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MEDITERRANEAN ACTION PLAN

MED POL

GUIDELINES FOR THE APPLICATION OF BEST AVAILABLE TECHNIQUES (BATs), BEST ENVIRONMENTAL PRACTICES (BEPs) AND CLEANER TECHNOLOGIES (CTs) IN INDUSTRIES OF THE MEDITERRANEAN COUNTRIES

GEF

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The thematic structure of the MAP Technical Series is as follows:

- Curbing Pollution
- Safeguarding Natural and Cultural Resources
- Managing Coastal Areas
- Integrating the Environment and Development

FOREWORD

The riparian States of the Mediterranean Sea, aware of their responsibility to preserve and develop the region in a sustainable way, and recognizing the threat posed by pollution to the marine environment, agreed in 1975 to launch an Action Plan for the Protection and Development of the Mediterranean Basin (MAP) under the auspices of the United Nations Environment Programme (UNEP) and, in 1976, to sign a Convention for the Protection of the Mediterranean Sea against Pollution (the Barcelona Convention). The Convention entered into force in 1978 and was amended in 1995.

Recognizing that pollution from land-based activities and sources has the highest impact on the marine environment, the Contracting Parties to the Barcelona Convention signed in 1980 a Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources (LBS Protocol). The Protocol entered into force in 1983 and was revised in 1996 to better cover industrial pollution sources and activities and to enlarge the coverage to include the hydrologic basin.

A Strategic Action Programme (SAP MED) to address pollution from land-based activities, which represents the regional adaptation of the principles of the UNEP Global Programme of Action (GPA) to address land-based pollution activities, was adopted by the Contracting Parties to the Barcelona Convention in 1997 as a follow up to the provisions of the revised LBS Protocol. The SAP MED identifies the major pollution problems of the region, indicates the possible control measures, shows the cost of such measures and establishes a work plan and timetable for their implementation.

In order to assist the Mediterranean countries in the long-term implementation of the SAP MED, particularly in the formulation, adoption and implementation of National Actions Plans (NAPs), a three-year GEF Project "Determination of priority actions for the further elaboration and implementation of the Strategic Action Programme for the Mediterranean Sea" was implemented by MAP, and in particular by the MED POL Programme, the MAP Regional Activity Centres and WHO/EURO. The project consists of numerous activities which include, among others, the preparation of regional guidelines and regional plans, whose main aim is to guide and assist countries to achieve the pollution reduction targets specified in SAP MED.

The present document is part of a series of publications of the MAP Technical Reports that include all the regional plans and guidelines prepared as part of the GEF Project for the implementation of the SAP MED.

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EXECUTIVE SUMMARY

In the following executive summary, the objectives, structure and content of the ***Regional Guidelines for the application of Best Available Techniques (BATs), Best Environmental Practices (BEPs) and Cleaner Technologies (CTs) in industries of the Mediterranean countries*** are introduced in a synthesized way to make the detailed chapters of the Guidelines easier to read.

1. Scope and objectives of the Guidelines

The aim of the guidelines is to provide a methodology of regional scope to facilitate the identification and application of BATs, BEPs and CTs in the industries of the Mediterranean Action Plan (MAP) countries: Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Morocco, Serbia & Montenegro, Slovenia, Spain, Syria, Tunisia and Turkey.

These guidelines have been elaborated using the guidelines provided by the following **general framework**:

- **The Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (LBS Protocol, 1996).** The LBS Protocol is based on the concept of sustainability and its aim is to achieve integrated prevention and control of the pollution originated by land-based sources and activities, particularly by means of applying the **Best Available Techniques (BATs), Best Environmental Practices (BEPs) and Cleaner Technologies (CTs)**.

- **The Strategic Action Programme (SAP, 1997) to address pollution from land-based activities.** The SAP establishes priorities and deadlines to implement action plans, programmes and measures in the different MAP countries, therefore facilitating the implementation of the LBS Protocol.

- **The GEF project "Determination of priority actions for the further elaboration and implementation of the Strategic Action Programme for the Mediterranean Sea (1998)".** This project is currently being developed with the Global Environment Facility (GEF) funding and includes, among other things, preparatory actions for the elaboration and implementation of regional guidelines and plans. More specifically, the project asserts the development of 50 main activities, one of them being the elaboration of regional guidelines addressed to facilitate the application of BATs, BEPs and CTs in the industrial activities that take place in the MAP countries.

These guidelines are addressed, specifically, to the industrial activities and polluting substances listed in Annex I of the **Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (LBS Protocol).**

2. Definitions

To facilitate the correct understanding of the framework in which the methodology included in these guidelines has been defined, the concepts of BAT, BEP and CT are presented below. These definitions are explained in greater detail in chapter 2 of these guidelines.

- **Best Available Techniques (BATs)**

The term **"best available techniques"** means the latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste.

Revised version of LBS Protocol (1996 Syracuse, Italy)

- **Best Environmental Practices (BEPs)**

The term **"best environmental practices"** means the application of the most appropriate combination of environmental control measures and strategies.

Revised version of LBS Protocol (1996 Syracuse, Italy)

- **Cleaner Technologies (CTs)**

Cleaner Technology may be thought of a subset of Cleaner Production activities with a focus on the actual manufacturing process itself and considers the integration of better production systems to minimise environmental harm and maximise production efficiency from many or all inputs.

United Nations Environment Programme (UNEP)

3. Methodology for determining and implementing BATs, BEPs and CTs in a given company

This methodology consists of 7 basic consecutive stages. Only if these 7 stages are carried out, a reliable selection of the BATs, BEPs and CTs for the company in question will be assured.

These 7 stages are:

1. **Determining the key environmental aspects in the company**

   The environmental aspects are defined as the causes of the environmental impacts which are produced as a consequence of the production processes and the auxiliary activities in the industry or sector in general, during the whole life cycle of the company's activities.

   At the first stage the company has to identify and quantify its environmental aspects, balancing the inputs and outputs of both energy and materials of its industrial activity.

   Once the environmental aspects have been identified and, whenever possible, quantified, the second step will be evaluating and considering the environmental impacts associated with each identified environmental aspect, in either a quantitative or qualitative way**. The assessment identifies the major environmental impacts, and therefore the key environmental aspects within the specific industry.**

2. **Definition of the specific objectives of the company**

   Once identified the key environmental aspects of the company, the objectives to be achieved by implementing the BATs, BEPs or CTs need to be defined. These objectives have to be acceptable, precise, viable, and coherent with the objectives of the other areas of the company, and, at the same time, they have to be linked to the key environmental aspects of the company.

   As a result of this process, the company will obtain a list of objectives that have to be met through the election of its BATs, BEPs or CTs.

3. Identifying options to address successfully the key environmental aspects

Once the company's key environmental aspects and objectives have been determined, the company has to identify the options (techniques, practices or technologies) available to prevent or reduce at source the environmental impact that the company's activity is generating. As a result of this process and according to a preventive business policy, several options will be proposed that need to be further assessed.

In these guidelines we understand **options** as those **techniques, practices and technologies** that individually (one option) or in a combination (a set of options), may constitute the BATs, BEPs and CTs of a given company.

As a result of this process, the company will obtain a list of the options available to address the key environmental aspects, justifying the reasons why they are recommended.

4. Assessment of the options identified

With the assessment presented at this stage, the objective is to determine as quantitatively as possible which are the viable options for a given company.

This viability analysis plays a key role in the BATs, BEPs and CTs election process, underestimating those options that, either for environmental, technical or economic reasons, are not viable. Therefore, the evaluation of each option is composed of environmental, technical and economic assessments, detailed as follows:

- In the first place, the **environmental assessment** of the options. In case that the option does not provide significant environmental benefits, it will have to be rejected from the start. For all the environmentally viable options, the company will have to proceed to a technical assessment.

- The **technical assessment** of the options will enable finding what effect will applying an option have on the development of the company's daily activity and also knowing if the personnel needs extra training, equipments, within other things. For all the environmentally and technical viable options, the company will have to proceed to an economic assessment.

- The **economic assessment** will have to identify the options that provide economic benefits, sufficient to pay back the investment made (in case that an investment was necessary) in a reasonable period of time. Therefore, it also identifies which options will be rejected under economic assessment.

From this assessment, a list will be obtained of the viable and non-viable options for that given company.

5. Selection of BATs, BEPs and CTs for the given company

Finally, once the options have been identified and assessed, the company has to proceed to the final selection. At this stage, apart from the basic criteria and constraints evaluated at the third stage other general criteria and constraints need to be introduced to facilitate the selection of the options entailing more benefits to the environment as well as to the company.

The following general criteria and constraints are essential to make an appropriate selection of the BATs, BEPs and CTs.

- The **intangible benefits** related to the introduction of a particular option carried out to prevent pollution have a variable nature, and are specific to each company: an increase of the product's quality, image improvement, improvement of the working conditions, ...

- The **local environment conditions** (degree of pollution, protected natural areas, sensitive areas,...) and the geographical bcation (population density, water availability,…) of a given company are also taken under consideration in the election of the BATs, BEPs and CTs, together with the intangible benefits, being therefore another element that contributes to the decision making.

As a result of this analysis, the options (either techniques, practices or technologies) identified as the Best Available Techniques (BATs), Best Environmental Practices (BEPs) and Cleaner Technologies (CTs) for the company in question will have been determined.

6. **Implementation of BATs, BEPs and CTs in a given company**
   Once the BATs, BEPs and CTs of the company have been chosen, the company will have to look at several factors that might contribute to the successful implementation of the options. Notably, the company will have to assign responsibilities, train the workers, design a communication strategy of the actions (for both internal and external purposes), study space redistribution, manage adequately the documentation being generated, and carry out eventual trials and tests, if needed.

   As a result of this process, the company will have laid the ground to ensure a successful implementation of the BATs, BEPs and CTs.

7. **Monitoring and continual improvement**
   Even though the options have been defined and introduced in the company, this is not a one time procedure but has to be updated. Certainly, the company and the environment are not static and therefore, the BATs, BEPs and CTs do not remain the same. We have to take into account that the companies keep introducing changes in their processes as the market changes.

Therefore, the 7 stages of the guidelines' methodology have to be repeated frequently, to assure that the best options are used at every moment and that a continual improvement of the company takes place. There is a possibility that the options that were rejected once can be viable for the company in the future.

4. Resources for the implementation of the methodology

There are various resources available to the companies in the MAP countries that can facilitate carrying out the methodology developed in these guidelines. Chapter 5 includes a brief of these resources, indicating for what stage of the methodology they can be useful.

