Earth, our home, the nations meeting at the Earth Summit in Rio de Janeiro adopted a set of principles to guide future development. These principles define the rights of people to development, and their responsibilities to safeguard the common environment. They build on ideas from the Stockholm Declaration at the 1972 United Nations Conference on the Human Environment.

The Rio Declaration states that the only way to have long term economic progress is to link it with environmental protection. This will only happen if nations establish a new and equitable global partnership involving governments, their people and key sectors of societies. They must build international agreements that protect the integrity of the global environmental and the developmental system.

The Rio principles include the following ideas:

- People are entitled to a healthy and productive life in harmony with nature.
- Development today must not undermine the developmental and environmental needs of present and future generations.
- Nations have the sovereign right to exploit their own resources, but without causing environmental damage beyond their borders.
- Nations shall develop international laws to provide compensation for damage that activities under their control cause to areas beyond their borders.
- Nations shall use the precautionary approach to protect the environment. Where there are threats of serious or irreversible damage, scientific uncertainty shall not be used to postpone cost-effective measures to prevent environmental degradation.
- In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process, and cannot be considered in isolation from it.
- Eradicating poverty and reducing disparities in living standards in different parts of the world are essential to achieve sustainable development and meet the needs of the majority of people.
- Nations shall cooperate to conserve, protect and restore the health and integrity of the Earth's ecosystem. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.
- Nations should reduce and eliminate unsustainable patterns of production and consumption, and promote appropriate demographic policies.
- Environmental issues are best handled with the participation of all concerned citizens. States shall facilitate and encourage public awareness and participation by making environmental information widely available.

- Nations shall enact effective environmental laws, and develop national law regarding liability for the victims of pollution and other environmental damage. Where they have authority, nations shall assess the environmental impact of proposed activities that are likely to have a significant adverse impact.
- Nations should cooperate to promote an open international economic system that will lead to economic growth and sustainable development in all countries. Environmental policies should not be used as an unjustifiable means of restricting international trade.
- The polluter should, in principle, bear the cost of pollution.
- Nations shall warn one another of natural disasters or activities that may have harmful transboundary impacts.
- Sustainable development requires better scientific understanding of the problems. Nations should share knowledge and innovative technologies to achieve the goal of sustainability.
- The full participation of women is essential to achieve sustainable development. The creativity, ideals and courage of youth and the knowledge of indigenous people are needed too. Nations should recognise and support the identity, culture and interests of indigenous people.
- Warfare is inherently destructive of sustainable development, and Nations shall respect international laws protecting environment in times of armed conflict, and shall cooperate in their further establishment.
- Peace, development and environmental protection are interdependent and indivisible.

2.3.3 The Road from Rio

Agenda 21 and the other Rio documents form a series of stepping stones towards a more socially, economically and environmentally sustainable world. The challenge we face is to put the good ideas from Rio into action, even as we refine them and develop more detailed plans.

Two years of preparation for Rio broadened the global network of expertise on sustainable development. It opened the doors of international negotiations to many more people from business, non-governmental and other groups. It created an expectation for follow-up actions.

National action plans for sustainable development need to be created in all countries, based on broad public participation and community involvement. They should be backed up by specific programmes to deal with human needs and the sustainable use and conservation of the environment. It is too early to measure the ultimate success of Agenda 21 and the other documents, but they have already had a clear impact.

The United Nations, which created the Rio process, is deeply involved in seeing that the commitments made by governments are put into action. This means getting ratification of the climate change and biodiversity Conventions and working towards other agreements.

The United Nations has created groups to:

- Draft an international agreement to combat desertification.
- Work out means to prevent over-exploitation of fish in the high seas, beyond national coastal zones.
- Assist small island nations to develop in ways that meet human needs while maintaining a healthy environment.

The UN is increasing help for nations to implement sustainable development. A high-level UN Commission on Sustainable Development has been created. It will monitor and report on how the world is living up to commitments made in Rio. By 1997, the United Nations will hold a special session to review progress in reaching the goals of the Earth Summit.

Around the world, governments, businesses, non-governmental and other organisations are already putting the ideas from Rio to work.

It is crucial to maintain the momentum of the Rio process and implement the agreements that were reached. This task will require not only the leadership and funding of governments and business, but the vision, cooperation and work of every citizen.

2.3.4 About the ICC Business Charter

The ICC (International Chamber of Commerce) Business Charter defines business' environmental responsibilities in 16 principles. The Charter includes environmentally related aspects of health, safety and product stewardship. Its objective is "that the widest range of enterprises commit themselves to improving their environmental performance in accordance with the Principles, to having in place management practices to effect such improvement, to measuring their progress, and to reporting this progress as appropriate internally and externally"².

To date, over 2000 companies have signed the Charter and several industry associations and coalitions use it as the basis for their programs. ICC has developed Environmental Management Training Kits to assist organisations in improving their performance. Currently, ICC is analysing corporations' experiences in implementing the Charter¹.

2.3.5 Sources

Agenda 21: the plain text is available in English, French and Spanish at:
<http://www.igc.apc.org/habitat/agenda21/index.html>

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<http://www.iccwbo.org/Commissions/Environment/charter.htm>

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2.4 ENVIRONMENTAL STANDARDS: ISO 14000 FAMILY, ENVIRONMENTAL MANAGEMENT SYSTEMS (EMS)

The ISO 14000 series of standards have been designed to help enterprises to introduce and maintain their environmental management system towards sustainable management. They have been under development by the International Organisation for Standardisation (ISO) since 1991. They consist of a set of documents that define the key elements of a management system that will help an organisation address the environmental issues it faces. Basic concept is to give a system for continual improvement and further supporting tools. Figure 2.6 shows the relationships between the ISO standards. Three sets of tools are important in implementing an EMS:

Management system standards (ISO 14001, 14004);

Evaluation and auditing tools: auditing guidelines (ISO 14010ff); environmental performance evaluation (EPE; ISO 14031);

Product-oriented support tools: environmental labelling (ISO 14020ff); life cycle assessment (LCA; ISO 14040ff).

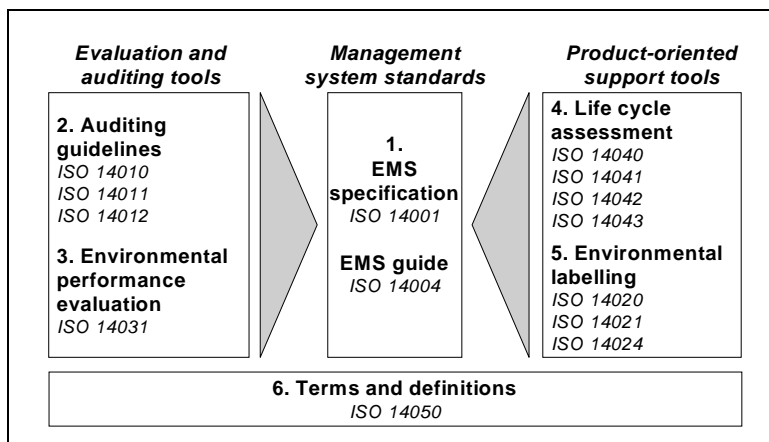


Figure 2.6: ISO 14000 series

ISO drafts and standards are edited in English, French and Russian by ISO. The final standards are published in Spanish by national Standard Bodies (e.g. ICONTEC = Instituto Colombiano de Normas Técnicas y Certificación; AENOR = Asociación Española de Normalización y Certificación). Tables 2.1 and 2.2 shows the ISO 14000 standards and their actual status.

Table 2.1: ISO standards

Standard	Status	Title	Publication in Spanish
Environmental management systems (EMS)			
14001	IS 1996	Environmental management systems - Specification with guidance for use	Sistemas de gestión medioambiental - Especificaciones y directrices para su uso
14004	IS 1996	Environmental management systems - General guidelines on principles, systems and supporting techniques	Sistemas de gestión medioambiental - Guías y principios generales - Sistemas y técnicas de soporte
Comparison ISO 14000 – Eco-management and audit scheme (EMAS)			
CR 12986		<i>Comparison document between Council Regulations (EEC) 1836/93 and the EN ISO 14000 series principles</i>	
CR 12969		<i>Bridging document between the EN ISO 14000 series and the Council Regulations (EEC) 1836/93 (EMAS)</i>	
Environmental auditing (EA)			
14010	IS 1996	Guidelines for environmental auditing - General principles	Directrices para la auditoría medioambiental - Principios generales
14011	IS 1996	Guidelines for environmental auditing - Audit procedures - Auditing of environmental management systems	Directrices para la auditoría medioambiental - Auditoría de los sistemas de gestión medioambiental
14012	IS 1996	Guidelines for environmental auditing - Qualification criteria for environmental auditors	Directrices para la auditoría medioambiental - Criterios de cualificación para los auditores medioambientales
14015	CD 2000	Environmental management - Environmental assessment of sites and organizations	
19011	CD 2000	Guidelines on quality and environmental auditing	
Forestry Management (FM) And Product Development (PD)			
TR 14061	TR	Information to assist forestry organisations in the use of Environmental Management Systems standards ISO 14001 and ISO 14004	
TR 14062	WD 2000	Guidelines for integrating environmental aspects into product development	
Environmental labels and declarations (EL)			
14020	IS 1998	Environmental labels and declarations - General principles	
14021	IS 1999	Environmental labels and declarations - Self-declared environmental claims (Type II)	
14024	IS 1999	Environmental labels and declarations - Type I environmental labelling - Principles and procedures	
14025	IS 1999	Environmental labels and declarations - Type III environmental labelling - Guiding principles and procedures	
Environmental performance evaluation (EPE)			
14031	IS 1999	Environmental performance evaluation - Guidelines	
TR 14032	TR	Environmental management – Examples of environmental performance evaluation (EPE)	
Life cycle assessment (LCA)			
14040	IS 1997	Life cycle assessment - Principles and framework	Análisis de ciclo de vida - Principios y estructura
14041	IS 1998	Life cycle assessment – Goal and scope definition and inventory analysis	
14042	IS 2000	Life cycle assessment - Impact assessment	
14043	IS 2000	Life cycle assessment - Interpretation	
TR 14047	WD 2000	Examples of application of ISO 14042	
TR 14048	CD 2000	Data documentation format	
TR 14049	D 2000	Examples of application of ISO 14041 to goal and scope definition and inventory analysis	
Terms and definitions			
ISO 14050	IS 1998	Environmental management - Vocabulary	
Environmental Aspects in Product Standards (ENAPS)			
Guide 64	1997	Guide for inclusion of environmental aspects in product standards	

IS: International Standard; FDIS: Final Draft IS; DIS: Draft IS; CD: Committee Draft; WD: Working Draft; TR: Technical Report

Table 2.2: Application of the ISO 14000 family documents

Application at the organisational level						
Implementing Environmental Management Systems (EMS)	ISO 14001: 1996 ISO 14004: 1996 These documents help an organisation to establish a new or improve an existing EMS	ISO 14001: 1996 This document specifies the requirements for an EMS that may be objectively audited for self-declaration or third-party certification/registration purposes	ISO 14004: 1996 This document provides guidance to help an organisation establish and implement an EMS, including guidance that goes beyond the requirements of ISO 14001	ISO/TR 14061 This document contains information that can assist in the implementation of ISO 14001 and ISO 14004 by forest management organisations and the forest products industry		
Conducting environmental auditing and other related investigations	ISO 14010: 1996 This document provides the general principles common to the conduct of any environmental audit	ISO 14011: 1996 This document provides the procedures for the conduct of EMS audits, including the criteria for selection and composition of audit teams	ISO 14012: 1996 This document provides guidance on the qualifications of internal or external environmental auditors and lead auditors	ISO/CD 14015 This document helps an organisation to identify and assess the environmental aspects of sites and entities to support the transfer of properties, responsibilities and obligations from one party to another		
Evaluating environmental performance	ISO 14031: 1999 This document provides guidance on the selection and use of indicators to evaluate an organisation's environmental performance	ISO/TR 14032 This document provides examples from real organisations to illustrate the use of the guidance in ISO 14031				
Application to products and services						
Using environmental declarations and claims	ISO 14020: 1998 This document provides general principles which serve as a basis for the development of ISO guidelines and standards on environmental claims and declarations	ISO 14021: 1999 This document provides guidance on the terminology, symbols and testing and verification methodologies an organisation should use for self-declaration of the environmental aspects of its products and services (Type II Environmental Labelling)	ISO 14024: 1999 This document provides the guiding principles and procedures for third-party environmental labelling certification programs (Type I Environmental Labelling)	ISO/TR 14025 This document provides guidance and procedures on a specialised form of third-party environmental labelling certification using quantified product information labels and preset indices (Type III Environmental Labelling)		
Conducting life cycle assessment (LCA)	ISO 14040: 1997 This document provides the general principles, framework and methodological requirements for the LCA of products and services	ISO 14041: 1998 This document provides guidance for determining the goal and scope of an LCA study, and for conducting a life cycle inventory	ISO 14042: 2000 This document provides guidance for conducting the life cycle impact assessment phase of an LCA study	ISO 14043: 2000 This document provides guidance for the interpretation of results from an LCA study	ISO/TR 14048 This document provides information regarding the formatting of data to support life cycle assessment	ISO/TR 14049 This document provides examples that illustrate how to apply the guidance in ISO 14041
Addressing environmental aspects in product standards	ISO Guide 64: 1997 This document helps the writers of product standards address environmental aspects in those standards					
Understanding terms and definitions						
	ISO 14050: 1998 This document helps an organisation to understand the terms used in the ISO 14000 series standards					

CD = Committee Draft; DIS = Draft International Standard; FDIS = Final Draft International Standard; TR = Technical Report; NWIP = New Work Item Proposal
Source: ISO 1998

2.5 GLOSSARY

2.5.1 General definitions

benchmarking:

Developed in such areas as Total Quality Management (TQM), benchmarking involves the comparison, ranking or rating of different business processes, units or companies against standards. The aim: to identify ways of improving the performance of operations, systems, processes. Environmental benchmarking is a growth area.

biodiversity:

The word - a contraction of 'biological diversity' - is sometimes used as a synonym for 'Life on Earth'. But its specific meanings, referring to the number, variety and variability of living organisms, will be central to 21st century values, thinking and action.

business ecosystems:

As traditional industry boundaries erode, new types of multi-industry coalitions and networks are emerging. Think of the Microsoft-Intel (or 'Wintel') business ecosystem. The real test for 21st century businesses will be to outperform their rivals at creating the new business ecosystems needed to build and sustain competitive triple bottom line (q.v.) performance.

complementors:

Those actors in an economy or society who supply complementary products, services or inputs to businesses or business ecosystems (q.v.). Increasingly, these can include actors once thought hostile, including competitors and campaigning groups.

co-opetition:

A business approach which recognises that in the new economy companies may often end up working alongside - or even through - their competitors. Key players are seen to be customers, suppliers, competitors and complementors (q.v.).

demand side management (DSM):

DSM can be applied in any industry where a product can be replaced by a service. The central principle is that a company or utility learns to provide (and have customers pay for) services (e.g. heated rooms, lighted spaces) rather than kilowatt-hours or therms of gas. Often, the market needs to be provided with new price signals or other incentives.

eco-efficiency:

Involves the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity.

ecological footprints:

The size and impact of the 'footprints' of companies, communities or individuals reflect a number of interlinked factors, among them human population numbers, consumption patterns and the technologies used. A more challenging version of the concept is 'environmental space', as developed by Friends of the Earth Netherlands/Milieudefensie.

eco-taxes:

The use of economic, and in particular fiscal, instruments for environmental protection is gaining support. Examples include charges and taxes on polluting emissions and products, tradable emission permits and deposit-refund schemes. The aim: to achieve environmental or broader sustainability policy objectives more effectively and at lower cost.

environmental justice:

In the same way that certain social groups or communities may be economically disadvantaged, so they may suffer disproportionate health, safety or environmental problems. Linked issues can surface around various types of industrial facility, from oil fields and chemical production complexes to major airports.

environmental management system (EMS) standards:

The main international EMS standard is ISO 14001. There are also emerging regional EMS systems, notably the European Union's Eco-Management and Audit Scheme (EMAS).

factor 4/ factor 10:

Key terms in the thinking of Germany's Wuppertal Institute and the US Rocky Mountain Institute. To be sustainable during a period when human populations will likely double and average living standards increase significantly, industry needs to increase its resource conversion efficiency by a minimum Factor 4 (i.e. 75% reductions in resource consumption for any unit of production). Given that western societies typically consume 20-30 times more than their less developed counterparts, the Carnoules Declaration calls for Factor 10 improvements (i.e. 90% reductions).

full-cost accounting (FCA):

Although this is an area in need of much further work, the Holy Grail is to develop accounting methods which account for all the key costs of a project or activity, not just the financial costs.

industrial ecology:

Discipline which focuses on the design, development, operation, renewal and decommissioning of industrial facilities as ecological systems, with an emphasis on the optimisation of resource efficiency.

industry covenants :

Some countries, particularly The Netherlands, are encouraging particular industry sectors to agree voluntary targets - and encourage member companies towards those targets - as an alternative to new regulation. The threat of regulation, however, is always in the background.

joint implementation (JI):

Proposed as a least-cost approach to cutting greenhouse gas emissions. The idea is that Annex 1 countries under the Framework Convention on Climate Change, which have binding commitments to cut their emissions, can invest in emission-reducing projects in countries which do not have such commitments.

clean production:

Pioneered by Toyota, this is the Japanese approach to waste management and resource efficiency. Aims to avoid: the production of goods that no-one wants or which fail to meet expectations; the use of processing steps that are not needed; and the non-productive transport of people or materials.

life-cycle assessment (LCA):

The overall process of assessing the life-cycle impacts associated with a system, function, product or service. Sometimes considered to include four stages: Initiation, Inventory, Impact Analysis and Improvement.