- MOED: Minimisation Opportunities Environmental Diagnosis
- GHPP: Good Housekeeping Practices Programme
- LCA: Life Cycle Assessment
- BREFs: Best Available Techniques Reference Documents
- Sector studies of RAC/CP

In this sense, during the use of any of these resources, the assessment of an expert in the subject is highly recommended.

5. Case studies of introducing BATs, BEPs and CTs in the MAP countries

6 practical cases of industries established in the MAP countries that have applied BATs, BEPs or CTs are shown in chapter 6 of the guidelines.

These examples of companies that belong to different industrial sectors show that implementing BATs, BEPs or CTs is viable, when the criteria defined in these guidelines are followed.

6. Conclusions and recommendations

The **main conclusions** that can be extracted from these guidelines are:

- The methodology proposed contemplates **integrated pollution prevention and control as a priority** for the reduction of industrial pollution.

- The environmental policy included in the presented methodology **enables business interests to be compatible with environmental protection**, which become increasingly key when valuing a company's image.

- The methodology presented is **applicable to any company** regardless of its size and the industrial sector it belongs to.

- This methodology enables **identifying the key environmental aspects** and facilitates the **identification of viable and feasible improvement** options for any specific company.

In this sense, it has to be taken into account that, even though these guidelines present a common methodology for all companies, the application method will be different for each company. Consequently, the guidelines also present a few recommendations to be taken into account by the companies, among which the following ones can be highlighted:

- **No environmental aspect should be rejected** during the determination of the key environmental aspects.

- In order to define the objectives that the company aims to meet by implementing the BATs, BEPs and CTs, it has to be highlighted that these objectives have to be established on the basis of consensus, and they have to be **acceptable**, **precise**, **viable, and coherent** with the objectives of the other areas of the company.

- During the identification of the options addressed to face the key environmental aspects of the company, **no option should be rejected before assessing it** (options that at first glance had a doubtful viability may be viable after assessing them, both on their own or combined with complementary options).

- During the assessment of the options identified, the proposed **ones have to avoid to transfer pollution from one medium to another (cross-media effects)** and setting up a multidisciplinary team for the assessment is highly advisable.

- During the election of the BATs, BEPs and CTs of the specific company, **the options selection will be carried out taking into account the specific company criteria and constraints** (intangible benefits, local conditions, ...) **and its geographical location** (lack of water resources, climatology, ...).

- During the implementation of the BATs, BEPs and CTs of the company, **specific parameters that play an important role in this stage have to be taken into account**: assignment of responsibilities, training and awareness raising among the workforce, communication of the actions (internal and external), redistribution of space and documentation where this process will be registered.

- During the pursuit and process of continual improvement, **options that at a certain time were non-viable for the company but may become viable later on have to be taken into account.** Therefore, it is necessary to apply periodically the methodology presented in these guidelines.

1. INTRODUCTION

The Regional Activity Centre for Cleaner Production (RAC/CP) of the Mediterranean Action Plan has prepared these regional guidelines as one of the components of the GEF Project *Priority Actions for the further elaboration and implementation of the Strategic Action Programme to Address Pollution from Land-Based Activities (SAP).* For carrying out these regional guidelines, RAC/CP counted on the collaboration of the consultancy Private Foundation Institut Cerdà.

1.1 Scope and Objectives of the Guidelines

The aim of the guidelines is to provide a methodology of regional scope to facilitate the identification and application of BATs, BEPs and CTs in the industries of the Mediterranean Action Plan (MAP) countries: Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Morocco, Serbia & Montenegro, Slovenia, Spain, Syria, Tunisia and Turkey.

Specifically, these guidelines are addressed to the industrial activities and the polluting substances listed in Annex I of the **Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (LBS Protocol):**

- Concerning the **industrial activities**, they can be included on the main following categories: manufacturing industry, waste management, extractive industry and energy production.
- Concerning the **polluting substances**, the LBS Protocol establishes a list of 19 substances as a reference to be considered by the MAP countries. These categories are detailed in Annex I C of the LBS Protocol and in chapter 4 of these guidelines.
- Concerning the **characteristics of the polluting substances**, these include 13 categories that include from bioaccumulation in the environment to radioactivity. These characteristics are detailed on the LBS Protocol Annex 1B.

1.2 Structure

The Guidelines are structured in 9 chapters and an executive summary. The content of each chapter consists of the following:

The **executive summary** describes briefly the guidelines' objectives, structure and the content in order for the company to have easier access to the information and the guidelines' methodology.

Chapter 1 identifies the guidelines' scope and objectives, the methodology used to compose the guidelines and a brief description of the guidelines' regional framework.

Chapter 2 describes the principles and concepts of the guidelines' regional framework. Specially the integrated prevention and pollution control principle, as well as the definitions of BAT, BEP and CT.

Chapter 3 presents the methodology developed in these guidelines, its structure, its contents and some general aspects to be taken into account by those companies who want to carry it out.

Chapter 4 develops the guidelines' main objective, and more specifically, provides a methodology of regional scope to make easier the identification and application of the BATs, BEPs and CTs in the industries of the Mediterranean Action Plan (MAP) countries. For this purpose, seven basic stages that should be carried out consecutively in order to achieve a satisfactory result are described:

- Determination of the key environmental aspects.
- Definition of the specific objectives of the company.
- Identification of the options to address the key environmental aspects of the company.
- Assessment of the options identified.
- Selection of BATs, BEPs and CTs for a given company.
- Implementation of BATs, BEPs and CTs for a given company.
- Monitoring and continual improvement.

Chapter 5 describes the resources available to the industry for identifying the possible improvements that could result from the BATs, BEPs and CTs application. The resources are the following:

- Minimisation Opportunities Environmental Diagnosis (MOED).
- Good Housekeeping Practices Programme (GHPP).
- Life Cycle Assessment (LCA).
- Best Available Techniques Reference Documents (BREFs).
- Sector studies of the Cleaner Production Regional Activity Centre (RAC/CP).

Furthermore, external expert support is highly recommended throughout the process of carrying out the methodology.

Chapter 6 presents practical cases of industries in the MAP countries that have successfully implemented BATs, BEPs and CTs.

Chapter 7 contains a summary of the main conclusions and recommendations to carry out the methodology proposed in these guidelines.

Chapter 8 includes a glossary with the definitions of the main concepts used in these guidelines, like, for example, environmental impact or environmental aspect.

And finally, on **chapter 9** the references used for the elaboration of the guidelines are detailed. These references are mainly the regional reference framework, as well as previous integrated prevention and pollution control handbooks and guidelines addressed to the industry at different levels (regional, state and international).

1.3 Working Methodology

The methodology used to compose the guidelines has been based on the following actions:

A	Analysis of the regional reference framework where the guidelines are developed: legislation, programs, plans, conventions and Mediterranean protocols.
B	Identification of the general and basic criteria to take under consideration for determining the BATs, BEPs and CTs in the MAP countries.
C	Description of some of the relevant resources available to the industry for carrying out several or all the stages of the guide's methodology.
D	Research of successful experiences in MAP countries that have implemented BATs, BEPs and CTs, according to environmental, technical and economical criteria.
E	Conclusions and recommendations.

1.4 General Framework

The Mediterranean region is one of the regions with more population and tourists of the world. The Mediterranean water bodies host the greatest biodiversity in Europe, and are the habitat for a large number of species affected by various human activities such as environmental pollution, fishing, uncontrolled urbanization and industrial activities.

The countries of the Mediterranean basin elaborated the **Mediterranean Action Plan (MAP)** in 1975, conscious of the economical, social and cultural value of their marine environment and of their responsibility to preserve and promote a sustainable development of their common heritage, for the benefit of present and future generations.

The MAP represents the framework for the cooperation of the Mediterranean basin countries in the adoption of measures, mainly to prevent and control pollution in the Mediterranean and for the protection and improvement of its marine environment. The countries that are participating in MAP are Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Morocco, Serbia & Montenegro, Slovenia, Spain, Syria, Tunisia, Turkey and the European Union.

With the objective of developing the MAP, a year after its approval, in 1976, the Convention for the Protection of the Mediterranean Sea against Pollution (the **Barcelona Convention**) was adopted, and, afterwards, a set of protocols foreseen by the Barcelona Convention, that established the measures, procedures and laws needed to guarantee the MAP application:

- Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft (Dumping Protocol).
- Protocol concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and other Harmful Substances in Cases of Emergency (Emergency Protocol).
- Protocol on Land-Based Sources (LBS Protocol).
- Protocol concerning Mediterranean Specially Protected Areas (SPA Protocol).

The United Nations Conference on Environment and Development in Rio de Janeiro (Brazil) in 1992 resulted in a new boost for the sustainable development concept to achieve, among other aspects, that the economic and social development is not associated with an increase of the consumption of natural resources nor the environment degradation. The main results of the conference were embodied in the Rio Declaration, in the conventions on Biological Diversity and Climate Change, in the Forest Principles and the Agenda 21.

Within this new international framework, and taking under consideration the possibilities of improvement and achievements of the first twenty years of the MAP, in 1995 the **Action Plan for the Protection of the Marine Environment and the Sustainable Development of the Coastal Areas of the Mediterranean (MAP Phase II)**, and also essential amendments of the Barcelona Convention and its protocols, were approved in Barcelona.

1.4.1 LBS Protocol

In 1996, the member countries of the Barcelona Convention signed in Syracuse (Italy) the revised version of the LBS Protocol, or **Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities.**

The adoption of the new LBS Protocol represents an important achievement in MAP's history towards the progressive implementation of the legal framework concerning pollution from land-based activities, and the adoption of measures to control industrial pollution, among other things.

The new LBS Protocol is based on the sustainability concept and aims to achieve integrated pollution prevention and control from land-based sources and activities, particularly through the application of the **Best Available Techniques (BATs), Best Environmental Practices (BEPs) and Cleaner Technologies (CTs)**.

According to this protocol, the MAP countries have made the commitment to elaborate and implement regional action plans addressed to prevent, as much as possible, pollution in the Mediterranean region caused by the waste and emissions generated by land-based industrial activities, giving priority to substances that are toxic, persistent or have a tendency to bioaccumulate. The following figure shows the objectives, the application scope and the main duties established in the LBS Protocol.

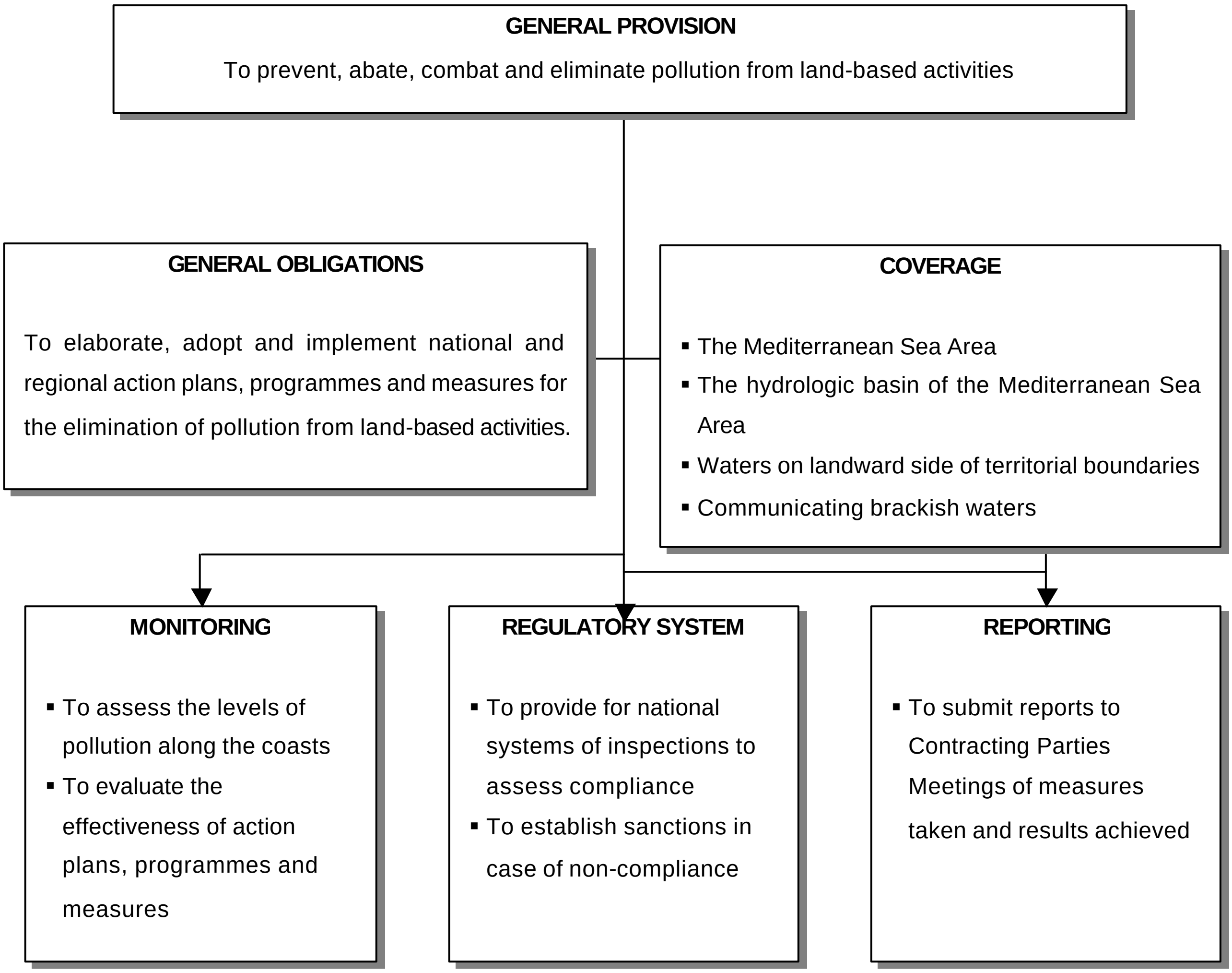

Figure 1.1 Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (Reference: UNEP/MAP 2001)

1.4.2 Strategic Action Programme (SAP)

According to the fifth article of the LBS Protocol, in 1997 the countries that signed the Barcelona Convention adopted **the Strategic Action Programme (SAP) to address pollution from land-based activities**, with the objective of establishing priorities and deadlines for the implementation of the action plans, programmes and measures in the different MAP countries.

The Strategic Action Programme (SAP) gives priority to integrated pollution prevention and control, considering it an important step towards a more sustainable balance between human activity and socio-economic development on one hand, and natural resources and the regeneration capacity of the environment on the other.

The SAP defines the objectives of minimising at source certain polluting substances originated by land-based activities, as for example the industries. The deadlines for accomplishing these objectives are defined according to the type of substance and a series of specific actions are proposed for each one: elaboration of regional guidelines, plans and programmes for information exchange, research and investigation, and the preparation of actions addressed to encourage citizen participation.

These actions are addressed both to urban environment and to industrial activities, establishing their responsibilities towards the generation of persistent toxic substances liable to bioaccumulate in the marine environment, giving special attention to the Persistent Organic Pollutants (POPs).

One of the actions proposed in the SAP is the elaboration of regional guidelines addressed to facilitate the application of BATs, BEPs and CTs in the industrial activities that take place in the MAP countries.

1.4.3 Mediterranean GEF Project

The SAP adoption and starting off activities for its implementation are a clear indicator of the determination of the MAP countries to carry out specific actions to prevent pollution from land by improving industrial processes, among other actions, and, at the same time, contribute to keep and restore the biodiversity, preserve human health and promote a sustainable use of the region's resources.

Shortly after its adoption, the SAP is recognized by the Council of the Global Environment Facility (GEF) as an important programme that deals with some of the most significant impacts regarding international waters. As a consequence of this recognition, in 1998 the GEF Council approved the Mediterranean GEF Project (2001-2003) funding a significant number of SAP activities which are essential for the programme’s success on the long term.

> The Global Environment Facility (GEF) provides grants and concessional funds to eligible countries for projects and activities that aim to protect the global environment. The United Nations Environment Programme (UNEP), the United Nations Development Programme (UNDP) and the World Bank implement it jointly.

Therefore, the project **“Determination of priority actions for the further elaboration and implementation of the Strategic Action Programme for the Mediterranean sea”** is currently being developed with Global Environment Facility (GEF) funds. This project includes, among others things, preparatory actions for the elaboration and implementation of regional guidelines and plans, investments for the elimination of priority hot spots of regional pollution, implementation and development of management plans for sensitive areas, economic instruments for SAP implementation, etc. The main actions included in the Mediterranean GEF Project are summarized in the following figure:

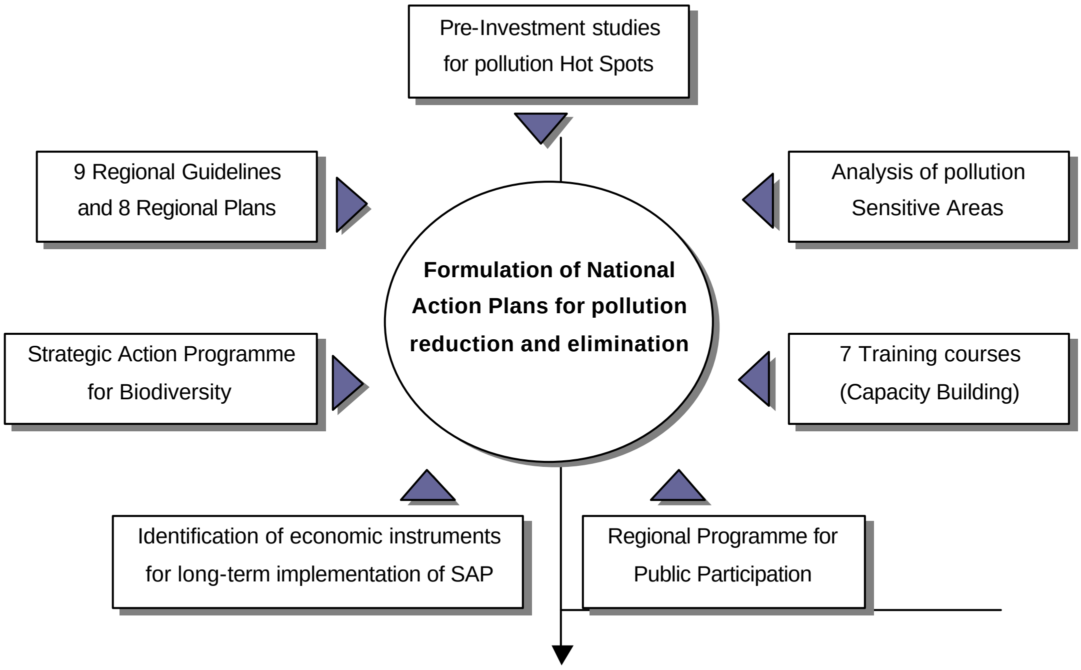

Figure 1.2 ***Mediterranean GEF Project outputs 2001-2003 (Reference: UNEP/MAP 2001)***

More specifically, the global objective of this project is to improve the quality of the environment in the Mediterranean region by means of a shared and better management of the pollution from land-based sources through international cooperation. To achieve this objective, the project establishes the development of 50 large activities, one of them being the elaboration of **regional guidelines addressed to facilitate the application of BATs, BEPs and CTs in the industrial activities of the MAP countries.**

These guidelines aim to be a useful tool for all the industrial activities that want to achieve an environmentally friendly production by implementing BATs, BEPs and CTs, and therefore;

- Optimising their processes by introducing environmental criteria.
- Studying in detail their waste flows in order to prevent them and the use of resources to minimise them.
- Optimising the environmental management costs.

Finally, a summary of the regional reference framework described in this chapter is presented, and, specifically, the history and main achievements on the preservation and sustainable development in the Mediterranean region since the Mediterranean Action Plan (MAP).