MIPS:

Proposed by Professor Friedrich Schmidt-Bleek of Germany's Wuppertal Institute, the MIPS approach focuses on the 'Material Intensity Per unit Service'. The approach aims to measure the "total material and energy throughput in mass units (like kilograms or tonnes) per unit good or per mass unit of good, from cradle to grave". As the units of service clock up for a product like a car, so the MIPS 'invested' in each unit of service supplied fall. The greater the durability of the product, within limits, the fewer the MIPS needed per unit of service.

outrage:

Perceived risk is usually a complex, volatile mix of hazard and outrage. Experts argue that companies minimise the risk of outrage when they engage stakeholders (q.v.) in the development and operation of major projects.

precautionary approach:

Policy or other action taken before the underlying science has reached absolute clarity.

remanufacturing:

Pioneered by companies like Xerox, remanufacturing involves the recovery of equipment or products for servicing, upgrading and re-sale as working systems. Potentially offers much higher environmental returns than recycling.

reverse logistics:

The use of logistical and distribution systems to recover products or materials destined for remanufacturing or recycling.

social capital:

A measure of the ability of people to work together for common purposes in groups and organisations. A key element of social capital is the sense of trust.

solutions campaigning:

Instead of simply focusing on problems, even campaigning groups like Greenpeace are now linking up with selected companies to develop and promote problem-solving technologies or approaches.

stakeholders:

The broadest definition of 'stakeholder' brings in anyone who affects or is affected by a company's operations. The key new perception is that companies need to expand the range of interests considered in any new development from customers, shareholders, management and employees to such people as suppliers, local communities and pressure groups.

sustainability:

There are over 100 definitions of sustainability and sustainable development, but the best known is the World Commission on Environment and Development's. This suggests that development is sustainable where it "meets the needs of the present without compromising the ability of future generations to meet their own needs."

triple bottom line:

Sustainable development involves the simultaneous pursuit of economic prosperity, environmental quality and social equity. Companies aiming for sustainability need to perform not against a single, financial bottom line but against the triple bottom line.

value - impact assessment:

A technique developed by Procter & Gamble to optimise the value delivered to customers and consumers, and to reduce the environmental or other impacts associated with the production, shipment, use or disposal of products.

value migration:

Market change pulls economic value from one company (or industry) and pushes it towards another. In losing control of the personal computer market, for example, it has been estimated that IBM may have lost up to \$90 billion to new business ecosystems (q.v.) centred on companies like Microsoft. The sustainability transition will also drive value migration between companies, sectors and economies.

values shift:

Over time, human and social values change. Concepts that once seemed extraordinary (e.g. emancipating slaves, enfranchising women) are now taken for granted. New concepts (e.g. responsible consumerism, environmental justice, intra- and inter-generational equity) are now coming up the curve.

This list covers some the terms used regularly by companies when discussing sustainability. A more detailed and complete list can be found for instance at: U.S. Environmental Protection Agency, Terms of Environment; <http://www.epa.gov/docs/OCEPAterms>

2.5.2 Definitions from ISO 14020, ISO 14031 ISO 14040 series

In accordance with ISO 10241, in some situations in this International Standard, the special usage of a concept in a particular context is indicated by the qualification given in angle brackets before the definition.

allocation: Partitioning the input or output flows of a unit process to the product system under study.

ancillary material: a material input that is used by the unit process producing the main product, but which is not used directly in the formation of this product.

audit conclusion

professional judgement or opinion expressed by an auditor about the **subject matter** of the audit, based on and limited to reasoning the auditor has applied to **audit findings**

audit criteria

policies, practices, procedures or requirements against which the auditor compares collected **audit evidence** about the **subject matter**

NOTE. Requirements may include, but are not limited to, standards, guidelines, specified organisational requirements and legislative or regulatory requirements.

audit evidence

verifiable information, records or statements of fact
NOTE 1 Audit evidence, which can be qualitative or quantitative, is used by the auditor to determine whether **audit criteria** are met.

NOTE 2 Audit evidence is typically based on interviews, examination of documents, observation of activities and conditions, existing results of measurements and tests or other means within the scope of the audit.

audit finding

result of the evaluation of the collected **audit evidence** compared against the agreed **audit criteria**
NOTE The findings provide the basis for the audit report.

audit team

group of auditors, or a single auditor, designated to perform a given audit

NOTE 1 The audit team may also include technical experts and auditors-in-training.

NOTE 2 One of the auditors on the audit team performs the function of lead auditor.

auditee

organisation to be audited

client

organisation commissioning **the audit**

NOTE. The client may be the **auditee**, or any other organisation which has the regulatory or contractual right to commission an audit.

certification: procedure by which a third party gives written assurance that a product, process or service conforms to specified requirements.

closed-loop recycling: a recycling in which the reclaimed output is used as an input to the same system, in order to replace a virgin input which would have otherwise been used, either directly or via a material pool containing material from several product systems.

comparative assertion: environmental claim made publicly available regarding the superiority or equivalence of one product versus a competing product which performs the same function.

data category: input to or output from a unit process or the system to be studied.

data quality: quantitative and qualitative characteristics of the individual data and the methods by which they were collected and integrated into the LCA model.

data quality indicators: measures which characterise attributes of data or data sets.

elementary flow: any flow of raw material entering the system being studied and which has been drawn from the environment without previous human transformation; any flow of material leaving the system being studied, and which is discarded into the environment without subsequent human transformation.

energy flow: input to or output from a system or unit process measured in energy units. Note: energy flows as inputs may be called energy input; energy flows as outputs may be called energy output.

environment: the surroundings, in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their interrelation.

environmental aspect: element of an organisation's activities, products or services which are likely to interact with the environment.

environmental impact: any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.

environmental label/declaration: claim which indicates the environmental aspects of a product or service. Note: An environmental label or declaration may take the form of a statement, symbol or graphic on a product or package label,

product literature, technical bulletin, advertising, publicity, among others.

environmental declaration TYPE III: quantified environmental data for a product with pre-set categories of parameter based on ISO 14040-series of standards but not excluding additional environmental information provided within a TYPE III environmental declaration programme.

environmental labelling TYPE I programme: voluntary, multiple criteria-based, practitioner programmes that award labels claiming overall environmental preference of a product within a particular product category based on life cycle considerations.

environmental performance: results of an organisation's management of its environmental aspects

environmental performance evaluation (EPE): process to facilitate management decisions regarding an organisation's environmental performance by selecting indicators, collecting and analysing data, assessing information against environmental performance criteria, reporting and communicating, and periodic review and improvement of this process.

environmental performance indicator (EPI): specific expression that provides information about an organisation's environmental performance.

feedstock energy: the gross combustion energy of a raw material input which can act as a fuel but is used as a material rather than a fuel. Examples are oil and gas used in the petrochemical industry and wood in paper production.

final product: one which requires no additional transformation prior to its use within the system being studied.

fugitive releases: unintended or uncontrolled emissions to air, water or land (e.g. material or product released from a pipeline coupling).

function: the performance characteristic of a product system.

functional unit: quantified performance of a product system for use as a reference unit in a life cycle assessment study.

interested party: individual or group concerned with or affected by the environmental performance of a product, or by the results of the life cycle assessment.

intermediate material: input or output from a unit process which undergoes further transformation to become a final product and stays within the product system under study.

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

life cycle assessment (LCA): compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.

life cycle characterisation: element of the life cycle impact assessment phase in which the potential impacts associated with the inventory data in each of the selected categories are analysed.

life cycle classification: element of the life cycle impact assessment phase in which the inventory parameters are grouped together and sorted into a number of impact categories.

life cycle evaluation: element of the life cycle impact assessment phase in which the relative significance of the data from the inventory analysis or results of the characterisation are established.

life cycle impact assessment: phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of environmental impacts based on the life cycle inventory analysis.

life cycle interpretation: phase of life cycle assessment in which a synthesis is drawn from the findings of either the inventory analysis or the impact assessment, or both, in line with the defined goal and scope.

life cycle inventory analysis: phase of life cycle assessment involving the compilation and quantification of inputs and outputs, for a given product system throughout its life cycle.

normalisation: techniques used to express all inputs and outputs of a unit process to a defined measurement of the intermediate or final product of a unit process and its functional unit. Note: This (mathematical/ physical) term is also used in the context of Impact Assessment for a different topic.

open-loop recycling: recycling in which the reclaimed output is used as an input to another product system.

practitioner: individual or group of people that conducts a life cycle assessment study.

process energy: energy input required for a unit process in order to operate the process or

equipment within the process excluding production and delivery energy.

process flow diagram: a technique using labelled boxes connected by lines with directional arrows to illustrate the unit processes or sub-systems included in the system and the interrelationships between those unit processes. The labels may include names and quantities of different flows (e.g. materials).

product system: collection of materially and energetically connected unit processes which performs one or more defined functions. Note: In this international standard, the term "product" used alone is synonymous to "product or service".

production and delivery energy: the energy used for the processes which extract, process, refine and deliver the process energy needed in the main process sequence.

purchaser: anyone in a product or service supply chain who buys the product or service from a seller.

raw material: primary or secondary recovered or recycled material that is used in a system to produce a product.

raw material acquisition: activities associated with delivery of raw materials needed in the main process sequence. These activities include exploration, extraction, and in the case of agriculture or forest products, cultivation and harvesting.

self-declaration environmental claim Type II: any environmental declaration that describes or implies by whatever means the effects that the raw material extraction, production, distribution, use or disposal of a product or service has on the environment. This applies to effects that are local, regional or global and to the environment that an individual lives in, affects or is affected by.

sensitivity analysis: a systematic procedure for estimating the effects on the outcome of an LCI study according to the behaviour of the system, to changes of parameters, allocation rules and calculation procedure.

specification: a technique for the determination of categories for similar inputs and outputs as specific compounds (e.g. CH₄) or as families of similar compounds (e.g. organics).

system: a collection of unit processes which, when acting together, perform some defined function.

system boundary: the interface between the product being studied and its environment or other systems.

third party: person or body that is recognised as being independent of the parties involved, as concerns the issue in question

transparency: open, comprehensive and understandable presentation of information.

unit process: smallest portion of a product system for which data are collected when performing a life cycle assessment.

waste: any output material from the product system which is of no further use and therefore is disposed of or released to the environment.

2.6 LITERATURE, SOURCES

2.6.1 Literature

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2.6.2 Addresses

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CML	Centre of Environmental Science, Leiden University: http://www.leidenuniv.nl/interfac/cml P.O. Box 9518, NL-2300 RA Leiden, The Netherlands, Phone: +31-71-5275653, Fax: +31-71-5275587
EEA	European Environment Agency: http://tiger.eea.eu.int/projects/EnvMaST/lca/default.htm : Information on LCA
IVAM	Environmental Research, University of Amsterdam: http://www.ivambv.uva.nl Plantage Muidergracht 14, 1018 TV Amsterdam, P.O. Box 18180, 1001 ZB Amsterdam, The Netherlands, Phone: +31-20-5255080, Fax: +31-20-5255820

ICONTEC	Instituto Colombiano de Normas Técnicas y Certificación Carrera 37 52-95 Apartado 14237 Santafé de Bogotá, D.C. cliente@icontec.org.co Colombia
ISO	International Standardisation Organisation: 1, rue de Varembé, C.P. 56, CH-1211 Genève 20, Switzerland. Phone +41 22 749 01 11, Fax +41 22 733 34 30, E-mail: central@iso.ch , http://www.iso.ch ISO 14000 Info Center: http://www.iso14000.com/
ISO/TC 207	ISO Technical Committee 207, Environmental Management responsible for developing and maintaining the ISO 14000 series of standards and guidance documents. http://www.tc207.org/home/index.html
OECD	Organisation for Economic Co-operation and Development: 2, rue André-Pascal, F-75775 Paris CEDEX 16, France Tel: (33) 01.45.24.82.00, Fax: (33) 01.45.24.85.00, E-mail webmaster@oecd.org , http://www.oecd.org
SETAC-Europe	Society of Environmental Toxicology and Chemistry Europe: http://www.setac.org/eurplca.html Avenue E. Mounier 83, Box3, 12000 Brussels, Belgium, Phone: +32-2-7727281, Fax: +32-2-7705386, e-mail: setac@ping.be
UNEP	United Nations Environment Programme Industry and Environment: http://www.unepie.org 39-43, Quai André Citroën, 75739 Paris CEDEX 15, France, Phone: +33-1-44371450, Fax: +33-1-44371474

2.6.3 Annex from ISO 14050: Additional concepts encountered in the international environmental community

The public's present concern related to protection of the environment from adverse impacts resulting from an organisation's activities, processes, products and services gives rise to the need for a common understanding of generic environmental concepts.

The following widely used concepts and terms are listed to aid to a common understanding. Reference is given below to documents where descriptions or definitions can be found.

2.6.3.1 Best Available Technique (BAT)

- EU Directive 96/61/EEC (September 24, 1996) concerning Integrated Pollution Prevention and Control, Article 2(11).
- OECD Council Recommendation, May 1972, Environment and Economics, Guiding Principles concerning international economic aspects of environmental policies.
- Convention on the Protection of the Marine Environment of the North East Atlantic. Paris, 22 September 1992, Article 2, clause 3 (b) and amendment No 1 .

2.6.3.2 Critical load

- Dowing, R.J.; Hettelingh, J.-P. and de Smet, P.A.M., 1993. Calculation and Mapping Critical Loads in Europe. Status Report 1993.

2.6.3.3 Precautionary principle

- ISO 14004:1996, Environmental management systems - General guidelines on principles, systems and supporting techniques, Annex A, principle 15.
- The Rio Declaration on Environment and Development, principle 15.
- Convention on the Protection of the Marine Environment of the North East Atlantic. Paris, 22 September 1992. Article 2, clause 2 (a).
- The Ministerial Conference in Bergen, 16 May 1990. Agenda 21, Chapter 19.

2.6.3.4 "Polluter pays" principle

- ISO 14004:1996, Environmental management systems - General guidelines on principles, systems and supporting techniques, Annex A, principle 16.
- The Rio Declaration on Environment and Development, principle 16.
- Convention on the Protection of the Marine Environment of the North East Atlantic. Paris, 22 September 1992. Article 2, clause 2 (b).
- The Polluter Pays Principle, OECD 1975.

2.6.3.5 Pollution

- EU Directive 96/61/EEC (September 24, 1996) concerning Integrated Pollution Prevention and Control, Article 2(11).
- IMO/UNESCO/INMO/IAEA/UN/UNEP Joint Group of experts on the Scientific Aspects of Marine Pollution (GESAMP).
- Convention on the Protection of the Marine Environment in the North East Atlantic. Paris, 22 September 1992. Article 1, clause (d).
- Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention), Article 2, clause

2.6.3.6 Sustainable development

- "Our Common Future": Report published by the World Commission on Environment and the Development (the Brundtland Report).
- The President's Council on Sustainable Development, February 1996.
- Towards Sustainability: A European Programme of Policy and Action in relation to the Environment and Sustainable Development. EU Vol. 11. 27 March 1992.

3 CLEANER PRODUCTION

3.1 INTRODUCTION

3.1.1 Aims

This part explains the concept of Cleaner Production (CP), describes many of the activities that constitute such production and outlines the advantages of and barriers to implementing Cleaner Production programmes in developing countries. (Source: UNIDO)

The specific learning objectives are as follows:

- To understand the **concept of Cleaner Production** as essential for achieving Ecologically Sustainable Industrial Development (ESID);
- To review the many **activities** that can achieve Cleaner Production;
- To learn what many enterprises already have **achieved by implementing** Cleaner Production;
- To be **aware of the barriers** to introducing Cleaner Production to industry.

3.1.2 Key Points

1. Industry first tried to deal with pollution by using the natural environment to dilute the impact of pollutants. Subsequently, it became clear that some action had to be taken to minimise the impact of pollutants on the environment. This led to the use of **pollution control (end-of-pipe)** technology. These methods are expensive and, often, they are not fully effective;
2. **Cleaner Production** avoids industrial pollution **by reducing waste generation** at every stage of the production process in order to minimise or eliminate waste before any potential pollutants are created;
3. The terms “pollution prevention”, “source reduction” and “waste management/minimisation” are often used to mean the same thing as Cleaner Production;
4. Cleaner Production can be **achieved in a number of ways**, such as good housekeeping and operating procedures, materials substitution, technology changes, on-site recycling and product redesign or any combination of these actions;
5. Cleaner Production is **more cost-effective** than pollution control. By minimising or preventing waste generation, the costs of waste treatment and disposal are reduced. Furthermore, the systematic avoidance of waste and pollutants reduces process losses and increases process efficiency and product quality;
6. The environmental advantage of Cleaner Production is that **it solves the waste problem at its source**. Conventional end-of-pipe treatment often only moves the pollutants from one environmental medium to another, e.g. the scrubbing of air emissions generates liquid waste streams;
7. Cleaner Production is often not accepted because of human factors rather than technical problems. The traditional end-of-pipe approach is well known and accepted by industry and engineers. Existing government policies and regulations often favour end-of-pipe solutions, which are administratively easier to impose. There is **a lack of communication** between those in charge of production processes and those who manage the wastes that are

generated. There is often a lack of easily accessible information. Managers and workers who know that the factory is inefficient and wasteful are not rewarded for suggesting improvements;

8. Although Cleaner Production techniques are preferable, some end-of-pipe treatment still may be necessary when it is impossible, at least for now, to eliminate completely the production of wastes;
9. Because Cleaner Production attacks the problem at several organisational levels at once, the introduction of an industry/plant-level Cleaner Production programme **requires the commitment of top management and a systematic approach** to waste reduction in all aspects of the production process;
10. Future industrial development based on Cleaner Production would bring industrial activity closer to meeting the Environmental Sustainable Industrial Development (ESID) criteria because it would both reduce pollutant discharges and increase the efficiency of raw material and energy utilisation

3.2 DESCRIPTION

3.2.1 Historical Background

The approach to pollution control has evolved through three stages over the last 50 years:

1. **Dilution**

2. **Treatment**

3. **Avoidance -> Cleaner Production (3R: Reduce, reuse, recycle)**

Many countries are still at the dilution and/or treatment stage.