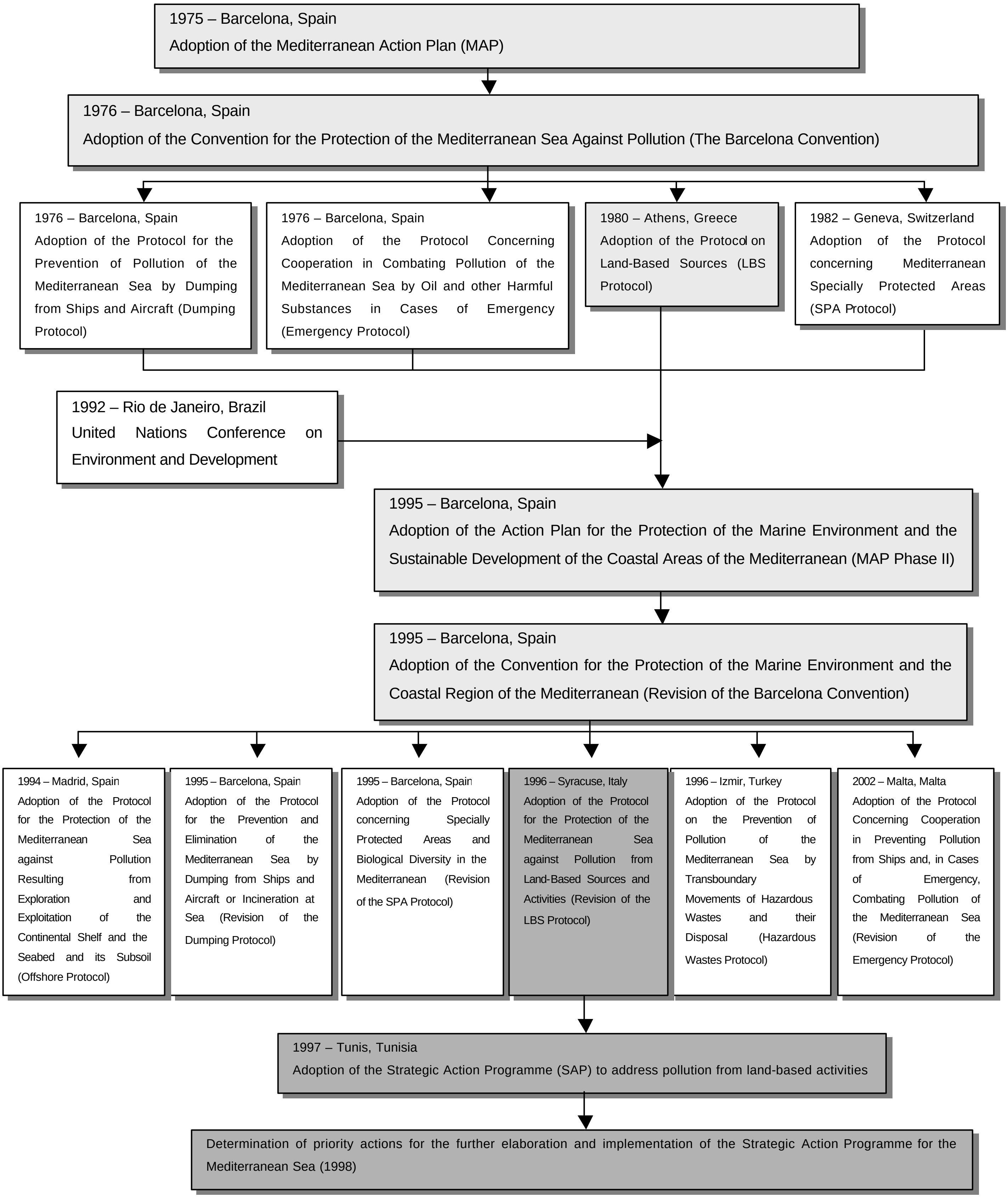

Figure 1.3 History and main achievements on the preservation and sustainable development in the Mediterranean Area since the Mediterranean Action Plan (MAP) adoption, 1975. (Reference: http://www.unepmap.gr)

2. BACKGROUND

The MAP Phase II is the origin of the guiding principles that should lead the signing countries to achieve the following objectives:

- to ensure sustainable management of natural marine and land resources and to integrate the environment in social and economic development, and land-use policies;
- to protect the marine environment and coastal zones through prevention of pollution, and by reduction and, as far as possible, elimination of pollutant inputs, whether chronic or accidental;
- to protect nature, and protect and enhance sites and landscapes of ecological or cultural value;
- to strengthen solidarity among Mediterranean coastal States in managing their common heritage and resources for the benefit of present and future generations; and
- to contribute to improvement of the quality of life.

In consonance with Rio's Earth Summit (1992), to accomplish these objectives a special emphasis is given to the introduction of the sustainable development concept in the various economic activities which have a significant impact on the environment: industry, agriculture, tourism, transport, and others.

One of these economic activities is **industrial development**, that puts certain pressure on the Mediterranean environment but that has also possibilities of improving the protection of the air, soil, water and quality of life in general. In this sense, in order to comply with the national and regional necessities and to prove the international and Mediterranean markets that a sustainable development is possible, the MAP Phase II recommends that industrial development should take into account the following objectives:

- encourage and facilitate the use of appropriate industrial procedures and CTs;
- facilitate the transfer, adaptation and control of technology among Mediterranean countries;
- consolidate and accelerate the introduction of programmes for the control and reduction of industrial pollution; and
- strengthen and expand programmes for the reduction and management of industrial waste.

In this chapter, the guidelines define the principles, strategic lines, action and concepts included in the MAP Phase II, in the Barcelona Convention and in the different protocols that develop it. These act as a reference framework for the guidelines, mainly **the integrated pollution prevention and control principle.**

2.1 Principles

▪ **<u>Eco-efficiency as an opportunity for the Mediterranean industry</u>**

Eco-efficiency consists of providing products and services with a competitive price that satisfy human needs and provide quality of life, while progressively reducing the ecological impact and the consumption of resources during the life-cycle of the product, down to an appropriate level according to the estimated carrying capacity of the environment.
Eco-efficiency is a goal that integrates two of the sustainability concepts: ecology and economy. It is understood as a management philosophy that encourages environmental improvements providing economic benefits. It also has to be understood as a business

opportunity that enables the industry to carry out a sustainable development and obtain more benefits. Eco-efficiency improves the efficiency of the procedures and habits that the company carries out, as well as stimulating creativity and innovation in the research of a new expression of the company.

The objectives of eco-efficiency that have a positive repercussion on the protection of the Mediterranean environment are the following:

- Decrease in the consumption of resources: using less amount of energy, materials, water, and land by promoting recycling and longer lasting products.
- Decrease in the environmental impact: includes the minimisation of emissions at source (air emissions, waste water or solid waste), an adequate waste disposal, the prevention of the dispersion of toxic substances and the promotion of the use of renewable resources instead of non-renewable ones.

The incorporation of eco-efficiency in the decision making concerning products and services offers a **great number of opportunities:**

a. If the company optimises the use of resources, this efficiency is translated into economic savings for both the company and its customers, due to both the reduction in the consumption of raw materials and the reduction of costs in treating emissions and waste.

b. On the other hand, the implementation of eco-efficiency measures also implies competitive advantages, like the generation of value by promoting new products and services that are environmentally friendly or the improvement of the company's image, two factors that have immediate repercussions on the industrial development and the company's sales.

All these economical benefits can often be generated with minimum investment and at the same time can finance the application of eco-efficiency measures of a higher complexity. This often means that eco-efficiency is self financed in the company. The investments on eco-efficiency usually have less risk than other kinds of investments, and can even bring additional intangible benefits (see section 4.5.1).

Dragging unnecessary costs (use of resources), carrying out an inefficient management, not evaluating nor controlling the processes and products, among others, are the disadvantages that affect the company's competitive capacity, as they deteriorate the company's image, making their products more expensive and generating less value, as well as exposing the company to unexpected costs and risks.

As a result, the company is interested in responding with anticipative and adapting strategies to the challenge of eco-efficiency in the Mediterranean industry. If the company does not introduce eco-efficiency measures now, the adaptation will be more difficult later, because the companies that have done it before will have greater capacity to compete and gain market quota, progressing from a more solid base and with a greater experience.

- **<u>Cleaner Production as a tool to improve eco-efficiency</u>**

Cleaner Production[1] is the continuous application of an integrated preventive environmental strategy applied to processes, products and services to increase overall efficiency and reduce risks to humans and the environment.

- With regard to production processes, cleaner production includes conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes.
- With regard to products, the goal of the strategy is to reduce negative impacts during the life cycle of a product, from the raw materials extraction to its ultimate disposal.
- With regard to services, this includes incorporating environmental concerns into designing and delivering services.

Cleaner production requires changing attitudes, responsible environmental management and evaluating technology options.

The hierarchy of cleaner production is detailed on the following figure:

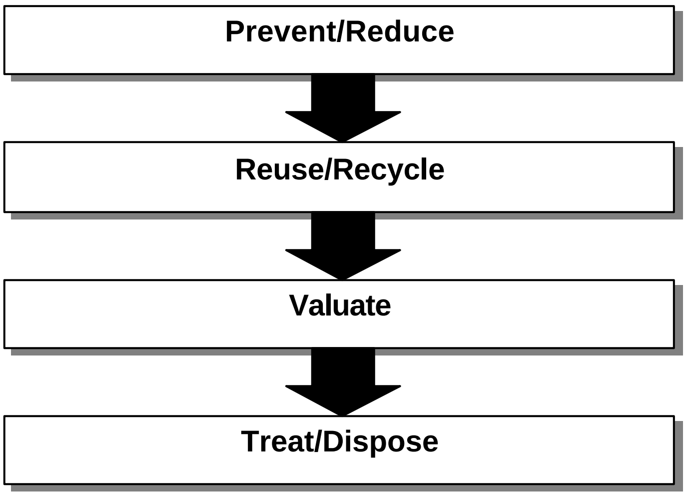

Figure 2.1 ***Environmental policy priorities (Reference: Minimisation Opportunities Environmental Diagnosis. Regional Activity Centre for Cleaner Production, 2000)***

Cleaner production is a **strategy of continuous, integrated, and preventive application** that can be applied to the company's processes, as much as to products and services. The objective is to prevent pollution and save resources. This should be possible for large companies as well as for small and medium-size ones.

Achieving cleaner production in the industry implies several **advantages compared to end-of-pipe treatment**, and this is the reason why it is preferable as a strategy for environmental management. End-of-pipe treatments, which are corrective measures, would be complementary.

The advantages related to cleaner production are mainly the following:

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[1] Reference: United Nations Environment Programme.

- Cleaner production is a business management strategy that goes beyond any specific goals that may arise on occasion, and entails a policy that takes all the productive process of a business into account.
- Cleaner production optimises processes taking place in the company, it enhances the adaptation to new trends towards process efficiency and facilitates the company's competitiveness and growth by improving its operating conditions.
- As a strategy incorporated within the production process, cleaner production automatically responds to the variations that this process may produce (increase in productivity, increase in the use of certain materials, ...) and can be applied to a specific process or to all the processes in a company, to different stages of a process or it can be started in stages according to the needs and possibilities of the company.
- Through the application of viable cleaner production measures, savings are made in the cost of waste flow treatment, and also significant savings in the consumption of water, energy, raw materials, among other things. At the same time, the optimisation of production processes brought about by cleaner production can lead to an increase in a business productivity due, for example, to time-saving which can be reinvested in the same industrial process.
- The adoption of cleaner production in industry as a strategy, based on preventing the generation of pollution and accomplishing a more efficient use of resources, is a more positive option for the environment.
- Cleaner production is an integral policy of involvement that improves the working structure and technical level of the industry. Moreover, it is a strategy that is adopted by the entire working force of a company, from machine operators to the managing director, and involves a prior learning awareness process that is reflected in better environmental and production practices.
- Cleaner production, like all the strategies that incorporate environmental criteria, is beneficial to the company's image.

▪ **<u>The principle of integrated pollution prevention and control</u>**

Applying the integrated pollution prevention and control principle to the industry (understanding environment as a whole that comprises water, air and soil) implies the need to take preventive measures when it is suspected with foundation that an activity may cause harm to the environment even if there is no absolute proof (**prevention principle**), or when it cannot be avoided by prevention, reducing the emissions into the atmosphere, water and soil, and the waste generation, favouring an equilibrium between human activity and economic development (**control principle**). Specifically, these principles are applied through the introduction of the BATs, BEPs and CTs in the industries.

This is precisely the hierarchy that has been described previously (cleaner production principle): preventing as a first option, and when that is not possible, reducing the pollution of a company on any field of the environment.

The **integrated approach** takes into account the emissions of the activities into the atmosphere, water and soil, including waste generation, with the objective of environmentally evaluating the activity as a whole and this way accomplishing a high level of protection for the environment.

- From a legislative point of view, this approach seeks minimisation at source of the emissions instead of transferring them from one environment to another, in order that water, atmosphere and soil are in equal conditions.

- From a technical and managerial point of view, therefore economic, the combined and integrated treatment of the environment facilitates decision making and rationalizes management. Specifically, it brings a global and planed solution instead of giving partial solutions that only respond to occasional needs, without taking under consideration the strategic lines of the company.

The implementation of a pollution prevention policy in the industry, apart from achieving environmental improvements, reduces the cost of the environmental management, facilitates the design of adequately sized treatment facilities, reduces the responsibility risks, improves the company's image and gives a higher degree of protection to the people and the environment.

The Annex I of the LBS Protocol, in consonance with the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, adopted in Washington, D.C. in 1995, gives priority to the prevention of substances that are toxic, persistent liable to bioaccumulate, in particular the Persistent Organic Pollutants, as well as to waste water treatment and management. When the reduction of these substances is not possible it is recommended to give special emphasis to the reduction of their toxicity.

2.2 Definitions

The implementation of the principles and actions that are compiled in the different legal and political instruments of reference for the Mediterranean region, described in chapter 1, have to keep improving the way of minimising the pollution, generation, and treatment of the industry's waste flows, beyond the prescriptive character of the legislation. The application of BATs, BEPs and CTs offers the industry the possibility of new opportunities of optimisation and saving, at the same time it avoids causing environmental impacts.

In this section BAT, BEP and CT are defined and described according to the reference framework described in chapter 1.

- **Best Available Techniques (BATs)**

The revised version of the LBS Protocol or "Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities" and the Council Directive 96/61/EC of the 24th of September concerning integrated pollution prevention and control (IPPC) establish the criteria for the definition of the Best Available Techniques (BATs).

The term **"best available techniques"** means the latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste.

- "techniques": shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;
- "available" techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the member state of MAP in question, as long as they are reasonably accessible to the operator;
- "best": shall mean most effective in achieving a high general level of protection of the environment as a whole.

The Best Available Techniques (BATs) are a step forward to achieve eco-efficiency in a company, because they represent the substitution of the actual productive operations by the BATs. Specifically, the BATs are a group of available techniques that have proved to be cost-effective when they have been applied in the industrial sector.

The BATs refer to a specific activity and are the most environmentally friendly techniques to carry out an activity, taking under consideration that the implementation and exploitation costs, if there are any, are within reasonable limits, for the company that will have to assume them.

When the BAT concept refers to equipment, machinery, instrumentation and operations corresponding to the production installations, in the adoption of BATs it is essential to carry out a correct operation of the installations and an adequate and constant maintenance.

The BAT concept takes specially into consideration the cost generated by the adoption of certain techniques and the possibilities of being commercially exploited and, in this case, that they are within reach of the means of many companies. In other words, the BATs definition contemplates the technological possibilities and the economic parameters, attending also the cost-effectiveness ratio.

- **<u>Best Environmental Practice (BEP)</u>**

The revised LBS Protocol, or "Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities", establishes the criteria for the definition of the Best Environmental Practice (BEP).

> The term **"best environmental practice"** means the application of the most appropriate combination of environmental control measures and strategies.

The responsibility of the industry with the environment entails, as a direct consequence, the introduction of a new contributing factor in their progress scheme: the environmental impact, or in other words, how the practices of the industry affect the environment. The BEPs would be those practices that are better than the present or most common ones. Specifically, **the BEPs are the set of individual and group habits, that through the performance of each and everyone of the persons that conform an organization, enable carrying out a correct environmental management.** The BEPs bring the industry closer to the global sustainability concept and therefore to the individual sustainability of the company.

The Protocol indicates the necessity to establish, in first place, a selection of the practices that can constitute the BEPs of a certain company. To carry out this selection, all the measures that each practice may require have to be considered, for example, the necessity to train the personnel on the 3 R principle (recovery, re-use and recycling), the reduction of natural resources consumption or working procedures that avoid generating waste.

For the selection of the BEPs of the company in question, special consideration has to be given to aspects like the elimination of polluting activities, the benefits that the practice can bring, the time needed when introducing the practice, and so forth.

The efforts to protect the environment entail a quality improvement and a reduction of costs. The effort necessary to keep, for example, a warehouse tidy represents saving costs and a better quality service for the customer, as well as a reduction of the amount of waste and of the resources used to manufacture the products that have turned into waste.

As a BEP example, the sorting or segregation of waste facilitates the minimization and enables giving the most adequate treatment to each type of waste, therefore the valuable fraction increases and the economic cost associated to the management decreases.

- **Cleaner Technologies (CTs)**

The definition of the United Nations Environment Programme (UNEP) regards CTs as the combination of technologies that enable the development of a cleaner production.

> **Cleaner Technology** may be thought of a subset of Cleaner Production activities with a focus on the actual manufacturing process itself and considers the integration of better production systems to minimise environmental harm and maximise production efficiency from many or all inputs.

CT is to be understood as the method for manufacturing products in which raw materials and energy are used in the most rational way and integrated in the cycle (natural resources, raw materials, production, final product, use, secondary materials) in order minimise the environmental impacts.

Therefore, the CT concept adds into the modification of the production process the totality of the technologies for emission, waste and disposal minimisation, and reduction of energy consumption, under an integrated conception of the problem that involves the control of polluting processes at source.

A misinterpretation that can arise when talking of CTs, that can constitute an obstacle to its introduction in companies, is understanding the CTs as new technologies or assuming that they are not available to the small or medium-size businesses.

In this sense, **technology** can also be defined as the knowledge associated to an industrial art or mechanical profession. From this perspective, CT does not have to correspond only to new sophisticated and expensive equipments that require a very specific training for its operation and maintenance.

The modification of production equipment by means of CTs is a solution with certain costs, not only due to the economic investments needed but also because it may involve the modification of the stages of the production process with the necessary preparation of the production lines and training of personnel. However, during the economic evaluation of the different options based on the modification of process equipments the reduction or elimination of the management costs, reuse, recycling and emission, waste and disposal treatment, have to be considered as a saving.

3. PRESENTATION OF THE METHODOLOGY

The Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (LBS Protocol) determines the general guidelines that have to be considered when selecting a specific BAT, BEP or CT.

a Local environment conditions and geographical location

- ecological, geographical and physical characteristics,
- the economic capacity of the countries and their need for development,
- the level of existing pollution and
- the real absorptive capacity of the marine environment

b Specific factors of each facility

In most cases, when a company wants to carry out an initiative of pollution prevention at source, there are a large variety of options to choose from. Normally the election is not easy, because nowadays there is no option (either a technique, practice or technology) that achieves a zero degree of pollution. After comparing the different options from different points of view, the company has to decide which options to choose.

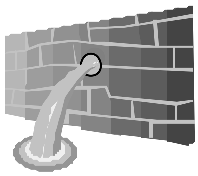
Carrying out this comparative analysis requires a specific methodology and a previously defined environmental, technical and economic assessment.

Therefore, the information in chapter 4 wishes to be a starting point in the election of best available techniques (BATs), best environmental practices (BEPs) and cleaner technologies (CTs) for the companies in the Mediterranean region. Specifically, it describes the criteria that will have to be considered, according to the geographical diversity of the Mediterranean Region and the characteristics of each industrial facility.

3.1 Summary of the Methodology

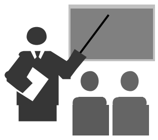
The objective of this section is to synthesize the methodology defined in these guidelines, to facilitate the companies in the MAP countries to carry out an adequate and logic election of their BATs, BEPs and CTs.

This methodology consists of 7 basic consecutive stages. Every step has to be followed in order to achieve a reliable result. It is important to realize that carrying out only one of the stages is not going to provide enough information to carry out an adequate election, although there will be some cases in which the company will have carried out one of this options (as happens in the identification of key environmental aspects in the companies that have implemented an environmental management system). These stages are:



1. **Determining the key environmental aspects of the company**

   The first step that a company has to carry out is identifying its key environmental aspects (1st stage), balancing the inputs and outputs of both energy and materials of its industrial activity. This balance has to be based mainly on the knowledge of the company's consumption of resources and the identification and quantification of the waste flows (gas, liquid or solid) as well as the identification of the environmental impacts related to every key environmental aspect.



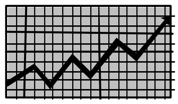
2. Definition of the specific objectives of the company

Once the key environmental aspects of the company have been identified, the second step is to define the objectives to be met by implementing the BATs, BEPs or CTs. These objectives have to comply with some characteristics as far as possible; they should be: acceptable, precise, viable and coherent with the objectives of the other areas of the company.

As a result of this process, the company will obtain a list of objectives that must be reached with the election of their BATs, BEPs or CTs.