The **dilution approach** involves the discharge of pollutants directly into the environment. It relies on the assimilative capacity of the water, air and soil to dilute or neutralise the impacts. This approach can work if the amount of waste is small compared to the volume of the receiving environment.

The **treatment stage**, traditionally called **end-of-pipe** treatment, has been used at the end of the production process to collect pollutants and then to separate or neutralise them in various ways, usually in specially built treatment installations. Treatment often merely separates the pollutants from the waste stream, but they still have to be disposed of somewhere.

Dilution and treatment, and even recycling, are not long run solutions. Natural systems have a limited assimilative capacity to dilute wastes. In areas where there is a heavy concentration of industry, this capacity is easily exceeded. Wastes can impair human health, reduce the productivity of fisheries and agriculture and damage man-made materials. The level of treatment is often limited because only so much of production costs can be allocated for pollution control, which is a non-productive investment. Recycling often suffers from poor or unpredictable markets for its products. Both treatment and recycling generate further residues themselves, some of which may be worse than the original waste product.

The **costs of the end-of-pipe** treatment (Figure 3.1 above) approach are creating a barrier to further industrial development. The United States spent US\$ 100 billion and the countries of the

European Community spent more than US\$ 30 billion on pollution control in 1992. There is little direct financial return to the industries that incur this expenditure.

The composition of the pollution is becoming more complex. Thousands of new chemicals are introduced into the market each year to add to those already there. Some of them find their way into emissions and wastes. Also, the potential toxicity of these chemicals means that safety regulations are required to protect workers and users. The costs of complying with these regulations must be borne by chemicals producers and users.

Strengthened environmental regulations are putting pressure on industry to increase its environmental performance. It is often difficult, however, to modify existing plants at a reasonable cost.

Cleaner Production (Figure 3.2 below), the preventive way, is a better approach to avoiding and minimising environmental problems. Avoiding pollution by preventive methods often solves the problem rather than treating the symptoms. As a consequence of Cleaner Production, there are often cost savings and better quality products.

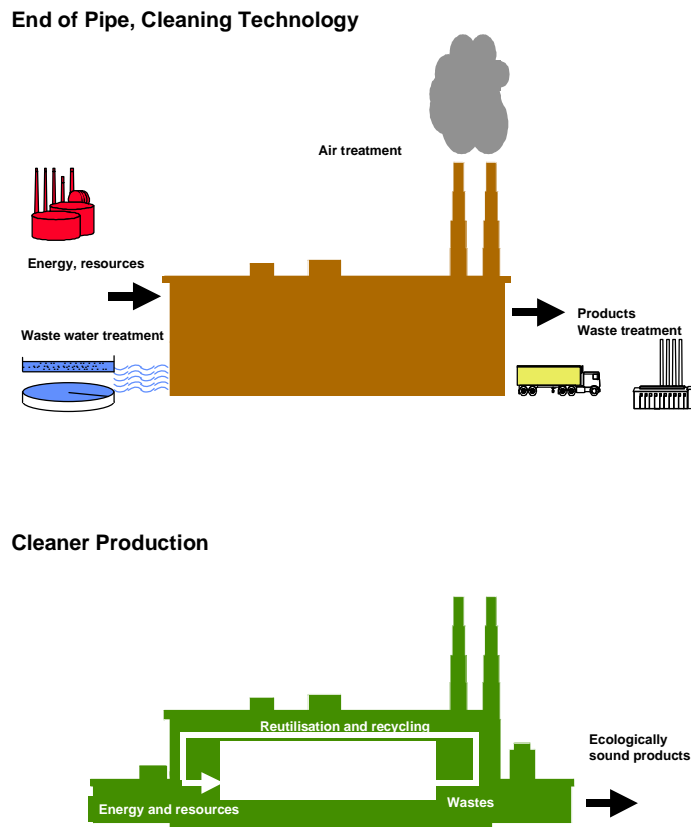


Figure 3.1 End of pipe and Cleaner production

3.2.2 Definition

Cleaner Production is defined by UNEP (United Nations Environment Programme) as “the continuous application of an integrated preventive environmental strategy to processes and products to reduce risks to humans and the environment.”²

- For production **processes**, Cleaner Production includes conserving raw materials and energy, eliminating toxic processing materials and reducing the quantity and toxicity of all emissions and wastes before they leave a production process.
- For **products**, the approach focuses on the reduction of environmental impacts along the entire life cycle of a product, from raw material extraction to the ultimate disposal of the product, by appropriate product design.
- For **services**: ...incorporating environmental concerns into designing and delivering services.

3.2.3 Benefits

Cleaner Production is good for the environment because it reduces pollution from industry. There are also some **direct benefits** to the companies that follow this approach, such as:

1. Cost-saving through reduced use of raw materials and energy
2. Improved operating efficiency of the plant
3. Better product quality and consistency because the plant operation is controlled and therefore more predictable
4. Recovery of some wasted materials
5. Waste reduction -> tax reduction
6. Smaller insurance taxes
7. Higher credibility for credit facilities from banks

Because it often leads to cost savings and improved operating efficiencies, Cleaner Production enables business and other organisations to pursue their economic goals while improving the environment at the same time.

Cleaner Production requires:

1. Applying know-how
2. Improving technology Changing attitudes

Cleaner Production does not always require new technologies and equipment. Some examples of practical Cleaner Production techniques are listed in the subfolders.

In the PRISMA project, the Government of the Netherlands selected 10 of the most efficient industries. An initial assessment of Cleaner Production possibilities yielded 164 options, distributed as follows: improved house keeping (28%), material substitution (22%), technology changes (39%), on-site recycling (10%) and product redesign (1%).

² http://www.unepie.org/cp/cp_ginf.html

The Cleaner Production approach to industrial environmental management requires a hierarchical approach to pollutant management practices. Figure 3.2 shows the **order of preference** in decision-making on design and operation of waste handling.

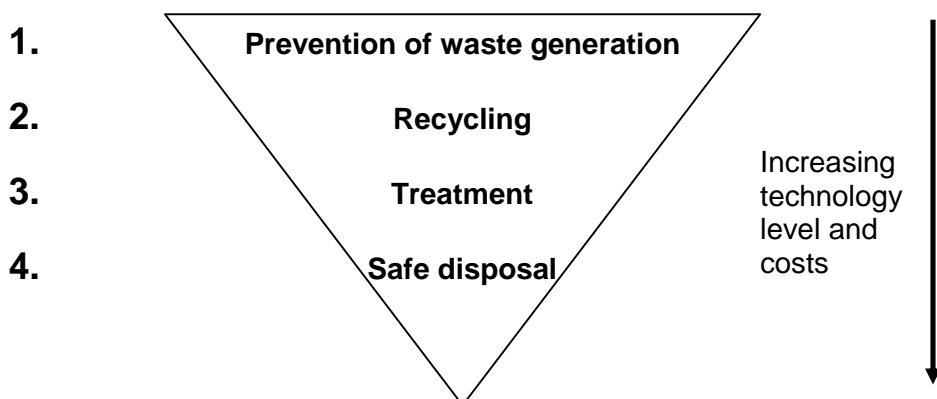


Figure 3.2: Order of preference in CP waste management

Only when prevention techniques have been fully adopted should recycling options be used. Only when wastes are recycled as far as possible should treatment of the residues be considered. To use off-site recycling or end-of-pipe technologies before prevention has been maximised is not Cleaner Production.

The implementation of Cleaner Production involves changes in human thinking and attitudes about production and the environment.

Good housekeeping and operating procedures

- Tighten valves and check pipes to reduce leaks. Turn off water when not needed.
- Minimise dragout when objects are removed from processing baths.
- Optimise operating parameters of the plant.
- Reduce storage and transfer losses by revising procedures.
- Improve materials handling to reduce the incidence of spillage.

Material substitution

- Replace solvents with water.
- Replace acid pickling of steel with peroxide treatment.
- Replace chlorine bleaching with oxygen bleaching.

Technology changes

- Batch instead of continuous processing
- Mechanical instead of solvent cleaning
- Powder painting instead of wet painting
- Automatic instead of manual chemical feed
- Dry heating instead of heat treatment baths for metal finishing

On-site recycling

- Internal recycling of rinse waters
- More efficient washing or cleaning using counter current principles
- Steam condensate recovery and recycling

Product redesign

- Remove toxic substances from product components
- Concentrate product to reduce packaging
- Increase durability and improve reparability
- Use materials that can be recycled

Source: UNEP / UNIDO

3.3 IMPLEMENTATION

3.3.1 Audit methodology according to DESIRE (1995)

The DESIRE audit methodology divides the waste minimisation audit into six stages. The objective of each of these is as follows:

1. *Getting started*: Planning and organisation of the waste minimisation audit, including the establishment of a project team and the selection of the audit focus.
2. *Analysing process steps*: Evaluation of the unit operations relevant to the selected audit focus in order to quantify waste generation, its costs and its causes.
3. *Generating waste minimisation opportunities*: Development and preliminary selection of waste minimisation opportunities.
4. *Selecting waste minimisation solutions*: Evaluation of the technical and financial feasibility and environmental desirability of waste minimisation opportunities in order to select feasible waste minimisation solutions.
5. *Implementing waste minimisation solutions*: Actual implementation of the feasible waste minimisation solutions and monitoring of the results achieved by their implementation.
6. *Sustaining waste minimisation*: Perpetuating continuous search for waste minimisation opportunities.

A flowchart of this manual with a specification and a short explanation of the tasks to be executed in each phase are included in figure 3.3.

Phase 1. Getting started

In order to prepare for the waste minimisation audit, the following tasks need to be executed:

1. *Designate waste minimisation team*: The team should be made up of representatives from the groups in the company that will have a major interest in waste minimisation. Size and composition of the team should fit to the company's organisational structure. The team should

be capable of identifying potential areas, developing solutions and implementing them. To this end, input from both in-house and external experts might be needed.

2. *List process steps (unit operations)*: All process steps should be specified, including utilities, storage and waste treatment and disposal facilities, in order to get a proper overview of all manufacturing processes. The team should specifically highlight major and obvious waste generating areas and, if possible, identify the reasons for waste generation. In addition, housekeeping and process control practices should be broadly assessed. Special attention should be paid to periodic activities e.g. washing and regeneration (of catalysts, absorbents etc.) as these are often highly wasteful but still overlooked.

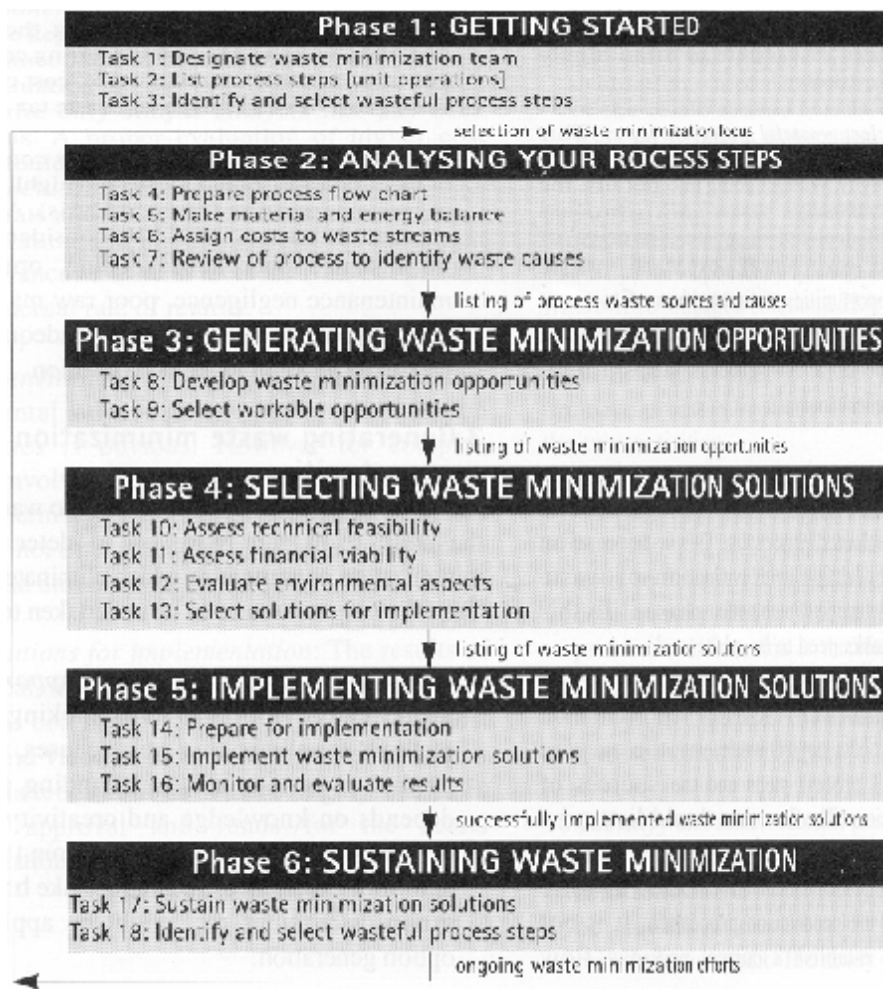


Figure 3.3: Flow sheet for the DESIRE auditing procedure (NPC 1994)

3. *Identify and select wasteful process steps*: This activity might be considered a preliminary prioritisation activity. Without going into details, the team should broadly assess all process steps in terms of quantum of waste, severity of impact on the environment, expected waste minimisation opportunities, estimated benefits (cost savings) etc. Such preliminary assessment helps in focusing on one or a few process steps (audit focuses) for detailed analysis.

Phase 2. Analysing process steps

This step covers the detailed data collection and evaluation for the selected processes. This information will enable the generation and evaluation of waste minimisation opportunities in the next phases. To this end the following tasks need to be addressed:

4. *Prepare process flow chart:* A schematic representation of the selected process steps is made, with the purpose of identifying all process steps and the sources of wastes and emissions. The flow chart should list and to some extent - characterise the input and output streams per process step. Given the historic development of the production processes, it is not always easy to establish a correct process flow diagram. This is however crucial for the smooth development of the waste minimisation audit.
5. *Make material and energy balance:* These balances are needed to quantify the process flow diagram and the occurring losses (wastes). Later on, balances can be used to monitor progress of the implementation of waste minimisation. Normally, only a preliminary balance can be derived, given the lack of records and the lack of data on composition of input and output material streams and complex recycle streams. It may be worthwhile to draw component balances for important resources, e.g. water and fibre balance in paper industry or print paste balance in the textile finishing industry.
6. *Assign costs to waste streams:* In order to assess the profit potential of waste streams, the monetary loss incurred by a waste stream should be evaluated. A preliminary estimate can be made with a calculation of the cost of raw material and intermediate product lost with the waste stream (like fibre loss in the pulp and paper industry). A more detailed analysis might reveal additional costs, including the cost of raw materials in waste, the manufacturing cost of material in waste, cost of product in waste, cost of treatment of waste, cost of waste disposal, waste tax etc.
7. *Review of process to identify waste causes:* A review of the processes should locate and highlight the causes of waste generation (cause analysis). A wide variety of possible causes should be considered, including for instance poor housekeeping, operational and maintenance negligence, poor raw material quality, poor layout, bad technology, inadequately trained personnel and employee demotivation.

Phase 3. Generating waste minimisation opportunities

Having identified and assigned causes to waste generation, the audit team can move on to determining waste minimisation opportunities which eliminate these causes. The following tasks need to be undertaken to this end:

8. *Developing waste minimisation opportunities:* The team, ready with data, starts looking for possible methods for eliminating waste causes, which in turn minimise waste generation. Finding such options, depends on knowledge and creativity of the team members, much of which comes from their education and work experience. Techniques like brainstorming, group discussions etc. might be applied to boost option generation.
9. *Select workable opportunities:* The waste minimisation opportunities are now screened in order to weed out those which are impractical. This weeding-out process should be simple, fast and straightforward and may often be only qualitative. The remaining opportunities are then subjected to more detailed feasibility studies.

Phase 4. Selecting waste minimisation solutions

The feasibility of the workable waste minimisation opportunities is to be evaluated in order to select the most practical set of waste minimisation solutions. The following need to be undertaken to this end:

10. *Assess technical feasibility:* The technical evaluation determines whether a proposed waste minimisation opportunity will work for the specific application. To this end, impact of the proposed waste minimisation on process, product, production rate etc. has to be evaluated. In addition, an inventory has to be made of the necessary technical changes for the implementation of the waste minimisation opportunity.
11. *Assess financial viability:* Financial viability will often be the key parameter in the evaluation of waste minimisation opportunities. Priority should be given to the evaluation of the low-cost options, which often require only simple analysis like pay back calculations. A proper evaluation of higher cost options should include the full array of potential savings (including, but not limited to, savings on raw materials and energy, increased production and lower operation and maintenance cost) and might require advanced financial methods (like net present value or internal rate of return).
12. *Evaluate environmental aspects:* In most cases the environmental advantage of waste minimisation opportunities is obvious. However for complex options, involving changes of raw materials or process chemistry, care should be taken to assess whether or not a net reduction of toxicity and quantity of waste and emissions occurs.
13. *Select solutions for implementation:* The results of the technical, financial and environmental evaluation have to be combined in order to select the most practical and viable solutions. Proper documentation of the selected solutions will be highly useful in obtaining approval and funds for the actual implementation of these solutions.

Phase 5. Implementing waste minimisation solutions

The selected waste minimisation solutions now have to be implemented. A significant number of solutions might be implemented as soon as they are identified (i.e. repairing of leaks and enforcement of working instructions), while others would require a systematic plan of implementation. To this end, the following tasks should be undertaken:

14. *Prepare for implementation:* This includes arranging finances, establishing task forces, detailed technical preparation and planning of the implementation. Good liaison, awareness and information dissemination should assist in obtaining the involvement of key departments and persons.
15. *Implement waste minimisation solutions:* Implementing waste minimisation solutions is similar to any other industrial modification. In order to optimise the implementation results, the simultaneous training of manpower should not be missed out.
16. *Monitor and evaluate results:* A performance evaluation is needed to assess causes for deviation of the results obtained from the results expected as well as to inform management and to sustain its commitment for waste minimisation.

Phase 6. Sustaining waste minimisation

It might seem in the first place that waste minimisation is completed upon the implementation of the feasible waste minimisation solutions. However, the team still faces the major challenge of sustaining waste minimisation in order to further reduce wastes and improve profits in the future. This basically consists of the two activities:

17. *Sustain waste minimisation solutions*: Especially for housekeeping and process optimisation, employees tend to return to the wasteful, old practices if not continuously motivated to sustain the improved practices. Information is therefore crucial in order to monitor ongoing achievements. Reward and recognition schemes could safeguard the ongoing involvement of the employees.
18. *Identify and select wasteful process steps*: Having improved the environmental performance of selected wasteful processes, a new selection should be made as the focus for the next waste minimisation audit. The newly selected processes should then be subjected to the audit procedure (start at step 2: "Analysing production process steps").

3.3.2 Technical manuals

The generic guidelines for waste minimisation focus on industrial entrepreneurs in order to convince them of the opportunities and benefits of waste minimisation. The guidelines contain only a brief and general introduction to the techniques of waste minimisation auditing. It is envisioned that these entrepreneurs will then pass on the job of implementation of waste minimisation to their technical staff. In order to serve this technical staff in the execution of the waste minimisation audit, a series of sector-specific technical manuals has been developed.

Objective and outline

The sector-specific waste minimisation manuals address primarily technical experts in the respective industry sector. Reading through the manual, they should be able to find enough information on suggested waste minimisation opportunities and auditing tools to conduct a waste minimisation audit in their industry. To this end, example waste minimisation opportunities are broadly evaluated and the audit methodology has been tailored to the industry sector. In addition, examples of company-level waste minimisation audits are included.

To achieve the above general objective, the following logical sequence of aims has been elaborated in each of the technical manuals

1. Establish the *potential* for waste minimisation;
2. Suggest waste minimisation as the *solution*;
3. Provide a set of *practical approaches*;
4. Provide a *framework for the implementation* of waste minimisation;
5. Identify *additional assistance*.

This has been elaborated into a technical manual of about 100 pages for the agro-residue-based pulp and paper industry, textile dyeing and printing industry and pesticides formulation industry. Each manual contains numerous examples and technical details. Table *** has been compiled to summarise the coverage of each of the technical manuals.

3.4 CASE STUDIES, EXAMPLES

Source: UNIDO

More information about case studies can be found in:

National Cleaner Production Centers: Case Studies (UNIDO) (cf. Sources)

3.4.1 Reduction of Chromium Pollution and Waste in Leather Tanning

The conversion of hides to leather has been carried out from the earliest times and still follows the same basic procedure. Many agents (vegetable, organic and metallic) can be used in the tanning stage, each conferring different characteristics to the leather.

The use of trivalent chromium as a tanning agent is comparatively recent, only becoming established on a large commercial scale by about 1910. Now it is the most widely used process. Chromium imparts desirable qualities of wear, softness, feel and texture to the leather. The level of chromium normally used for high quality leather is 4-5 per cent by weight. To achieve this, even by the most efficient processing, some 30 per cent of the chrome offered to the hide is left in the tanning liquor and wasted.

The British Leather Company, which processes about 6,000 hides a week employs a cleaner technology that entails two stages. The first stage uses a liquor based on titanium, aluminium and magnesium, with no chromium. This is the TAL process of ICI. In the second stage, a chromium tan is used with 9 per cent chromium instead of the normal 17 per cent. This results in a leather with a chromium content of about 3 per cent but with characteristics comparable to traditional leather.

Residual chrome in the spent liquor is reduced because less chrome is used initially and the percentage uptake is greater. The overall effect is to reduce the chromium content of the spent liquor from 1,200 to 350 ppm and the level in the final effluent to 10 ppm.

Advances in leather technology combined with extensive tanning trials have made this process commercially viable. Considerable research was carried out to identify the optimum tanning properties of the various combinations of metals used in the first stage of the process.

The solution adopted has two advantages:

1. The chromium level in the discharge is substantially reduced, removing a potential constraint on production
2. The technology requires no additional capital equipment and can be used in an existing plant

There are also modest savings in tanning reagent costs. The main incentive to move to cleaner technology is the anticipation of higher future standards. The company can expect to save at least US\$ 300,000 that would be required for an abatement plant to achieve the same chromium reduction as that obtained by cleaner technology.

3.4.2 Cement Kiln Pollution and Waste Reduction by Improved Process Control

The manufacture of cement in its present form was patented in 1824. Known as Portland cement, it requires the burning of fuel together with limestone and clay, yielding a clinker which is then ground with gypsum to give cement. Burning is carried out in a rotating, inclined kiln. The process is complex, in terms of the reaction chemistry, the thermal conditions in the kiln and the dynamics of the process. The temperature largely determines the quality of the product cement. However, both the NO_x and SO_x levels increase with higher temperatures.

The process must, therefore, be operated within a certain band of temperature, with the optimum at the lower end. If the process is operated too far below this optimum, an unusable product is generated. If the temperature is too high, energy is wasted, cement quality reduced and air pollution increased. There are many possible disturbances to the process, for example, changes in the calorific value of the coal and the composition of the feed, which make it difficult to operate manually.

The LINKman expert system, developed by Image Automation, continuously monitors all the appropriate process variables such as the flue gas temperature, oxygen, NO_x level and the power used to turn the kiln. It then makes adjustments to the coal, air and feed rates on the basis of a model of the plant's behaviour derived from operational experience. The system can also make smaller adjustments more frequently. This allows the plant to be run much closer to its optimum conditions than is possible under manual control. One significant novel feature of the instrumentation is the measurement of the NO_x level in the flue gas, which gives valuable information on the temperature in the firing zone and can be used to help minimise NO_x air pollution.

The system has been made possible by improvements in the science of expert system control and in measurement technology, which have led to a reliable and sensitive NO_x analyser.

The system was installed on two of its kilns by Blue Circle Industries in the United Kingdom. It generated cost savings of US\$ 1,860,000 in 1987. The payback period for the capital investment of US\$ 406,000 was three months.

The advantages are as follows:

1. Coal wastage avoided;
2. Better quality product;
3. Less energy for clinker grinding;
4. Kiln lining has longer life;
5. NO_x and SO_x emissions are reduced from 500 ppm to 200 ppm

3.4.3 Upgrading of Tin Concentrate

Tin has been mined from the earliest times. There has been a steady improvement in the percentage of tin in the concentrate that is sent to the smelters. The tin content of the concentrate has a strong bearing on its value. Other materials such as copper, tungsten and zinc are also recovered from the ore.

The traditional process involves a number of steps culminating in flotation. The slurry containing the tin ore flows cross-current to the rising bubbles, which float as a foam carrying the tin rich particles. The separation and upgrading of the ore have now been improved by introducing column flotation. The rising bubbles and falling ore flow counter current, giving the effect of multiple stages of normal flotation. A water wash gives improved separation at the top of the column.

Carnon Consolidated, in the United Kingdom, reported that based on annually upgrading concentrate with a tin content of 800 tonnes, the capital investment of US\$ 32,000 had a payback period of only 18 days, because the price for the tin concentrate increased by US\$ 640,000.

The advantages can be summarised as follows:

1. Higher market value for the concentrate;
2. Less waste from smelting;
3. Less energy used for smelting;
4. Low capital investment

3.4.4 Trivalent Chromium Plating

High quality chromium plating, used for decorative finishes and to impart resistance to wear and corrosion, has traditionally required a high concentration of toxic hexavalent chromium ions, which give a highly toxic effluent. One company in the United Kingdom, W. Canning Materials, has introduced an electrolyte with a much lower concentration of the less toxic trivalent chromium ion. Two technical problems had to be overcome:

1. The tendency of the trivalent chromium to oxidise to hexavalent at the anode. This was overcome by using a membrane that had originally been developed for the mercury free electrolysis of brine;
2. The low rate of deposition at the cathode due to the kinetics of the reaction. This was overcome by in house development of organic additives that modify the reaction and give a performance superior to the traditional process

For a new plant, economic benefits arise from the use of smaller baths to achieve the same production rate and from reduced expenditure on effluent clean-up. Where there is a premium on quality or where hexavalent chromium is not permitted, savings are even greater. The new technology leads to five advantages:

1. A safer working environment
2. Reduced discharges of toxic hexavalent chromium, typically from 80 ppm to less than 3 ppm of less toxic trivalent chromium;
3. Quality is improved because the plating is more uniform. This also saves chromium and allows more articles to be plated in the same bath;
4. Only half as much electricity is required to deposit the same quantity of chromium;
5. Reduced effluent treatment costs

3.5 FURTHER DOCUMENTS

3.5.1 International Declaration on Cleaner Production

UNEP INTERNATIONAL DECLARATION ON CLEANER PRODUCTION

We recognize that achieving sustainable development is a collective responsibility. Action to protect the Global environment must include the adoption of improved sustainable production and consumption practices.

We believe that Cleaner Production and other preventive strategies such as Eco-efficiency, Green Productivity and Pollution Prevention **are preferred options.** They require the development, support and implementation of appropriate measures.

We understand Cleaner Production to be the continuous application of an integrated, preventive strategy applied to processes, products and services in pursuit of economic, social, health, safety and environmental benefits.

To this end we are committed to:

LEADERSHIP	<p><i>using our influence</i></p> <ul style="list-style-type: none"> - to encourage the adoption of sustainable production and consumption practices through our relationships with stakeholders.
AWARENESS, EDUCATION AND TRAINING	<p><i>building capacity</i></p> <ul style="list-style-type: none"> - by developing and conducting awareness, education and training programmes within our organization; - by encouraging the inclusion of the concepts and principles into educational curricula at all levels.
INTEGRATION	<p><i>encouraging, the integration of preventive strategies</i></p> <ul style="list-style-type: none"> - into all levels of our organization; - within environmental management systems," - by using tools such as environmental performance evaluation, environmental accounting, and environmental impact, life cycle, and cleaner production assessments.
RESEARCH AND DEVELOPMENT	<p><i>creating innovative solutions</i></p> <ul style="list-style-type: none"> - by promoting a shift of priority from end-of-pipe to preventive strategies in our research and development policies and activities; - by supporting the development of products and services which are environmentally efficient and meet consumer needs.

COMMUNICATION *sharing our experience*
by fostering dialogue on the implementation of preventive strategies and informing external stakeholders about their benefits.

IMPLEMENTATION *taking action to adopt Cleaner Production*

- **by setting challenging goals and regular reporting, progress through established management systems;**
- by encouraging new and additional finance and investment in preventive technology options, and promoting environmentally-sound technology cooperation and transfer between countries;
- through cooperation with UNEP and other partners and stakeholders in supporting this declaration and reviewing, the success of its implementation.

3.5.2 BACKGROUND INFORMATION INTERNATIONAL DECLARATION ON CLEANER PRODUCTION

QUESTION: WHAT IS THE DECLARATION OF CLEANER PRODUCTION?

This International Declaration is a statement of commitment to the practice of a specific preventative environmental management strategy, *Cleaner Production*, to systematically reduce pollution and improve efficiencies in resource use. *Other organizations may use different terminology (ecoefficiency, pollution prevention, waste minimization, etc.) for essentially the same approach.*

QUESTION. WHY IS THIS DECLARATION NEEDED?

The production and consumption of goods in the world is unsustainable and increasing faster than the earth can restore the natural resources used for these purposes. Wastes and pollutants are building up to unmanageable and sometimes dangerous levels. The result is a growing environmental crisis. Therefore a renewed dedication to a proven strategy to resolve this crisis is urgently needed. Commitment by noteworthy political, public and private business leaders will re-enforce the general recognition and endorsement for a more intense and broader adoption of Cleaner Production in all countries worldwide.

QUESTION. WHAT IS "CLEANER PRODUCTION" AND HOW CAN IT HELP?

Cleaner Production is a widely recognized and proven strategy for improving the efficient use of natural resources and minimizing wastes, pollution and risks to human health and safety at the source, rather than the end of the production process, i.e. the "end-of-pipe" stage. This practice ultimately reduces pollution, but importantly it also generates tangible economic savings for a business enterprise by improving the overall efficiency of production.

This prevention oriented strategy typically involves the modification of production processes, technology, operational or maintenance practices and results in meeting consumers needs with more environmentally compatible, quality products and services.

QUESTION. WHAT IS THE ROLE OF THE SPONSOR UNEP!

UNEP, United Nations Environment Programme, has been actively promoting the *Cleaner Production* strategy around the world since 1989. By working mainly as a catalyst, UNEP has successfully elevated the awareness of the need for a more effective answer to today's environmental Problems (*i.e. Cleaner Production*). In addition, it has encouraged public and private sector leaders to appreciate what Cleaner Production can accomplish. However, more must be done and new partners engaged, hence this proposed International Declaration on Cleaner Production which has been drafted by UNEP.

QUESTION. WHAT ARE THE SPECIFIC GOALS OF THIS DECLARATION?

To spread the awareness of the urgency of current environmental Problems and the concept of a preventative strategy ("Cleaner Production") as a preferred solution, in a way that society and community leaders understand exactly how this strategy works and the relevant benefits it provides.

To renew and intensify the commitment to actually using Cleaner Production by society and community leaders, to the extent that they acquire "ownership" and take the initiative for the local management of this practice.

To diversify and broaden the client base for using Cleaner Production, thereby increasing the overall demand.

To encourage local support for the adaptation of actual Cleaner Production activities as a prudent economic investment, which should motivate and facilitate wide scale implementation beyond current demonstration activities.

To promote further international cooperation and technology transfer that will maximize initiatives around the world for the Cleaner Production strategy.

QUESTION. WHO WILL SIGN THIS DECLARATION?

Government: The Minister or Director-General, or similar status, regional, provincial or local administrators.

Business (including business associations and trade unions): the President, Chairperson, Executive Director/Secretary General or a similar status.

Civil Society: Prominent community leaders.

International Agencies / Associations: Executive Directors.

3.6 SOURCES

Literature

H. Schnitzer et al.: Cleaner Production Training Programme UNEP/UNIDO. STENUM GmbH, A-8010 Graz, 1995

IVAM: Training workshop for counterpart organisations in the UNIDO/UNEP-NCPC Programme. Amsterdam, March 1998

Cleaner Production: A training resource package. UNEP IE, Paris 1996, ISBN 92-807-1605-0

DESIRE (**DE**monstration in **S**mall Industries for **RE**ducing Waste): From waste to profits - Experiences. UNIDO, Vienna 1995.

NPC (National Productivity Council): From waste to profits: guidelines for waste minimisation, NPC, New Delhi 1994.

National Cleaner Production Centers: Case Studies UNIDO, Vienna 1997

Organisations

UNEP - IE: United Nations Environment Programme - Industry and environment)
Tour Mirabeau 39-43 quai André Citroën, F-75739 Paris cedex 15
Tel: (33 1) 44 37 14 50, Fax: (33 1) 44 37 14 74, Email unepie@unep.fr,
<http://www.unepie.org/home.html>

UNIDO: United Nations Industrial Development Organisation
P.O. Box 300, A-1400 Vienna, Austria
Tel: (+43 1) 26026, Fax: (+43 1) 269 26 69
<http://www.unido.org/>

Addresses of National Cleaner Production Centers of UNIDO/UNEP:
<http://www.unepie.org/cp/ncpc.html>

IVAM: Interfaculty Department of Environmental Science, University of Amsterdam (UvA)
Nieuwe Prinsengracht 130, 1018 VZ Amsterdam, The Netherlands.
<http://www.ivambv.uva.nl/welcome.html>

STENUM GmbH (Stoffe - Energie - Umwelt), NCPC
Geidorfgürtel 21, A - 8010 Graz, Austria
Tel: +43 316 367156 - 0 Fax: +43 316 367156 - 13 Email: stenum@stenum.co.at
<http://www.stenum.at/home.htm> (in German only)

Centre for Environment and Development (CED), Norwegian University of Science and Technology (NTNU), Trondheim <http://www.smu.ntnu.no/>,
with lectures: <http://www.smu.ntnu.no/PROG/STIE/LectureSlides/>
link page: <http://www.smu.ntnu.no/PROG/STIE/Links/>

4 ENVIRONMENTAL MANAGEMENT SYSTEMS ACCORDING TO ISO 14001

4.1 INTRODUCTION, HISTORICAL BACKGROUND

Business community operates in very competitive and global markets. They are also operating in a society which is becoming more informed and increasingly aware of a wide range of social issues including the protection of the environment. These trends are creating new pressure.

There is a growing requirement placed upon economy to be able to demonstrate their environmental responsibility to "stakeholders" such as customers, legislators, employees, shareholders, investors and NGO's (see Fig. 4.1).