3. Identifying options to address successfully the key environmental aspects of the company

Once the company's key environmental aspects and objectives have been determined, the company has to identify the options (techniques, practices or technologies) available to prevent or reduce at source the environmental impact that the company's activity is generating (3rd stage). As a result of this process and according to a preventive business policy, several options will be proposed that need to be further assessed.



4. Assessment of the options identified

The fourth step consists of evaluating every option previously proposed, under **environmental, technical and economic criteria** defined in these guidelines (4th stage).

As it can be seen in figure 3.1, the order that this assessment has to follow consists of the following steps:

- First, **the environmental assessment** of the options (assessing the effectiveness of environmental protection of the techniques, practices or technologies). In case that the option does not provide significant environmental benefits, it will have to be rejected from the start. For all the environmentally viable options, the company will have to proceed to the introduction of technical assessment.
- The technical assessment of the options will enable finding what effect will applying an option have on the development of the company's daily activity, its production processes, the lay-out of products and also knowing if there is need for extra training of the personnel, equipment, within other things. The options that do not involve any technical difficulties that cannot be solved will be considered technically viable. In these cases, as a last stage the company will proceed to the economic assessment.
- The economic assessment of the environmentally and technically viable options will have to identify the ones that provide economic profits, sufficient to pay back the investment made (in case that an investment was necessary) in a reasonable period of time. As a result, it also identifies which options will be rejected under economic criteria.

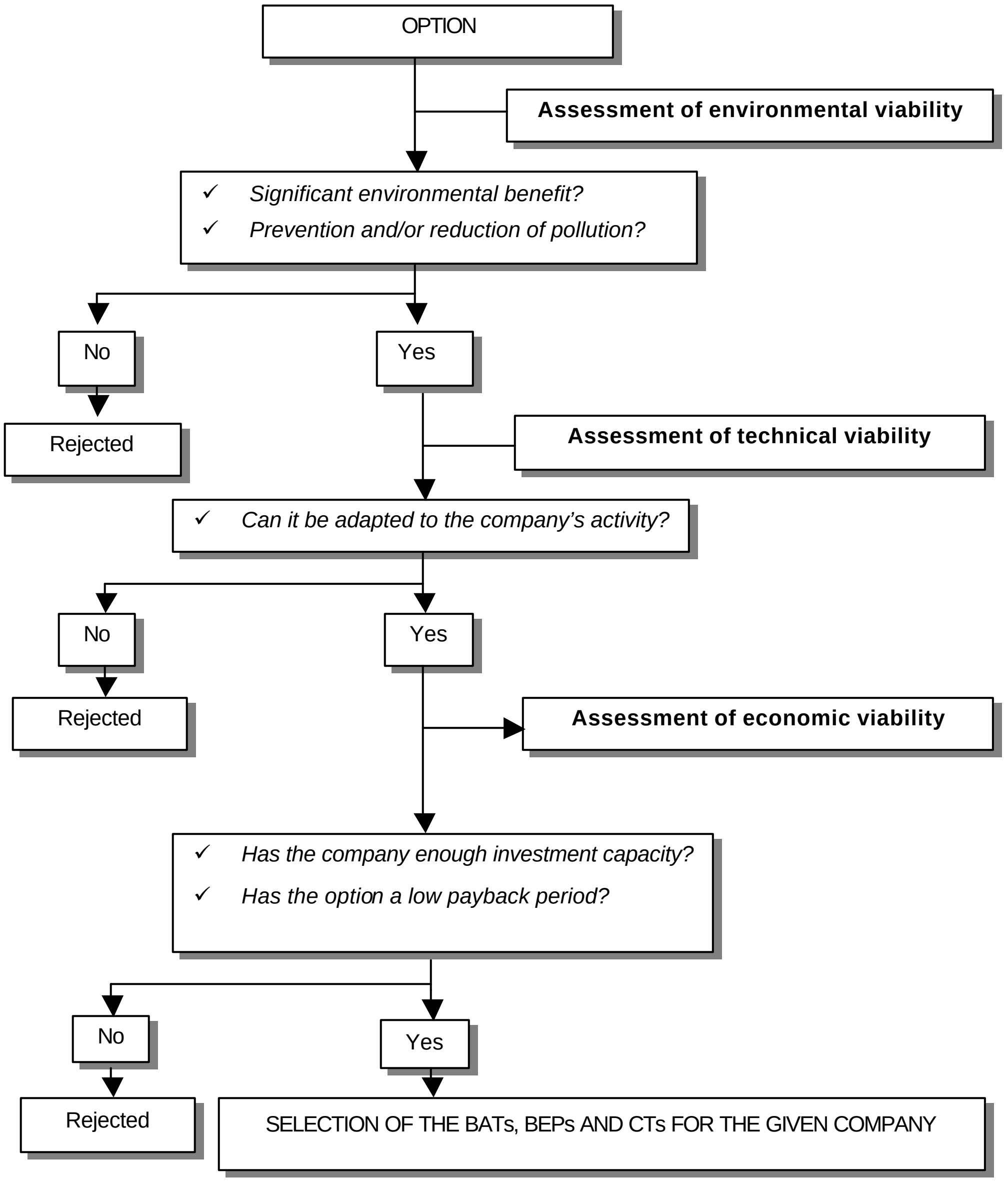


Figure 3.1 Assessment of the options

This assessment will result in a list of the viable and non-viable options for the company in question.

5. Selection of BATs, BEPs and CTs for the given company

Finally, once the options have been identified (3^{rd} stage) and assessed (4^{th} stage), the company has to proceed to the final selection (5^{th} stage). At this stage the company needs to be aware of not only the basic criteria and constraints that have been taken into account on the 4^{th} stage, but has to introduce other general criteria and constraints that will facilitate the selection of the options entailing more benefits to the environment as well as to the industry (see figure 3.2):

- **Basic criteria and constraints** applicable to every option: environmental, technical and economic criteria.
- **General criteria and constraints** for the final decision: intangible benefits, local environment conditions and geographical location.

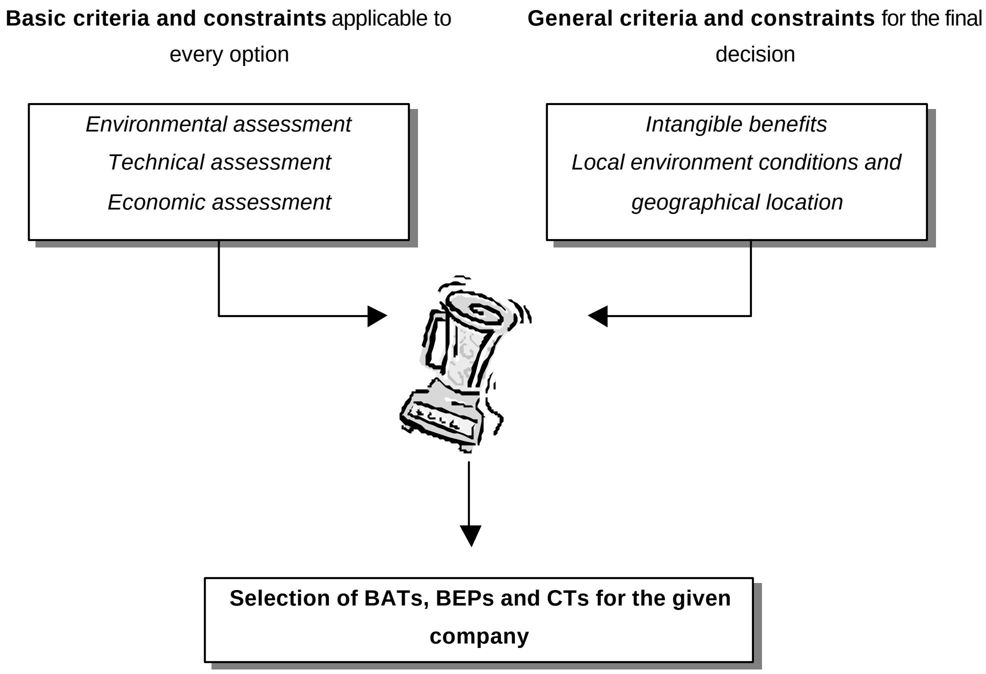
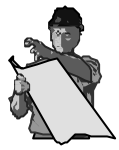


Figure 3.2 Selection of BATs, BEPs and CTs in a given company

This analysis will result in the identification of the options (either techniques, practices or technologies) that have been considered the Best Available Techniques (BATs), Best Environmental Practices (BEPs) and Cleaner Technologies (CTs) for the company in question.



6. Implementation of BATs, BEPs and CTs for a given company

Once the BATs, BEP and CTs of the company have been chosen, the company will have to look at several factors that might contribute to the successful implementation of the options. Notably, the company will have to assign responsibilities, carry out training and awareness raising among the personnel, design a communication strategy of the actions (both internal and external), study space redistribution, manage adequately the documentation being generated, and carry out eventual trials and tests.

As a result of this process, the company will have laid the ground to ensure a successful implementation of the BATs, BEPs and CTs.

7. Monitoring and continual improvement

Even though the options have been defined and introduced in the company, the methodology presented is not a one-time procedure. On the contrary, this has to be a dynamic process as the company and the environment are not static and therefore, the BATs, BEPs and CTs do not remain the same. We have to take into account that companies keep introducing changes in their processes as the market changes, like in the situations below.

- Appearance of new scientific progress and experiences that lead to a better understanding and efficiency of the industrial processes and the application of new undeveloped options and, at the same time;
- The consumer requirements change as a consequence of a greater environmental awareness. This fact is directly linked with ecolabelling, which informs about the environmental aspects involved in the product's life-cycle, encouraging environmentally friendly manufacturing.

Therefore, as it can be seen in figure 3.3, the 7 stages of the guidelines' methodology have to be repeated frequently in order to assure that the best options are used at every moment and that continual improvement of the company takes place. There is a possibility that the options that were once rejected can be viable for the company in the future.