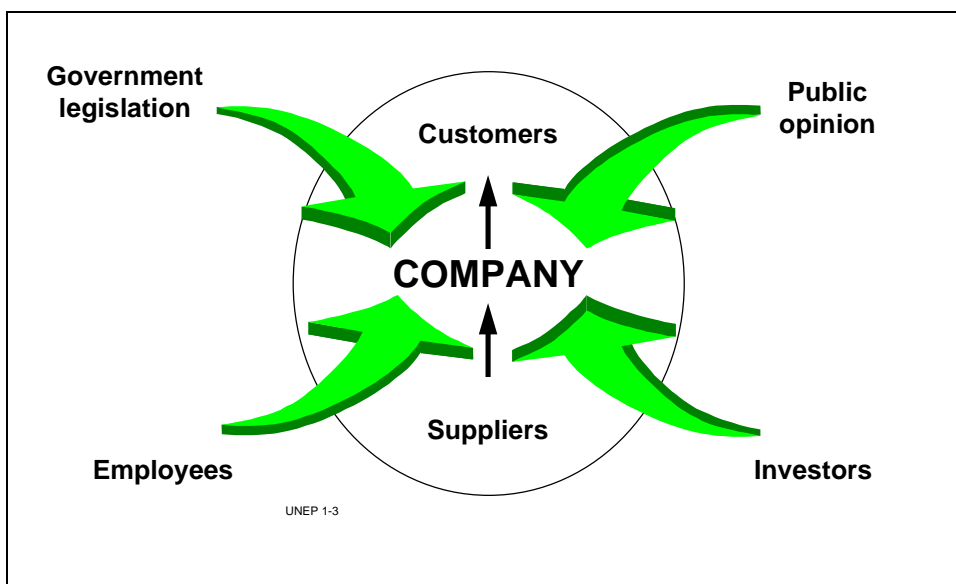


Figure 4.1: Interested Parties of a company

As a result there has been an increase in environmental legislation worldwide. In consequence, environmental accidents are getting very expensive. These costs must now be counted not only in terms of newly introduced fines, but also in terms of clean-up bills and the bad reputation which is often caused.

At the same time evidence was also seen that many companies had tried to satisfy the growing environmental lobby by launching "Green Products", and this frequently resulted in a difficult and sometimes sterile debate being promoted about the trade-off between one type of environmental impact versus another.

Industry in parallel had tried in a fairly uncoordinated way to resolve some of the issues by the use of publications, various guides and documents, and the use of consultants. Although the response was uncoordinated, a growing number of environmental guiding principles from various organisations, such as the International Chamber of Commerce (ICC) and the Chemical Industries Association, did contain certain common elements. These included:

1. A policy statement of an organisation's commitment to environmental management.
2. Reduction of waste and avoidance of excessive consumption.
3. Legal compliance.
4. Employee education and public information.
5. Measurement of environmental performance.
6. A commitment to continual improvement.
7. Promotion of environmental principles to suppliers, customers, etc.

The existence of a number of similar guiding philosophy statements can also be translated into a model which provides us with a systematic and structured management approach to the way an organisation tackles environmental concerns. These, in fact, provide the basis for ISO 14001. This standard provides a framework for the approach, design and integration of an environmental management system (EMS) that enables any organisation to meet the requirements of the guiding principles.

Establishing and maintaining a good environmental management is becoming increasingly important for organisations. An EMS is a systematic approach to environmental care in all aspects of business. Implementation of this approach is normally a voluntary process.

The development of ISO 14001 represents a significant step forward in improving and formalising an EMS. An organisation with an EMS certified to this standard has a public and clearly recognisable level of attainment, competence and commitment. Certification provides a proof of efforts being made within the technological and economical limits of a company.

Far from being under constraint, it is argued that an effective EMS can help companies to increase sales, reduce costs and obtain competitive advantage.

The potential benefits may be as follows:

- **Legislation**

Environmental legislation is increasing worldwide. A proactive and systematic approach to comply with the law reduces the risk of illegal practice and consequential penalties. It can also provide a competitive advantage.

- **Cost Savings**

Enterprises which find ways of reducing or even eliminating pollution, waste and energy consumption can bring about important cost savings, and thus be more competitive. Common cleaner production opportunities are found in areas such as energy efficiencies, emission reductions, recycling or recovering value from waste, minimising raw material usage, etc.

- **Customer requirements, investment, insurance**

Enterprises do not like to risk their reputation or inherit liabilities as a result of poor environmental performance by their suppliers. Investment and Insurance Investment will become increasingly difficult to secure as investors become more concerned about risk due to poor environmental performance. Banks and insurance companies increasingly require environmental audits to be carried out and/or management systems to be in place as a condition of investment or cover.

- **Market Opportunities, competitiveness**

Good environmental performance can be a key factor in market profiling of an organisation

and gives a competitive edge. This is especially so with younger generations who tend to be increasingly environmentally conscious.

- **Corporate Image, awareness, reputation**

A good environmental record can improve corporate image and create better relations with stakeholders. Adverse publicity about environmental performance can be very damaging. Enterprises in emerging economies soon will have to play by the same rules as their counterparts in the USA and the European Union (EU). To be able to sell their products in the USA and EU, they will have to demonstrate that they follow accepted international environmental practices.

As with previous standards on management systems, ISO 14001 is applicable to all types of organisations, whether manufacturing or service providing, no matter what their size in terms of workforce or turnover. Costs to the organisations who undertake implementing the standard will obviously be dependent on a series of factors such as size, relative complexity of operations, the existence of any other standardised management systems, information and manpower resources, as well as any other specific environmental initiatives undertaken before implementation.

One of the most important aspects of the standard is that while it provides a generic model, it does **not** attempt to outline expected levels of performance in environmental terms. It is intended to be used as a management tool, not a regulatory device, enabling management teams to devise their own policy and then provide the necessary support and information systems that are required. Assurance based on conformance with the standard is thus centred on the ability of the management to meet its own stated objectives, not on the actual level of performance attained.

Following the recommendations of the ISO Strategic Advisory Group on Environment (SAGE) which included representatives of 20 countries, 11 international organisations and more than 100 environmental experts, the Technical Committee (TC) 207 was created to develop standards in 6 areas (see Fig. 2.6). However, without some background information, it may not be easy to see how such a standard could help organisations improve their environmental performance.

The key is the concept of "environmental auditing", originally used in the United States to cope with increasingly tough environmental laws and also the demands of investors looking to protect financial and economic interests.

As the concept has changed and broadened, an element of confusion has crept into the use of the term "environmental audit", though the International Chamber of Commerce (ICC) have defined an environmental audit as:

1. A management tool comprising a system, documented, periodic and objective evaluation of how well environmental organisations management and equipment are performing with the aim of helping to safeguard the environment by,
2. facilitating management control of environmental practices,
3. assessing compliance with company policies, which would include meeting regulatory requirements.

ISO 14001 can be used for any of several purposes, such as:

1. Creating an environmental management system.
2. Auditing an environmental management system.

3. Seeking third-party certification.
4. Seeking customer recognition of an environmental management system.
5. Declaring the environmental management system to the general public.

4.2 REQUIREMENTS FROM AN ORGANISATION

Commitment: *Do we want this?*

First an organisation will only undertake the development of its internal EMS to ISO 14001 if there is a commitment at senior level to do so. An environmental management system is really just another good business practice that should be embraced by any well-informed management team. ISO 14001 calls for top management to define an organisation's environmental policy (see figure 4.2).

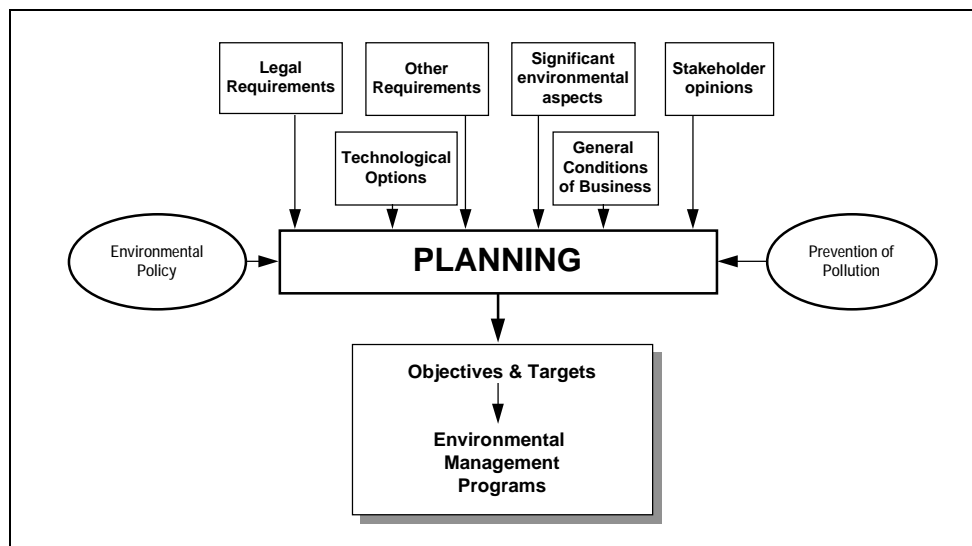


Figure 4.2: The requirements of ISO 14001

Initial Review: *Where are we?*

In order to develop the system, an organisation will need to understand from where it is starting, an initial review will be necessary. This establishes the baseline. From this baseline the organisation can develop its EMS. This system constitutes an integrated set of practices and procedures to ensure that both the legislative and policy requirements of the organisation are met effectively and consistently.

The review is not essentially part of ISO 14001, as it is not an assessable element of an established system. ISO 14001 states that those organisations with operating environmental management systems do not have to undertake such a review. However, organisations need to understand the environmental requirements that they are expected to meet, particularly those set out in legislation.

Policy: *What do we want?*

The key in this is the environmental policy, a documented statement that is relevant to the activities, products and services of the organisation and which contains a commitment to continual improvement and to prevention of pollution. It has to be publicly available, understood and implemented throughout the organisation, and forms the basis of the organisation's objectives and targets.

The policy should also include a commitment to comply with the relevant environmental legislation and regulations, and to meet other requirements to which the organisation subscribes. These can include commitments to voluntary programs, such as the International Chamber of Commerce (ICC) Chapter and the Chemical Industry Association's "Responsible Care" program.

Planning: *What needs to be done?*

Planning involves the identification of key environmental requirements for the organisation, identifying opportunities for improvement and the development of programs to achieve them. The following four elements need to be satisfied (Figure 4.3).

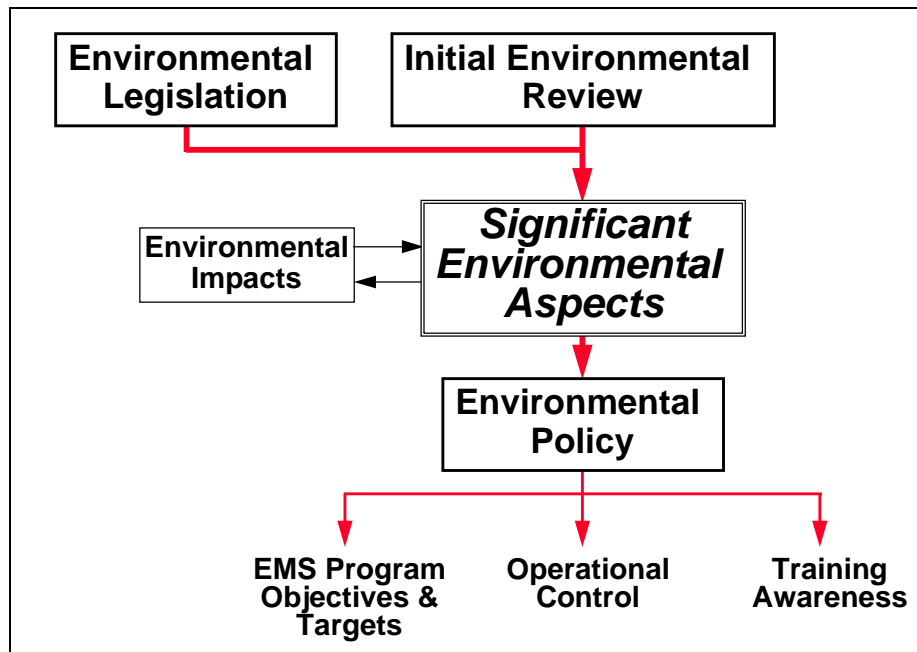


Figure 4.3: The thread of an EMS

1. Environmental Aspects: What have we got to watch?

Planning begins by defining where your organisation can control or influence the environmental results of its operations, products and services. The organisation should identify significant environmental aspects that should be addressed as a priority by the environmental management system.

The identification of environmental aspects is an ongoing process that determines the past, current and potential impact (positive or negative) of an organisation's objectives on the environment. One way to help in this part of the planning phase is to compile an up-to-date list of environmental regulations and requirements that relate to the organisation.

2. Legal and other Requirements: *What are we obliged to manage?*

The organisation should establish and maintain procedures to identify and have access to legal and other environmental requirements to which it subscribes.

3. Objectives and Targets: *Where do we want to be?*

From these considerations come the objectives and targets which are set at various levels in the organisation, and quantified where practicable. The objectives and targets should be consistent with the environmental policy. The purpose of this requirement is to ensure that there are clear environmental goals within the organisation as a whole, and for appropriate management teams. In addition, consideration should be given to financial, operational and business requirements when setting objectives and targets. Also, the concerns of other interested parties have to be considered.

4. Environmental Management Program: *How do we get there?*

The management program is the plan to achieve the objectives and targets, suitably documented. The program will exist at every level where objectives and targets have been set. It should be dynamic and revised regularly to reflect changes in organisational objectives, targets and procedures. It is important that the program identifies responsibilities, methods and measures. The program will not just list the things to be done; it will also state who is responsible, when plans will be achieved, and how the owner (and everyone else) will know the plans have been achieved.

Implementation and Operation: *What do we need to do to achieve this?*

Under ISO 14001, implementation and operation of an organisation's environmental management system should consider the following seven elements:

1. Structure and Responsibility: *Who is going to take us?*

The successful implementation of an environmental management system calls for the commitment of all employees of the organisation. Lines of responsibility must be defined and people and resources provided to get the job done. The goal is to establish a set of management responsibilities and resources sufficient to implement and support the EMS.

2. Training, Awareness and Competence: *What skills and knowledge do we require?*

All employees who can have a significant impact on the environment have to be trained to meet identified levels of skills and knowledge. ISO 14001 specifies two types of training to be provided by the organisation:

- training for general awareness for all employees of an organisation;
- training for competence to perform a given assignment.

Training may also be required for contractors and suppliers whose work could also result in environmental impacts for the organisation.

3. Communications: *Whom do we need to talk with?*

Good environmental management involves communication with employees, local communities, regulators, customers and various other interested parties (stakeholders). ISO 14001 asks you to

- maintain internal communications between various functions levels of the organisation;
- receive, document and respond to relevant communication from external interested parties regarding environmental aspects and the EMS.

4. Environmental Management System Documentation: *What do we say we do?*

Environmental Management System processes and procedures need to be documented and kept current. There needs to be a match between the documented process and what is actually practised by the organisation. The documentation should be sufficient to describe the core elements of the environmental management system and their interaction, and provide direction on where to obtain more detailed information on the operation of specific parts of the management system. Documentation provides the foundation on which the environmental management system audit assesses compliance.

5. Document Control: *How do we keep a trace of this?*

The necessary documentation must be managed so that it is kept up to date and owned, so that a specific job holder has responsibility to update it, change it, withdraw it, etc.

6. Operational Control: *How do we achieve consistency in our approach?*

Operational control is the day-to-day management of the organisation's activities involving a quality system approach to ensure compliance with stated objectives. The requirement of ISO 14001 does not ask for instructions for everything everywhere, but it does ask for documented work instructions where the lack of them could result in a failure to achieve the environmental policy, objectives and targets.

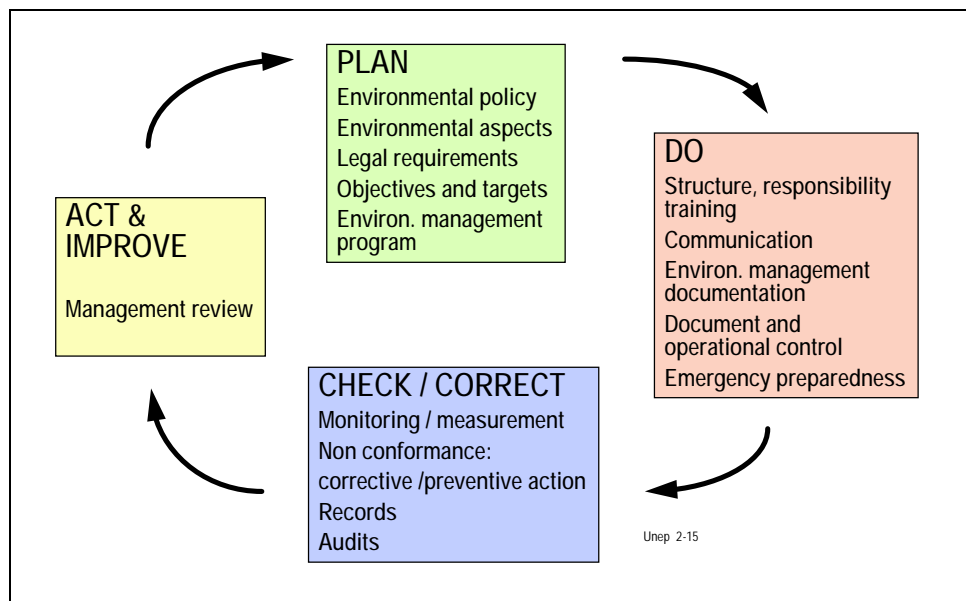


Figure 4.4: The elements of ISO 14001

7. Emergency Preparedness and Response: *How do we handle the unexpected?*

Emergency plans and procedures should be established to ensure an effective response to unexpected incidents. Also the organisation will need to consider how it will prevent further environmental damage while also correcting any damage as a result of such an unexpected

incident. The organisation should also regularly review and test such procedures in place, particularly after an incident.

Checking and Corrective Action: *Are we getting there?*

ISO 14001 requires organisations to check or monitor activities related to the EMS as well as providing the means and methods for taking corrective action if deficiencies are found.

Monitoring and Measurement: *How do we assess our progress?*

Organisations need to establish what operations require measuring to show they are under control. They will then need to monitor and measure on a regular basis in order to assess progress against stated environmental objectives and targets. The organisation, where appropriate, shall track performance, calibrate and maintain monitoring equipment and also periodically evaluate compliance with relevant environmental legislation and regulations.

Non-Conformance and Corrective Action: *How do we solve problems?*

ISO 14001 requires an organisation to establish and maintain procedures for realising, handling, investigating and initiating corrective and preventive action for non-conformance. The expression non-conformance refers to occurrences where deviations from the environmental management system (and from ISO 140001) falls outside specified requirements. This can be identified through monitoring and measuring procedures; the follow-up action to correct the problem is essential for continued confidence in the management system.

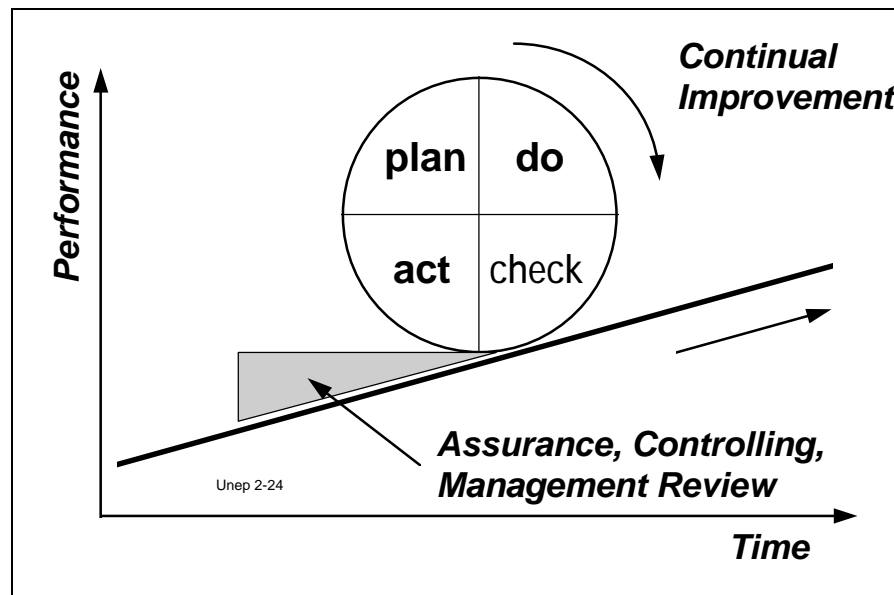


Figure 4.5: The system to ensure continual improvement

Records: *What should we record?*

Maintaining environmental records is a key part of an environmental management system. Records are evidence of what has been achieved and will provide an audit trail that demonstrates to the organisation (and external assessors) the status of the management

system. The goal is to establish and maintain a set of records to demonstrate conformance with ISO 14001 requirements.

The records should also show the extent to which the program to achieve environmental objectives and targets has been successful.

Environmental Management System Audit: *How do we check our achievement?*

An Environmental Management System Audit provides the basis for the conformance assessment of the system. The purpose of the audit is to determine whether the management system conforms to planned arrangements for environmental management and to see if it is properly implemented and maintained. ISO 14001 defines an environmental management system audit as "a systematic and documented verification process to objectively obtain and evaluate evidence to determine whether an organisation's environmental management system conforms to the EMS audit criteria set by the organisation, and to communicate the results of this process to management".

There are separate guidelines for environmental auditing. These include the following documents:

- ISO 14010, "Guidelines for Environmental Auditing - General Principles on Environmental Auditing"
- ISO 14011, "Guidelines for Environmental Auditing - Audit Procedures: Auditing of Environmental Management Systems"
- ISO 14012, "Guidelines for Environmental Auditing - Qualification Criteria for Environmental Auditors performing Environmental Management Systems Audits"

Management Review: *Did we get there?*

Management review of the audits and the whole operation of the system should be carried out to ensure that an environmental management system exists to meet the organisation's requirements. According to ISO 1001, a management review is performed and documented at intervals determined by management to ensure that the EMS is

- suitable,
- adequate,
- effective.

This will include a review of all major aspects of the EMS, including the need for changes to the policy, objectives and targets, based on the results of updating the environmental aspects evaluations. Results of internal audits should also form a part of the agenda and this should include progress of improvement against objectives and targets.

The review ensures that senior managers responsible for the organisation's environmental management system have the opportunity to assess the overall performance and the need to adapt any of its component parts.

4.2.1 Conclusions

ISO 14001 represents a challenging, but achievable set of requirements for any organisation. For those that have been operating environmental management systems for many years, the standard provides a useful benchmark. By comparing existing systems with the requirements of ISO 14001, organisations are able to identify potential weaknesses in their own procedures. On the other hand, ISO 14001 also provides a useful framework to help organisations without their own formal management system develop systems commensurate with the risks they are facing.

The challenge for many organisations is that a new aspect of business life, the environment, is being entered onto the balance sheet for the first time. The use of environmental management standards will give an organisation confidence in the knowledge that they are tackling environmental concerns in a systematic and integrated way.

4.2.2 Literature

- UNEP/ICC/FIDIC (1995) Environmental Management System Training Resource Kit, Version 1.0; ISBN 92-807-1479-1
- Dyllick, Gilgen, Häfliger, Wasmer (1996) SAQ-Guidelines to ISO 14001; ISBN 3-85849-002-4
- Hutchinson, J. (1997) ISO regional training seminar for Countries of Central America and the Caribbean on Environmental Management Systems and ISO 14000. Seminar proceedings.

5 ENVIRONMENTAL PERFORMANCE EVALUATION (EPE)

5.1 INTRODUCTION

The EMS standard requires organisations to develop measurable objectives and targets, and to monitor and evaluate their performance against them. The EMS does not audit this performance but it does audit the management of performance objectives and targets. ISO TC 207/SC4 is developing a standard (14031) and a technical report (TR 14032) to help organisations managing this monitoring and evaluation process.

The basic premise is that what gets measured gets done. Measurements allow an organisation to more clearly understand and quantify where it stands and how far it has to go to meet its objectives and targets. It also provides a basis for understanding improvement. The EPE then will provide the organisation with a systematic tool for generating information. A necessary element of generating useful information is selecting or defining the environmental performance indicators (EPis) or performance measures that will be used.

EPE is different from environmental audits in several significant ways. EPE is an ongoing process. As part of the management system it is something that is put in place and available at all times. It helps to define actions, responsibilities and information flows that are part of ongoing, day-to-day operations. An environmental audit is just a snapshot in time. It is a periodic verification that everything is as it should be. While the evidence collected during an audit is existing evidence, the information generated by an EPE is new evidence. Within the framework of an EPE an organisation can conduct research and investigate new issues, within an audit one can only assess claims concerning the current state.

Since an EPE system provides the framework for information gathering, it also provides a logical link to reporting. Organisations will have many internal and external reporting and communication requirements and an EPE system can ensure that the information is gathered and disseminated correctly and on time. Many organisations also choose to voluntarily report on their environmental management system or environmental performance.

5.2 DESCRIPTION

The standard being developed by ISO will allow organisations to develop appropriate systems to measure, evaluate, describe and communicate environmental performance. It is part of the environmental management system. Thus ISO 14001, the EMS specification document, requires that organisations monitor and measure on a regular basis the key characteristics of its operations and activities. The developers of this standard, however, intended to develop a document that will be useful to an organisation that wishes to evaluate its environmental performance whether or not it has a formal environmental management system in place. If an organisation without an EMS wishes to use the EPE system it must still have a mechanism for developing objectives and targets since the EMS document and not the EPE document provides this guidance.

5.3 IMPLEMENTATION

The current draft of the EPE document (ISO 14031 DIS 1997) contains the following elements, referring to the "plan-do-check-act" management model (see Figure 5.1).

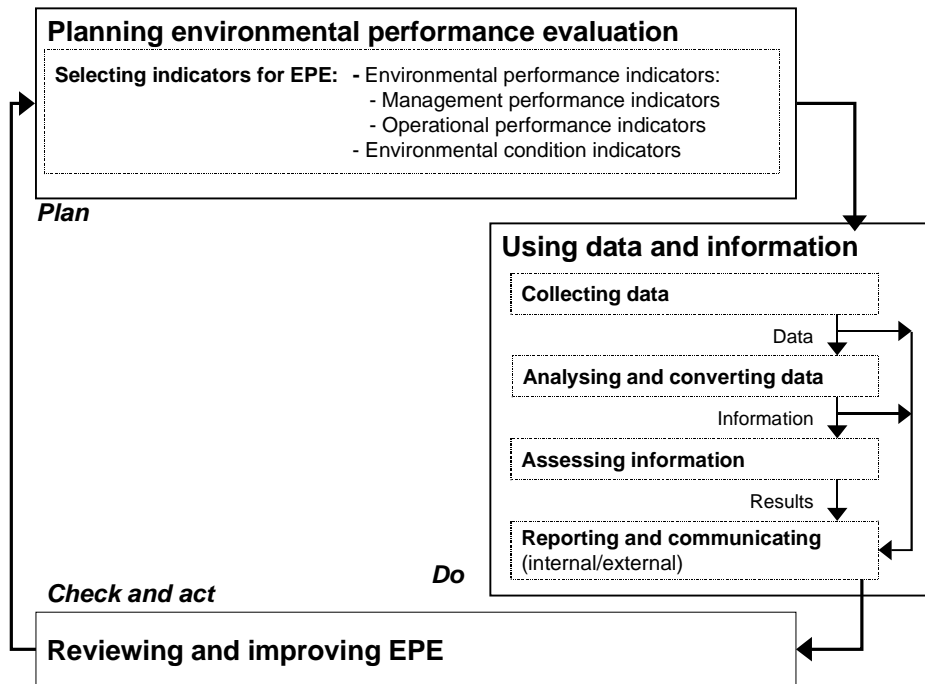


Figure 5.1: Elements of Environmental Performance Evaluation (ISO/DIS 14031 1998)

5.3.1 Planning EPE ("Plan")

Planning involves reviewing or identifying those environmental aspects of an organisation's activities, products and services that have generated objectives and targets. It is essential that the EPE process is integrated in an EMS since the development of objectives and targets should include identifying what an organisation wants to measure and therefore how it wants to measure and check it.

5.3.2 Selecting indicators for EPE

The selection or definition of environmental performance indicators is key at this juncture. There is much debate about the development of EPIs. Should there be generic EPIs across sectors? Common EPIs would provide the basis for comparison and benchmarking. They might also provide the basis for generation of national, regional or international environmental accounts. But is the development of such generic EPIs possible given the diversity of business operations, local conditions and measurement capabilities? Should individual sectors develop their own EPIs? If generic EPIs are too difficult to develop should sector-based EPIs be developed?

ISO/DIS 14031 proposes three types of indicators, all of them can be objectively measured and checked.

A. **Management performance indicators (MPIs)** are a type of EPI which provide information to support the evaluation of management efforts to influence the environmental performance of the organisation's operations. MPIs relate to the policy, people, planning activities, practices, procedures, decisions and actions at all levels of the organisation.

Examples of MPIs:

- implementation of policies and programs
- conformity
- financial performances

B. **Operational performance indicators (OPIs)** are a type of EPI which provide management with information on the environmental performance of the organisation's operations. OPIs relate to:

- inputs: materials (e.g.: processed, recycled, reused, or raw materials; natural resources), energy and services;
- the supply of inputs to the organisation's operations;
- the design, installation, operation (including emergency events and non-routine operation), services, wastes (e.g. solid, liquid, hazardous, non-hazardous, recyclable, reusable), and emissions (e.g. emissions to air, effluents to water or land, noise, vibration, heat, radiation, light) resulting from the organisation's operations;
- the delivery of outputs resulting from the organisation's operations.

Examples of OPIs: materials, energy, products, wastes, emissions

C. **Environmental conditions indicators (ECIs)** provide information about the local, regional, national or global condition of the environment. An ECI is not a measure of an impact on the environment, but this information may help an organisation to better understand the impact or potential impact of its environmental aspects, and thus assist the planning and implementation of EPE.

Examples of ECIs: air, water, soil, flora, fauna

Any performance, i.e. also environmental performance, is energy (and work correspondingly) per time. Therefore, all these indicators characterising environmental performance must provide time-dependent (e.g. dynamical) interpretations. The question arises, if such indicators hence are defined in the time, domain? Let's have a look on some among them.

Indicators according to ISO/DIS 14031 (see Figure 5.2), exactly like the figures of an LCA, are not defined in the time domain. As a consequence, with both frameworks of data, EPE and LCA, everytime-dependent answers are made by so-called time series; by the addition of periods of days, weeks, months and years.

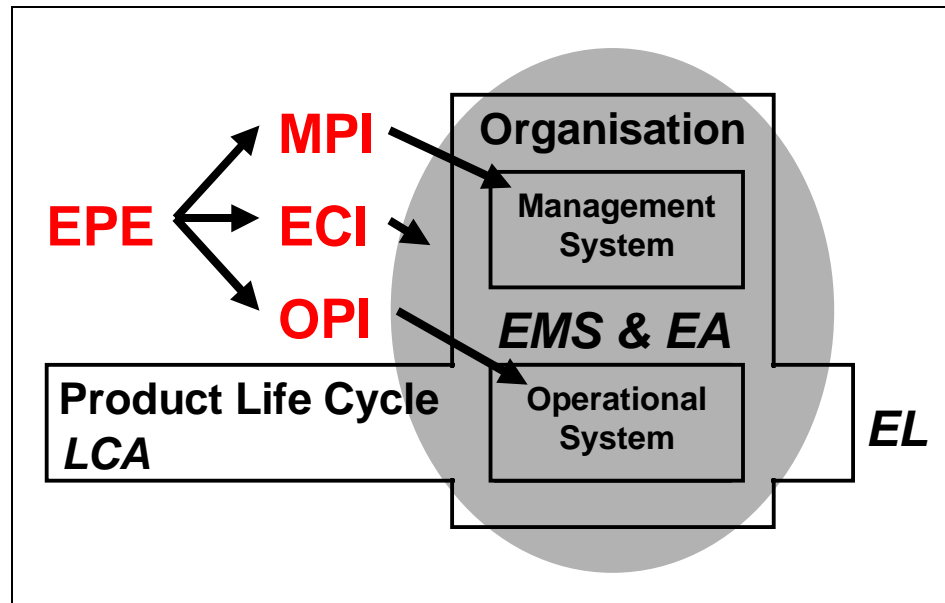


Figure 5.2: Categories of EPE indicators

5.3.3 Using data and information ("Do")

This step includes:

- collecting data relevant to the selected indicators;
- analysing and converting data into information describing the organisation's environmental performance;
- assessing information describing the organisation's environmental performance in comparison with the organisation's environmental goals, targets and objectives;
- reporting and communicating information describing the organisation's environmental performance.

5.3.4 Reviewing and improving EPE ("Check and act")

An organisation's EPE and its results should be reviewed periodically to identify opportunities for improvement. Steps may include a review of:

- cost effectiveness and benefits achieved;
- progress to meet environmental performance criteria;
- appropriateness of environmental performance criteria;
- appropriateness of selected indicators;
- data sources, data collection methods and data quality.

5.3.5 Example

Following an example to illustrate indicators for EPE is given (ISO TC207 SC4):

An organisation that operates a fleet of motor vehicles for delivery of its products may determine that emissions from its vehicles are a significant environmental aspect of the organisation. Therefore, it may select as appropriate indicators for EPE:

5.3.5.1 MPIs:

- amount of money allocated to study the use of alternative fuels;
- numbers of actions/decisions to reduce fuel consumption, increase fuel efficiency, and improve vehicle maintenance.

5.3.5.2 OPIs:

- amount of the emission of a specific contaminant from vehicles using alternative fuels;
- amount of the emission of a specific contaminant from vehicles not using alternative fuels;
- quantity of total fuel consumption by type of fuel;
- fuel efficiency by motor vehicle;
- frequency of vehicle maintenance;
- number of vehicles equipped with environmental control technologies.

5.3.5.3 ECI:

- concentrations in the air of specific contaminants associated with motor vehicle emissions.

Further, detailed examples can be found in ISO TR 14032 (1998, Draft) or in BMU/UBA (1997).

5.4 CONCLUSION

Life cycle assessment (LCA) is a powerful instrument for measuring environmental performance. The indicators for environmental performance evaluation (EPE) according to ISO/DIS 14031 «Environmental performance evaluation» can be seen as enlarged LCA's; this understanding of EPE is especially true in those cases where the scope of an “eco-balance” covers a complete organisation.

EPIs have a powerful appeal to business managers and outside parties. But to be most useful, this information must adhere to basic guidelines of what gets measured and how. The four categories of environmental performance - materials use, energy consumption, non-product output, and pollutant releases - help firms, regulators, communities, and others to reach beyond the traditional focus on compliance, turning the spotlight instead on resource efficiency, pollution prevention, and product stewardship.

Business leaders committed to these goals can gauge their performance in these areas, establish goals, and publicise their progress. At the same time, government reporting requirements and their information management needs major reorganisation: EPIs provide key elements for this overhaul. Communities, investors, NGOs, researchers, and others with a stake in the environmental performance of business should press for credible, comparable environmental information and reward those firms and sectors who rise to this challenge. From these collective efforts, a new system will emerge of accountability for corporate environmental performance, and a robust framework for evaluating progress toward environmental objectives from a local to a global scale.

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6 LIFE CYCLE ASSESSMENT (LCA) - PRINCIPLES AND FRAMEWORK

6.1 OVERVIEW: LIFE CYCLE THINKING

6.1.1 Description

The need of making a decision based on ecological criteria choosing one out of several products or services and the complexity of environmental problems, have formed several analytic environmental management tools based on one main principle: Life cycle thinking.

Life cycle thinking means to study a product or service from its 'cradle to its grave' considering raw material extraction, transports, production of the semi-products, production of the finished product, the use phase, maintenance and the disposal phase (Figure 6.1).