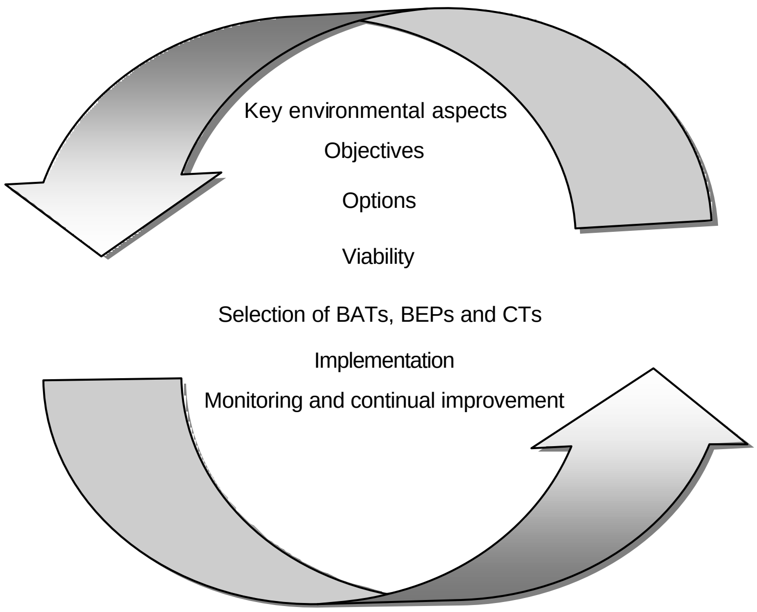


Figure 3.3 Monitoring and continual improvement

It is very important that the options selected as BATs, BEPs or CTs are the most efficient ones, that is, they should be proportional to the desired objective, and above all, they should guarantee the success of the project.

Next, the methodology presented will be developed in chapter 4. During this description, a case study is presented in order to facilitate understanding of the methodology.

3.2 General Considerations

The main objective of this methodology is to facilitate the selection of the BATs, BEPs and CTs in a given company. This methodology, during its different stages, is subjected to several general considerations. These considerations influence several aspects of the methodology, and to avoid extending the content of this chapter unnecessarily, these are briefly described below. Because of these and other considerations the company will choose some specific options instead of others.

- In these guidelines **options** are understood as those **techniques, practices and technologies** that individually (one option) or in a combination (a set of options), may constitute the BATs, BEPs and CTs for a given company. In those cases when it is necessary the guidelines make the convenient distinctions between technique, practice or technology.
- The options assessment has to take into account the whole of its **life cycle**, the way in which the option has to be designed, started, maintained, exploited and finalised/updated. In some way it is like analysing the life cycle of the option. For example, in case of its exploitation, we have to take into account the raw materials used in the production process, if it is necessary to import resources from abroad, if it can produce substances that are toxic, persistent and liable to bioaccumulate,…
- The methodology presented in this chapter will be applied in different ways, depending on if we are dealing with **new facilities or already existing ones**. The already existing facilities will have more difficulties to adapt the options into their process compared to the new ones, because the latter are on a design stage, and can easily overcome any requirements related to an option, being either environmental, technical and/or economic.
- The methodology presented goes hand in hand with that of **EMAS** (**Eco-Managment and Audit Scheme)**[2] **and ISO 14001**[3]; like those, this methodology allows the industrial company to organize its activity considering all its environmental impacts and the measures to prevent and reduce them. In those environmental management systems, the main objective is to establish the bases for evaluation and continual improvement of the industrial activities in relation with the environment. Therefore, by carrying out the proposed methodology, the company will also be close to the aforementioned environmental management systems.

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[2] EMAS (Eco-Management and Audit Scheme), is a voluntary initiative designed to improve companies environmental performance. It was initially established by European Regulation 1836/93, although this has been replaced by Council Regulation 761/01.

[3] ISO 14001, the only ISO 14000 standard against which it is possible to be certified by an external certification authority, specifies the actual requirements for an environmental management system.

4. METHODOLOGY FOR DETERMINING AND IMPLEMENTING BATS, BEPS AND CTS IN A GIVEN COMPANY

4.1 Determining the Key Environmental Aspects

4.1.1. Key environmental aspects of the sector

4.1.2. Key environmental aspects of the company

4.1.3. Expected results at this stage

An example

A company located in the outskirts of a large city in the Mediterranean region has been working for over 30 years on tanning hides.

The company has decided to design an environmental improving plan for the following years, promoted by the environmental policy of the company's management that, moreover, recognizes cleaner production as a new way of business. The environmental strategy is ambitious; it goes further than the implementation of an environmental management system and consists of implementing the techniques, practices and technologies which are more environmentally friendly and that are available to the company.

In order to design the improvement plan, in first place an analysis of the environmental situation of the company was carried out, and to accomplish this, relevant bibliography about the sector was previously consulted for identifying the key environmental aspects. To identify the key environmental aspects of the company, the General Manager had a meeting with all the persons in charge of the units involved (production, storage, purchase, engineering, environment, security and quality)[4] *and lined up a working team under the leadership of the person in charge of the environment. This team analysed the production processes of the company and quantified the inputs and outputs of both energy and materials, and finally identified the environmental impacts derived from the activity of the company.*

To quantify the energy and material balances they used the data from the purchase of raw and auxiliary materials, the data extracted from the consumption of water and energy invoices and from the invoice for the external waste management. Moreover, the data from the process sheets was also used and the different operators of the company had to participate. As a result of the analysis of these processes the general diagram was drawn, which is detailed on the following figure:

[4] This organigram is from a specific company and does not have a representative character.

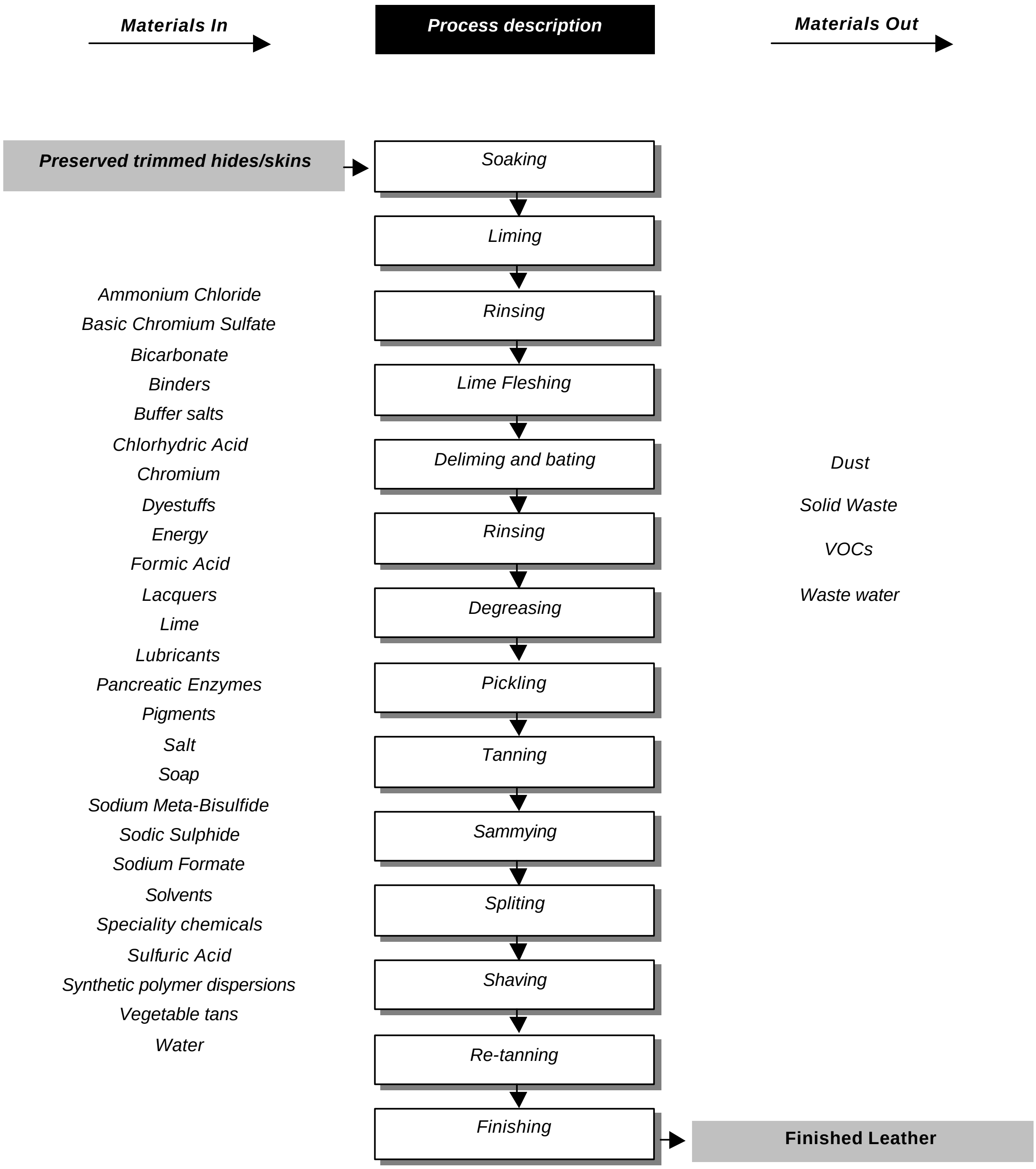

Figure 4.1 Diagram of the company's process

Afterwards, the company wanted to know in more detail the inputs and outputs of every subprocess and a specific diagram of every subprocess was made. An example of these diagrams is presented below.