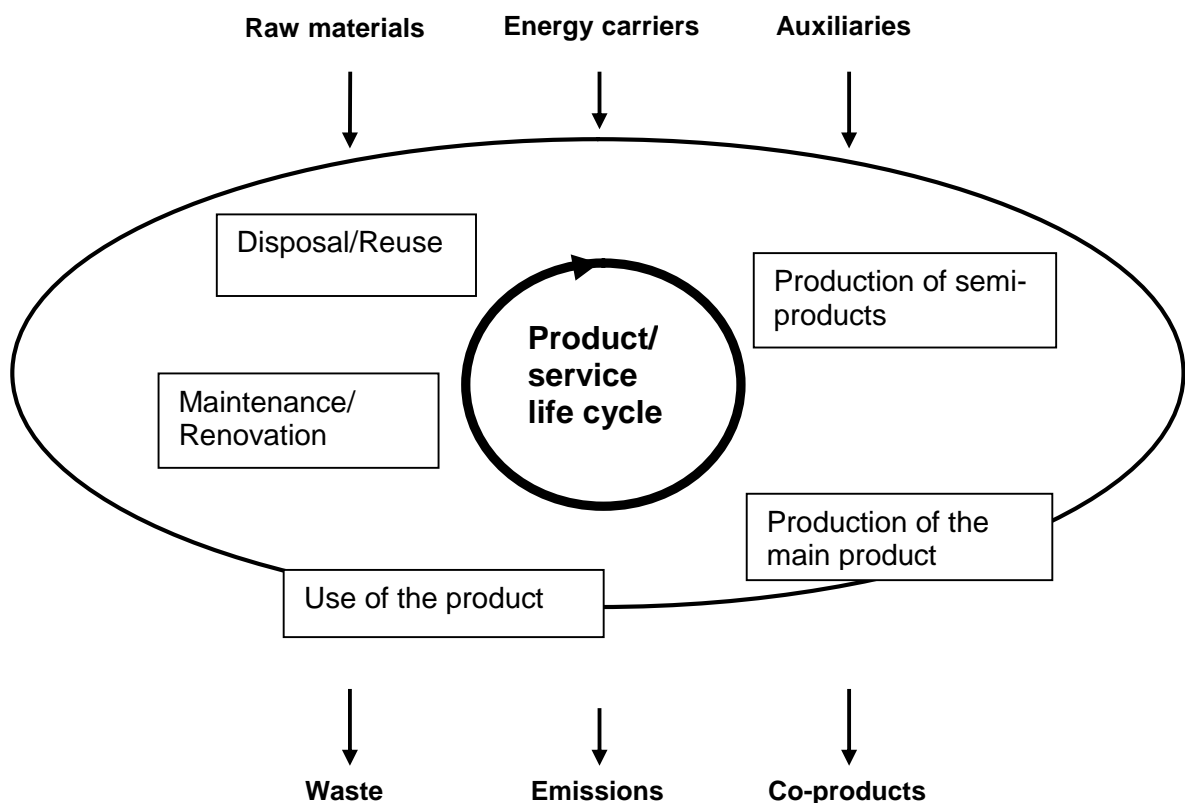


Figure 6.1: The life cycle of a product/service

The focus of this approach varies from tool to tool.

The concept of Life cycle thinking has several advantages, independent of the tool this concept is used with:

- due to its structured approach it allows to include all the (environmental) effects induced by a product or service
- it forces consideration of trade-offs along the life cycle and thus avoids problem shifting from one life phase to another due to the completeness of the approach
- it forces to move beyond sector-based analysis to consider wider implications of any activity
- it has an enormous educational potential as it promotes to consider the cradle-to-grave implications of any action
- it broadens the environmental debate from single issues and supports strategic product and activity planning

Life cycle thinking reflects the acceptance, that key societal actors cannot strictly limit their responsibilities to those phases of the life cycle of a product, process or activity, in which they are directly involved. It expands the scope of their responsibility to include (environmental) implications along the entire life cycle of their product or service.

Life cycle thinking has become an integral part of several analytic environmental management tools, first of all Life cycle assessment, but also – depending on its application: Risk assessment, Material flow analysis, Waste management, Total cost accounting etc. Further on, it will hopefully play a more and more important role in the design of products and services (Ecodesign).

Life cycle thinking underlies much recent environmental legislation emanating from the European Union, especially regarding product and waste policy. Thus, the concept of producer responsibility, which is at the core of the European strategy, is essentially following the principles of life cycle thinking.

6.1.2 References

- ISO 14001:1996 Environmental management systems – Specifications with guidance for use
- ISO 14004:1996 Environmental management systems – General guidelines on principles, systems and supporting techniques. Draft.
- ISO 14040: 1997 Environmental management systems – Life cycle assessment – Principles and guidelines
- ISO 14041: 1998 Environmental management systems – Life cycle assessment – Life cycle inventory analysis

6.2 LIFE CYCLE ASSESSMENT (LCA)

The heightened awareness of the importance of environmental protection together with the possible impacts associated with products manufactured and consumed, has increased the interest in the development of methods to better comprehend and reduce these impacts. One of the methods being developed for this purpose is LCA. This is a technique for assessing the environmental aspects and potential impacts associated with products.

6.2.1 What exactly is an LCA?

LCA studies the environmental aspects and potential impacts along the continuum of a product's life (i.e. "cradle-to-grave") from the extraction of raw materials from the Earth through to production, use and disposal. The general categories of environmental impacts needing consideration include resource use, human health and ecological consequences.

There are two reasons for this approach. First, individual component operations could apparently be made cleaner and more efficient by simply displacing the pollution elsewhere, thus the benefits occurring in one location would be offset by the problems generated elsewhere so that there was no overall real improvement (Sub-optimisation). The second reason was that, by tradition, engineers had concentrated their efforts into making individual processes more efficient, but very few considered ways in which these unit operations were put together to form an overall production and use sequence. Sometimes, by rearranging the building blocks, overall systems can be made more efficient.

6.2.2 What are the benefits of an LCA?

LCA is a technique which can assist an enterprise in:

- identifying opportunities to improve the environmental aspects of products at various points in their life cycle;
- comparing company specific data with average data to determine any ecological weak points in a company's production processes as a basis for any improvement (benchmarking);
- decision-making in industry, government or non-government organisations (e.g. strategic planning, priority setting, product or process design or re-design);
- selection of relevant indicators of environmental performance, including measurement techniques;
- marketing (e.g. an environmental claim, eco-labelling scheme of environmental product declaration).

LCA is *one* of several environmental management techniques (e.g. risk assessment, site-related environmental auditing and environmental impact assessment) and may not be the most appropriate instrument to be used in all situations.

6.2.3 LCA and ISO

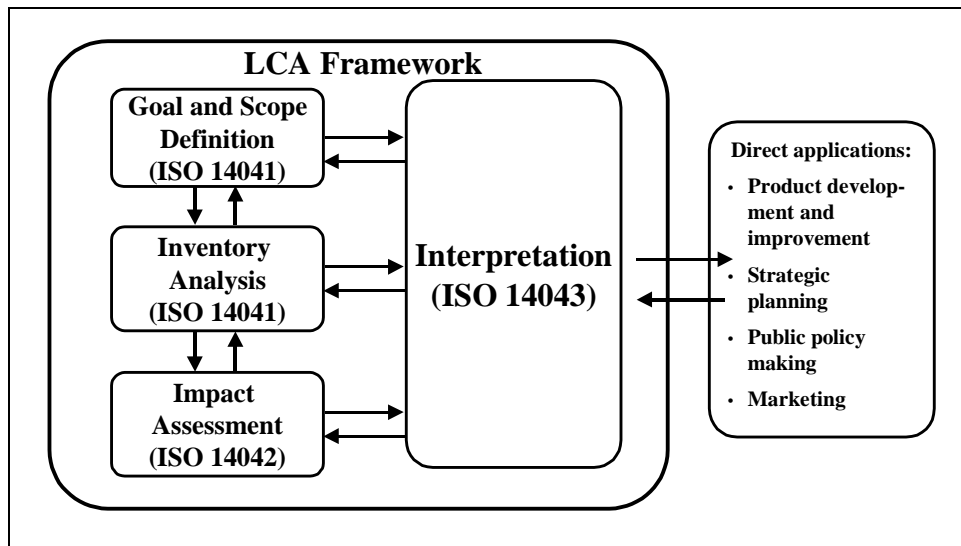
The ISO standard 14040 provides the life cycle assessment principles and framework but does not give any specific method for LCA. Additional details regarding methods are provided in the following supplementary ISO standards concerning the various phases of an LCA (see Table 6.1 representing situation Nov. 99)

With regard to the ISO 14000 series of environmental management systems, the 14040 documents about LCA can be seen as a very useful *product-oriented support tool*. LCAs are an extremely practicable approach to help to identify the significant environmental aspects associated with the activities, products or services of a company. ISO 14001 on environmental management systems, annex A.3.1 mentions LCA in connection with an initial (preparatory) environmental review. The standard proposes "...that organisations do not have to evaluate each product, component or raw material input. They may select categories of activities, products or services to identify those aspects likely to have a significant impact." In other words the application of LCA is recommended.

Table 6.1 LCA and ISO 14000

Standard	Title	Situation November 1999	Publication planned
ISO 14040	Life cycle assessment - Principles and framework	International Standard (IS) since 1997	
ISO 14041	Life cycle assessment - Inventory analysis	International Standard (IS) since 1998	
ISO 14042	Life cycle assessment - Impact assessment	Final Draft International Standard (FDIS): Aug 1999	International Standard (IS): beginning of 2000
ISO 14043	Life cycle assessment - Interpretation	Draft International Standard (DIS): May 1999	International Standard (IS): beginning of 2000
ISO 14048	Environmental Management – Life Cycle Inventory Data Format	New work Item, First working draft (WD), Dec 99	International Standard (IS): end of 2000
ISO 14049 Technical report Type 3	Life Cycle Assessment - Examples for the application of ISO 14041		Publication expected beginning of 2000

As illustrated in Figure 6.2, the phases of an LCA study are defined as goal and scope definition, inventory analysis, impact assessment and interpretation of the results. Applications of LCA, such as the examples listed below, are outside the scope of this life cycle assessment methodology standard.

**Figure 6.2:** Phases of an LCA according to ISO 14040

The purpose of life cycle inventory calculations is to provide information about the quantities of raw materials and fuels consumed by an industrial process and the quantities of waste materials and energy given out by this process as waste solids, liquids and gases. The results of such calculations provide the raw information needed to examine the relative importance of the different types of environmental problems.

6.2.4 LCAs in today's global economy

Over the last ten years there has been a rapid expansion in the demand for and the use of LCAs which are supported by both industry and governments. For industry, a major use is in characterising current operating practices, with a view towards how they stand in relation to current and proposed legislative measures (legal compliance). A series of LCAs performed by any company over consecutive years will fully determine that company's operating practices as well as establishing manufacturing trends and provides the basis for ecoindicators. For governments, awareness of the implications of proposed legislation, especially when the effects may counter those originally intended, can help in usefully amending legislation before it is adopted. A suitable example of this is the setting of realistic recycling targets.

For enterprises in rapidly emerging economies, ready access to up-to-date technologies and know-how is vital. Joint ventures with companies in the West for such an access is now an established approach. For the interested companies, particularly in large and populous countries, an ideal selling point would be the demonstration of their full awareness of the environmental aspects of their operations and adherence to regulations. This is where LCA, as an internationally accepted methodology for establishing full environmental credentials, would be invaluable. Equally, the application of LCA as a management tool, preferably implemented in a well-established environmental management system, could identify optimum strategies for the interested companies to become resource and energy efficient to world-class standards.

6.2.5 Application fields of LCAs

Today LCAs touch diverse sectors, not only with various product groups (foods, detergents, packagings, chemicals, electronics, etc.) but also with differentiated applications, i.e. product comparisons, overall assessments of enterprises, process optimisation, product development and design. With all their options and facilities, LCAs allow an innovative, environmentally favourable development (EcoDesign). In opposition to the still frequent "end-of-pipe" measures, LCAs offer (particularly in product development) global solutions and an integrated eco-technology.

In parallel with the growing concern about today's environmental problems, the interest of the general public in LCAs has increased. The users of this innovative tool have immediately realised that standardisation is imperative in order to grant a real opening for this new instrument. The simple need for an objective comparison of LCAs, elaborated by diverse companies/institutes, is an appeal for common rules.

Various international and European committees handle the standardisation of the LCA methodology, in particular SETAC (Society of Environmental Toxicology and Chemistry) and ISO. Most of the procedures for goal definition, scoping and inventory analysis have been defined and are now established. As to LCA phases of impact assessment and interpretation standardisation is more difficult., because these two steps are strongly characterised by subjective actions.

6.2.6 Technical framework

Although industry is primarily concerned with the marketing of products, it is the product-system that is of importance in an LCA. An industrial system is defined as any collection of operations which, when acting together, perform some defined function. Such functions may vary from the delivery of milk to a consumer on one hand to the cleaning of dirty laundry, on the other.

The initial system boundary defines the unit processes which are included in the system to be modelled. Ideally, all material and energy inputs into the system are traced back to their extraction from the Earth, and all releases associated with these materials and energy inputs into the system's environment are quantified. Such an extended system therefore consists of three main groups of operations, as shown in Figure 6.3. These are the main production sequence, the production of ancillary materials and the energy production industries involved.

A series of individual production steps divides the life cycle. These steps are often separated geographically, in which case transportation to the next operation site is required. The output of one unit process becomes the input for one or more consecutive processes. The boundaries of each process have been, to some extent, set arbitrarily and depend directly on the complexity of a process and on the location of individual production sites. The reason for dividing a product system into its component unit processes is to facilitate the identification of the inputs and outputs of the product system.

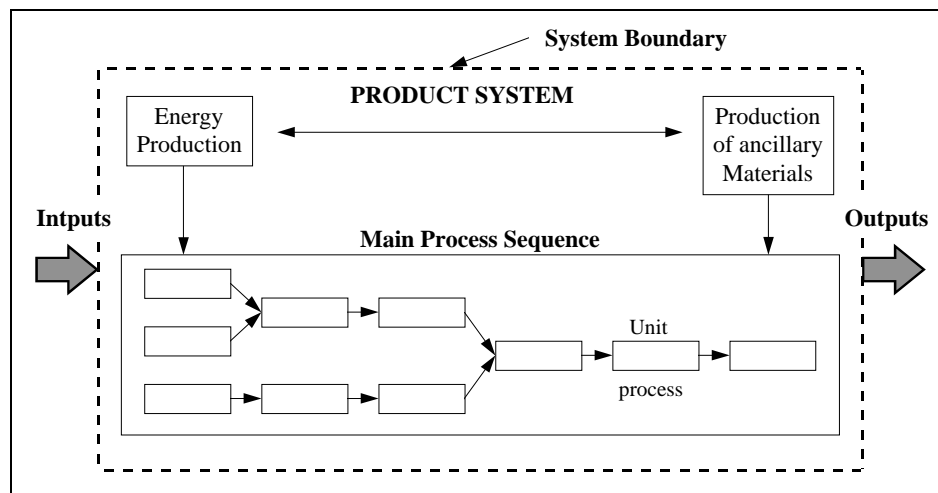


Figure 6.3: Example of a product system for LCA

6.2.7 Life cycle inventory analysis (LCI)

Inventory analysis is the phase of the LCA which involves the compilation, quantification and calculation of environmentally relevant inputs and outputs of a product system. These inputs and outputs may include the use of energy and resources as well as releases to air, water and land associated with the particular system. Some interpretation can already be drawn from these data, depending on the goals and scope of the LCA.

Data, either collected or calculated, are utilised to quantify the inputs and outputs of each individual unit process. Figure 6.4 shows the major headings under which data may be categorised.

Within these headings, the individual data categories will be further detailed to satisfy the goal of the study. For example, under emission to air, data categories such as carbon dioxide, carbon monoxide, sulphur oxides, nitrogen oxides, etc. may be separately identified.

In order to carry out the LCI calculations, the system is put together from a set of unit processes, each of which produces a single output. However, in practice, few operations satisfy this condition. Most commonly, industrial processes yield multiple products (e.g. chlor-alkaline electrolysis leads to NaOH, chlorine and hydrogen). It is therefore necessary to partition/allocate the characteristics of the system between these products using some procedure which most closely approximates to the physical behaviour of the unit process.

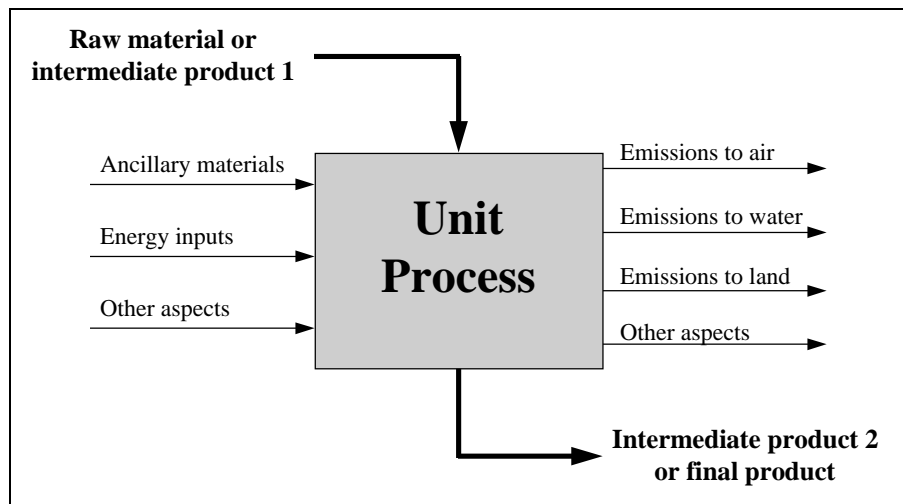


Figure 6.4: Example of a unit process within a product system

6.2.8 Life cycle impact assessment (LCIA)

The impact assessment phase of LCA aims to examine the product system from an environmental perspective using category indicators, derived from the results of the inventory. In other words, this process involves linking inventory data with specific potential environmental impacts and understanding those impacts. The general framework of the LCIA phase is composed of several mandatory elements that convert the LCI results to indicator results (Selection of impact categories, classification and characterisation). ISO 14042 describes and gives general guidance for the LCIA.

In addition there are optional elements for normalisation, grouping or weighting of the indicator results and data quality analysis techniques. The LCIA phase is only one part of a total LCA study and shall be coordinated with other phases of LCA. The elements of LCIA are illustrated in Figure 6.5.

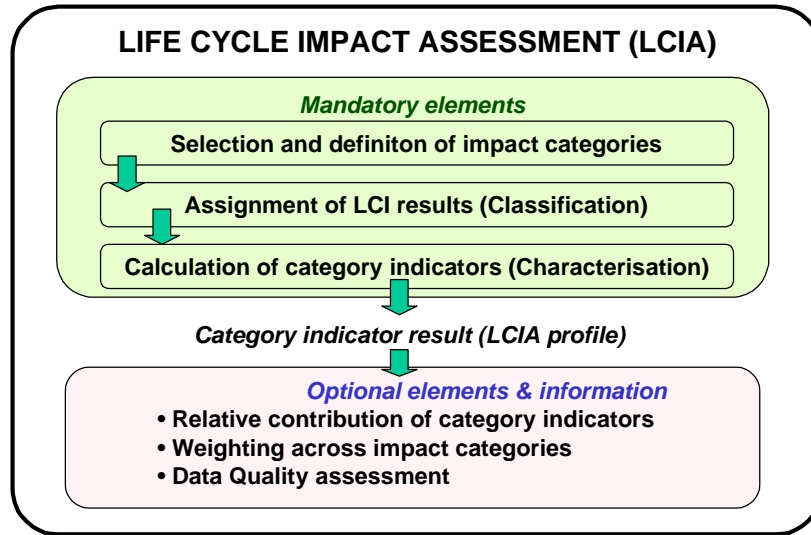


Figure 6.5: Elements of LCIA

6.2.9 Life Cycle Interpretation

In the interpretation, the results obtained from the inventory analysis and the involved elements of the impact assessment are summarised and discussed as a basis for conclusions, recommendations and decision-making in accordance with the goal and scope definition of the study (Figure 6.6).

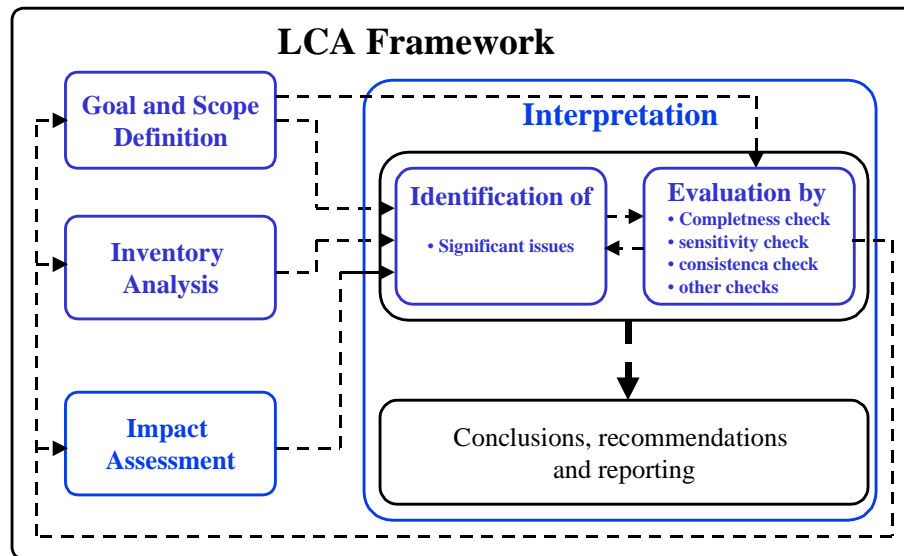


Figure 6.6: Relationship of the elements within the interpretation phase with the other phases of LCA

Life cycle interpretation is a systematic technique to identify, qualify, check and evaluate information from the results of the LCI and/or LCIA of a product system and present them in order to meet the requirements of the application as described in the goal and scope of the study. The practitioner undertaking the LCA study should be in close contact with the commissioner throughout in order to ensure that specific questions are addressed. Therefore, transparency throughout the life cycle interpretation phase is essential. Where preference, assumptions or value choices are involved, these need to be clearly stated by the LCA practitioner in the final report.

LCA is but one of several tools to help in decision-making, irrespective of the application for information or improvements. Life cycle interpretation may also demonstrate links, which exist between LCA and other environmental management techniques, by rationalising and focusing on the results. It is therefore important not only to go back from application to the life cycle interpretation phase of the LCA but also forward such as the concurrent use of other techniques. Life cycle interpretation includes communication to give credibility to the results of other LCA phases, namely the LCI and LCIA, in a form that is both comprehensible and useful to the decision maker.

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7 ENVIRONMENTAL LABELS (EL) - PRINCIPLES

7.1 WHAT IS AN ENVIRONMENTAL LABEL?

Environmental labels provide information about a product or service in terms of its overall environmental character, a specific environmental characteristic, or any number of characteristics. Purchasers can use this information in choosing the products they desire based on environmental as well as other considerations. The producer or provider of the product hopes the environmental label will be effective in influencing the purchasing decision in favour of its product. If the environmental label has this effect, the market share of the product can increase and other providers may respond by improving the environmental performance of their products, so enabling them to make environmental claims, resulting in reduced overall environmental impacts from that product category.

The International Standards on environmental labels employ a classification system covering some of the more common approaches to environmental labelling. At the time, many existing descriptions of approaches to environmental labelling were found to be interpreted somewhat differently by various groups when examined in detail. The proliferation of environmental claim created a need for environmental labelling standards which require that, where appropriate, life cycle considerations be taken into account when such claims are developed.

To date the Technical Committee 207 of ISO and its working groups have identified three types of ecolabels:

TYPE I (see chapter 7.5): Labels from independent third parties who award them to the best environmental performers in various product categories ("label of excellence"). The criteria are based on a life cycle approach. An example is the EU (European Union) ecolabelling scheme.

TYPE II (see chapter 7.4): Self-declared labels used by manufacturerers to make environmental claims about their products. The most well known of these is the recycling symbol composed of three arrows forming the Moebius loop.

TYPE III (see chapter 7.6): A much less common label licensed by independent organisations. This label serves as a report card, providing quantitative information (based on LCA data) on the possible environmental impact of a product and leaving it to the consumer to decide which product is best.

Certain approaches to environmental labels are not currently encompassed by one of the existing classifications. This simply reflects the fact that the classification system is a tool for identifying distinctions between approaches rather than any form of judgement. It is anticipated that the classification system will be broadened as the International Standardisation work progresses.

One major point, among other things, that is still under discussion is the concern about the discrimination against foreign products through eco-labelling programmes. Standards which allow for restrictive comparisons between products could adversely affect the competitiveness of products which cannot qualify for the label.

7.2 EL AND ISO

The ISO standard 14020 provides the basic principles for environmental labels and declarations. Additional details regarding self declaration, terms and definitions, testing and verifications are provided in the supplementary ISO standards 14021, 24 and 25.

The 14020 documents about environmental labels are a part of the ISO 14000 series and can also be seen – like LCA - as a very useful product-oriented support tool (see table 7.1). The use of environmental labels, based on accurate, non-deceptive and verifiable information, contributes to the overall goal of the EMS series by stimulating the potential for market-driven continual environmental improvement.

Table 7.1 EL and ISO 14000

Standard	Title	Date of Publication
ISO 14020	Environmental labels and declarations - General principles	International Standard (IS), 1998
ISO 14021 (TYPE II)	Environmental labels and declarations - Self-declared environmental claims (Type II environmental labelling)	International Standard (IS), 1999
ISO 14024 (TYPE I)	Environmental labels and declarations - Type I Environmental labelling - Principles and procedures	International Standard (IS), 1999
ISO 14025 (TYPE III)	Environmental labels and declarations - Environmental labelling TYPE III - Principles and procedures	Technical Report, 1999

7.3 BASIC PRINCIPLES OF ENVIRONMENTAL LABELS

According to ISO 14020 there are certain basic principles related to the use of environmental labels which are summarised below. These principles give a general guideline about the requirements of an environmental label:

1. Eco-labels shall be accurate, verifiable, relevant and not misleading.
2. Procedures and requirements for eco-labels shall not be prepared, adopted or applied with a view to or with the effect of creating unnecessary obstacles to international trade (!)
3. Eco-labels shall be based on scientific methodology that is sufficiently thorough and comprehensive to support the claim and that produces results that are accurate and reproducible.
4. Information concerning the procedure, methodology and any criteria used to support eco-labels shall be available and provided upon request to all interested parties.
5. The development of eco-labels should, wherever appropriate, take into consideration the life cycle of the product.
6. Eco-labels shall not inhibit innovation which maintains or has the potential to improve environmental performance.

7. Any administrative requirements or information demands related to eco-labels shall be limited to those necessary to establish conformance with applicable criteria and standards of the label.
8. The process of developing environmental labels and declarations should include an open, participatory consultation with interested parties. Reasonable efforts should be made to achieve a consensus throughout the process.
9. Information on the environmental aspects of products relevant to an eco-label shall be available to purchasers from the party making the eco-label.

7.4 SELF-DECLARATION ENVIRONMENTAL CLAIMS TYPE II (ISO 14021)

This standard deals with self-declaration environmental claims including statements, symbols and graphics. It establishes general guidelines regarding environmental claims in relation to the supply of products and services. The objective of this Intl. Standard is to harmonise the use of self-declared environmental claims.

It further defines and gives rules for the use of specific terms used in environmental claims. In this context it shall be noted that any environmental claim that is vague or non-specific or which broadly implies that a product is environmentally beneficial shall **not** be used (Figure 7.1).



Figure 7.1: Vague or non-specific environmental claims shall **not** be used

In contrast to these useless phrases the standard provides definitions and usage restrictions for selected terms commonly used in environmental claims. Specific terms which may be dealt with are for example:

- **Recycled material;** Material that has been reprocessed from recovered material by means of a manufacturing process and made into a final product or into a component for incorporation into a product.
- **Reduced resource use;** a reduction in the amount of material, energy or water used to produce or distribute a product or packaging or specified associated component.
- **Recovered energy;** gained from material that would have been disposed of as waste, but has instead been collected and converted into energy.
- **Solid waste reduction;** reduction in the quantity of material entering the solid waste stream due to a change in the product, process or packaging.
- **Extended life product;** a product designed to provide prolonged use, based on either improved durability or easier repair possibilities.
- **Reusable;** a characteristic of an item that has been conceived and designed to accomplish within its life cycle a certain number of trips, rotations or uses for the same purpose for which it was produced.
- **Refillable;** a characteristic of an item that can be filled with the same or similar products more than once, in its original form and without additional processing except cleaning or washing.
- **Designed for disassembly;** a characteristic of a product's design which enables the product to be taken apart at the end of its useful life and the parts re-used or recycled.

7.5 ENVIRONMENTAL LABELLING TYPE I (ISO 14024)

ISO 14024 relates to TYPE I environmental labelling programmes which award their eco-label to products which meet a set of predetermined requirements. The label thus identifies products which have been selected as a preferred environmental choice within a particular product category. This Intl. Standard establishes the principles and procedures for developing TYPE I environmental labelling programmes, including the selection of product categories, product environmental criteria and product function characteristics; and for assessing and demonstrating compliance. This Standard also established the certification procedures for awarding the label.

Environmental labelling TYPE I is voluntary and third party awarded. It can be operated by public or private agencies and can be national, regional or international in nature. The overall goal of a TYPE I eco-label is to contribute to a reduction in the environmental burdens and impacts associated with products, through the identification of products claiming overall environmental preference.

The criteria for environmental labelling shall be based on indicators arising from life cycle considerations. The following matrix is shown as an example of this approach (Table 7.2). The matrix links the stages of the product systems life cycle with the major environmental input and output indicators. The emission indicators are grouped by media and usually include more than one per medium. The analysis of the life cycle stages could lead to the consideration that environmental impacts in some stages are insignificant and therefore do not warrant further

consideration. Regardless, the study must show that the selection of criteria will not lead to the transfer of impacts from one stage of the life cycle to another or from one medium to another.

Such a life cycle approach to define eco-label criteria for a product is directly linked to the findings of a life cycle assessment. Therefore the two series ISO 14040 and 14020 are strongly related and create a useful addition to the basic ISO 14001 standard on Environmental Management System.

Table 7.2: Product environmental criteria selection matrix

Stage of the Life Cycle	Environmental Input/Output Indicator					
	Energy	Resources	Emissions to			Other
	Renewable/ Non Renewable	Renewable/ Non Renewable	Air	Water	Soil	
Resource Extraction						
Production						
Distribution						
Use						
Disposal						

7.6 ENVIRONMENTAL LABELLING TYPE III (ISO TR 14025)

Such TYPE III declaration represents quantified environmental data for a product with pre-set categories of parameters based on ISO 14040-series of standards but not excluding additional environmental information provided within a TYPE III environmental declaration programme. This means results from other environmental analysis tools might also be used to provide additional environmental information. This could include for example relevant elements of sustainable development such as economic or social elements.

TYPE III labelling involves an independent body collecting life cycle environmental data about the product in question and presenting it in a simple form on the label as a sort of report card. This card shows how the product rates in terms of environmental indicators, such as use of energy, natural resources, emissions to water and solid waste production. The labels in the one existing scheme use bar graphs to represent how the product compares on these indicators against other products in the same category.

In many ways TYPE III labelling has parallels with nutritional information, and the promoters expect the environmentally-conscious to become as familiar with these graphs as the health-conscious are with recommended daily intakes of various nutrients.

Within ISO, a project to develop an International Standard on TYPE III labelling is being handled in a special task group under ISO/TC 207/SC 3/WG1. Because TYPE III is closely linked to life cycle assessment, the task group includes leading scientists working on the practical application of LCA, many of whom participate in ISO/SC5 on LCA.

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8 SOME INFORMATION SOURCES ABOUT DIFFERENT ENVIRONMENTAL TOOLS

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 - ISO 14 040: LCA - Principles and framework; Standard 1997, Brussels
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8.2.3 Addresses

AENOR	Asociacion Espanola de Normalizacion y Certificacion Fernandez de la Hoz 52, 28010 Madrid, Espana Phone +34 91 432 60 00, Fax: +34 91 310 36 95
Chainet	European Network for chain analysis for environmental decision support: http://www.leidenuniv.nl/interfac/cml/chainet.hp22.htm c/o CML, Leiden University, P.O. Box 9518, NL-2300 RA Leiden, The Netherlands, Phone: +31-71-5275653, Fax: +31-71-5275587, e-mail: chainet@rulcml.leidenuniv.nl .
CML	Centre of Environmental Science, Leiden University: P.O. Box 9518, NL-2300 RA Leiden, The Netherlands, Phone: +31-71-5275653, Fax: +31-71-5275587, http://www.leidenuniv.nl/interfac/cml
EEA	European Environment Agency: http://tiger.eea.eu.int/projects/EnvMaST/lca/default.htm : Information on LCA
EMPA	Swiss Federal Laboratories for Material Testing and Research Ecology Section, Lerchenfeldstrasse 5, CH-9014 St. Gallen, Phone +41 71 274 74 41, Fax: +41 71 274 78 62, http://www.empa.ch
ESU	Life Cycle Inventories for Energy Systems: c/o Laboratorium für Technische Chemie, ETH Zürich, Zentrum-UNL, CH-8092 Zürich, Phone: +41-1-632 71 45, Fax: +41-1-632 12 83
ICONTEC	Instituto Colombiano de Normas Tecnicas y Certificacion Carrera 37 52-95, Apartado 14237, Santafe de Bogota, Colombia Phone: +571 315 03 77, Fax: +571 222 14 35
IVAM	Environmental Research, University of Amsterdam: Plantage Muidergracht 14, 1018 TV Amsterdam, P.O. Box 18180, 1001 ZB Amsterdam, The Netherlands, Phone: +31-20-5255080, Fax: +31-20-5255820, http://www.ivambv.uva.nl
ISO	International Standardization Organization: 1, rue de Varembe, C.P. 56, CH-1211 Genève 20, Switzerland. Phone +41 22 749 01 11, Fax +41 22 733 34 30, E-mail: central@iso.ch , http://www.iso.ch ISO 14000 Info Center: http://www.iso14000.com/

IWÖ	Institut für Wirtschaft and Ökologie, (Institut for Economy and Ecology) University St. Gallen Tigerbergstr. 2, CH-9000 St. Gallen, Phone: +41 71 224 25 95, Fax: +41 71 222 93 79,
OECD	Organisation for Economic Co-operation and Development: 2, rue André-Pascal, F-75775 Paris CEDEX 16, France Tel: (33) 01.45.24.82.00, Fax: (33) 01.45.24.85.00, webmaster@oecd.org , http://www.oecd.org
Pré Consultants	Product Ecology Consultants: PRé Consultants BV, Plotterweg 12, NL-3821 BB Amersfoort, The Netherlands Phone: + 31 33 4555022, Fax: + 31 33 4555024, E-mail: info@pre.nl , http://www.pre.nl/
SETAC-Europe	Society of Environmental Toxicology and Chemistry Europe: Avenue E. Mounier 83, Box3, 12000 Brussels, Belgium, Phone: +32-2-7727281, Fax: +32-2-7705386, e-mail: setac@ping.be , http://www.setac.org/eurplca.html
Sinum GmbH	Corporate Environmental Management, LCA Software Division PO Box: 1957, CH-9001 St. Gallen, Phone: +41 71 274 71 72, Fax: +41 71 274 71 72, sinum@sinum.com
UNEP	United Nations Environment Programme Industry and Environment: 39-43, Quai André Citroen, 75739 Paris CEDEX 15, France, Phone: +33-1-44371450, Fax: +33-1-44371474, http://www.unepie.org

8.2.4 More internet pages

<http://www.ecosite.co.uk/>

<http://www.cfd.rmit.edu.au/dfe/lca.html>

<http://www.tiac.net/users/tgloria/lca.html>

<http://www.trentu.ca/faculty/lca/>

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