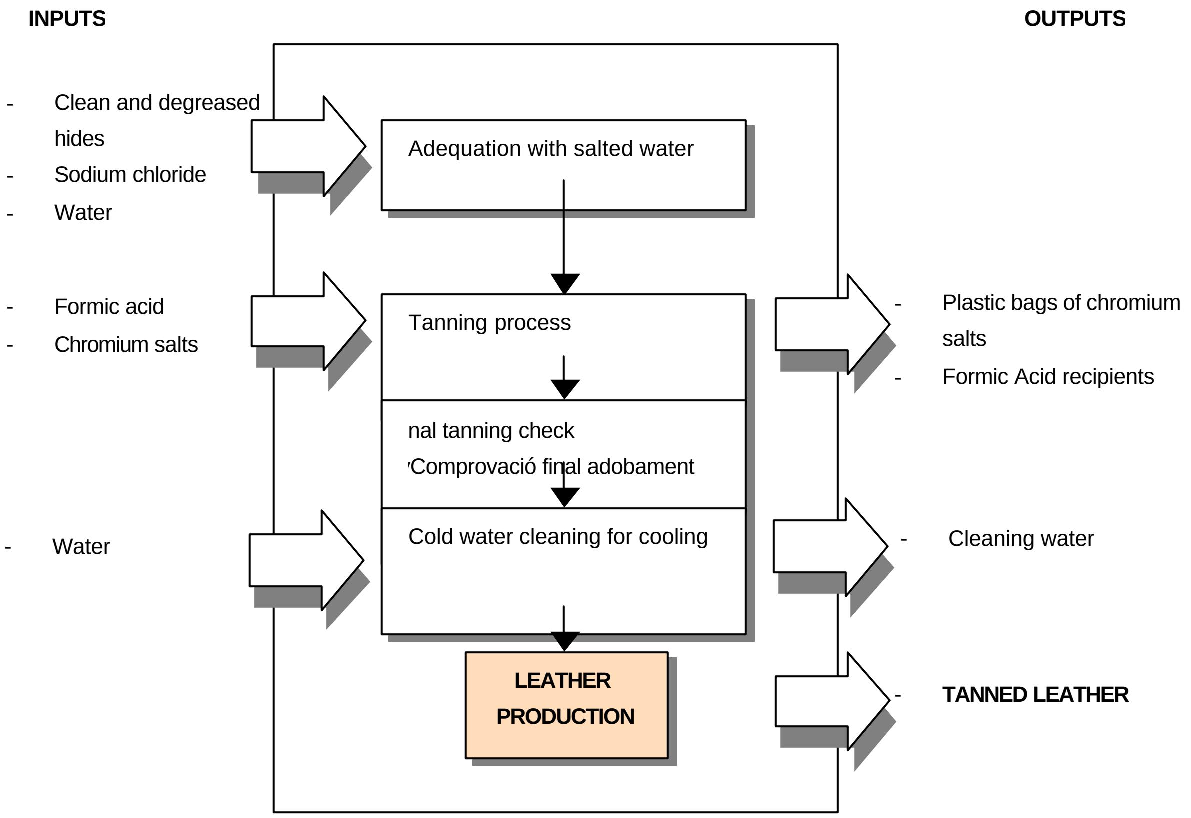

Figure 4.2 Diagram of flows involved in the tanning process

From these diagrams the material and energy balances of every process were made. On the following table the material and energy balance corresponding to the tanning process is presented.

Table 4.1

Inputs and outputs (waste flows and products) in the tanning process

INPUTS				OUTPUTS			
Material	Hides	160,000	Hides/ year	**Solid waste**	Plastic bags of chromium salts	480	Units/year
	Water	1,550	m^3/year		Formic acid recipients	336	Units/year
	Sodium chloride	120	ton/year	**Waste water**	Cleaning water	1,550	m^3/year
	Formic acid	8.4	ton/year	**Leather Production**		550,000	leather/year
	Chromium salts	24	ton/year				
Energy	Electricity	600,000	Kwh/year				

Analysing the data of the material and energy balances of the tanning process and comparing it with available consumption data of other companies of the sector, an excessive consumption of chromium salts was detected. This meant an unnecessary consumption of a chemical product and an addition of chromium into the cleaning waters.

Once the environmental aspects were identified, the company determined the environmental impacts that would take place if the company did not carry out pollution prevention measures.
The impacts identified are presented in the following table:

Table 4.2

Environmental impacts associated with the environmental aspects of the company

Environmental aspects of the company	Environmental impacts associated	Specific causes
Discharge of waste water into the marine environment	✓ Decrease in the level of dissolved oxygen in the water ✓ Decrease in the aquatic biodiversity: increase in generalist fauna and flora species and decrease in the specialists ones ✓ Increase in the ratio of faecal microorganisms ✓ Risk of infection in the swimming areas near the exiting point of the emissary	✓ Amount of organic matter in the waste water
	✓ Increase in turbidity and decrease in water clearness ✓ Decrease in the photosynthetic capacity of seaweed and marine phanerogam ✓ Habitat destruction (of poseidonia oceanica sea grass community) and associated fauna	✓ Generation of suspended solids
	✓ Decrease in safe water for recreational activities ✓ Intoxication risk	✓ Use of chromium and other chemical products and toxic waste (sulphur and ammonia) in the tanning process
Discharge of waste water into the soil	✓ Soil erosion ✓ Risk of polluting the underground waters ✓ Substitution of the present vegetation with halophyle resistant plants ✓ Loss of agricultural productive capacity (when crops are placed in the area where the company is located)	✓ Dispersion of waste water, containing salts and other toxic elements (mainly chromium), on the soil of the premises or using these for watering crops.
Waste disposal	✓ Risk of polluting the underground water ✓ Toxic and adverse risks for human health ✓ Visual degradation and landscape impact ✓ Waste of resources that could be reused or recycled at an adequate treatment plant	✓ Leachates filtration ✓ Inadequate solid waste management
Emissions into the atmosphere	✓ Unpleasant and harmful odors, causing complaints in the nearby residential areas depending on the direction the wind blows	✓ Gas emissions produced by several operations of the tanning process and the organic matter in decomposition generated by the waste water
	✓ Effects on human health: irritation of the mucous membrane and increase in respiratory problems specially in children, elderly and sick people ✓ Acidification of the soil and the wetlands nearby the facilities ✓ Effects on the pine forests and littoral bushes	✓ Use of specific chemical products that may be hazardous for human health, like the toxic emissions of H_2S
Water consumption	✓ Desertification ✓ Decrease in the river's flow	✓ Overexploitation of the water resources
Energy consumption	✓ Effects on human health: increase in the cardio-respiratory problems ✓ Increase in global warming	✓ Emission of combustion gases

Valuation criteria were defined (see table 4.3) depending on the magnitude of the environmental aspects, the frequency of its generation and the legislation compliance, with the aim of valuating every impact and defining over which environmental aspects action had to be taken (see table 4.4). The valuation criteria were the following:

Table 4.3

Valuation criteria

Valuation criteria			
Risk	**Proven negative effects**	**Possible negative effects**	**Initially, it does not have negative effects**
	High	Medium	Low
Frequency	**Daily**	**Weekly**	**Occasional**
	High	Medium	Low
Legislation compliance	**Non-compliance**		**Total compliance**
	High[5]		Low[6]

The valuation of impacts in the tanning process was the following.

Table 4.4

Valuation of environmental impacts associated to the environmental aspects of the company

Environmental aspects of the tanning process	**Associated environmental impacts**	**Valuation**		
		Risk	**Frequency**	**Legislation compliance**
Waste water discharge into the marine environment	✓ Decrease in the level of dissolved oxygen in the water ✓ Decrease in the aquatic biodiversity: increase in generalist fauna and flora species and decrease in the specialists ones ✓ Increase in the ratio of faecal microorganisms ✓ Risk of infection in the swimming areas near the exiting point of the emissary	High	High	High
	✓ Increase in turbidity and decrease in water clearness ✓ Decrease in the photosynthetic capacity of seaweed and marine phanerogam ✓ Habitat destruction (of poseidonia oceanica seagrass community) and associated fauna	High	High	High
	✓ Decrease in safe water for recreational activities ✓ Intoxication risk	High	High	High
Waste disposal	✓ Risk of polluting the underground water ✓ Toxic and adverse risks for human health ✓ Visual degradation and landscape impact ✓ Waste of resources that could be reused or recycled at an adequate treatment plant	High	Low	High
Water consumption	✓ Desertification ✓ Decrease in the river's flow	High	Low	Low
Energy consumption	✓ Effects on human health: increase in the cardio-respiratory problems ✓ Increase in global warming	High	Low	Low

From this valuation the discharge ***of waste water into the marine environment was identified as the key environmental aspect of the tanning process of the company****. Also, during the interview with the head of the waste water treatment plant of the company and analysing the discharge data, the working team found that occasionally there were difficulties to eliminate completely the chromium in the waste water with the physical-chemical treatment. This, as the head of the waste water plant explained, and as verified by the registered data of the flow, was due to peak flows that did not allow an adequate water treatment, because the water treatment premises were not designed to treat such volumes of water.*

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5 If a company does not comply with environmental legislation, the methodology assigns "high" in the table of valuation criteria (high environmental impact); if the company complies with environmental legislation, the methodology will assign "low" (low environmental impact).

The objective of this first stage is to **identify the key environmental aspects caused by the company's activity and which ones can be improved**.

To accomplish this objective, a good starting point is finding out which are the key environmental aspects of the sector. Identifying the key environmental aspects of the sector requires knowing the interaction that takes place between the sector that the company belongs to and the environment, by consulting specific documentation if necessary.

Once the company knows and is aware of the key environmental aspects of the sector, the production process and auxiliary activities of the company will have to be evaluated in order to identify the specific key environmental aspects of the company, due to different and specific realities and circumstances of each company.

4.1.1 Key environmental aspects of the sector

The industry is a set of activities related to the transformation of raw materials into intermediate or final goods. These activities often entail non-desired environmental impacts, in amounts and toxicities normally unknown for many companies.

To be able to act on the environmental impacts caused by these activities, the company first should know the environmental situation and specifically both the key environmental aspects of the sector and of the given company.

The pressure exerted by the industry over the Mediterranean sea principally comes from the chemical, petrochemical, metal, waste treatment, solvent recovery, surface treatment, paper, plastic and paint production, ink and printing and the tanning sectors, among others. (**Reference:** Promoting cleaner production in the industrial sector, RAC/CP 2002)

The **environmental aspects** are defined as the causes of the environmental impacts produced as a consequence of the production processes and the auxiliary activities in the industry or sector in general (since the raw material is extracted until the product is produced, since the construction of the premises until they are razed, …).

The **environmental impact** can be widely defined as any effect on human health or well-being or on the environment.

The key environmental aspects of an industrial sector, as it has been mentioned previously, constitute the relationship between companies and the environment during the whole life cycle (design, start up, exploitation, maintenance and dismantlement of the company). The key environmental aspects of any industrial sector can be divided into two main blocks:

- **Consumption of resources**: mainly raw materials, water and energy.
- **Generation of waste flows**: waste water, emissions into the atmosphere, solid waste, discharge into soil and subsoil, ...

Every sector applies specific pressures on the environment, different from the rest. At this first stage of the methodology it is interesting for the company to know and be aware of these pressures, if necessary, reinforcing this knowledge with **specific documentation of the sector** where it belongs. The documentation should:

The legislation sets the priorities of the public administration concerning the environment and through these the industry can also reinforce its knowledge on the key environmental aspects of the sector.

- Identify the trends and initiatives of the sector and of the countries of the Mediterranean region towards an economic and environmental sustainable development, specifically the ones concerning prevention and reduction of pollution at source.
- Inform the industries about the opportunities and possibilities

for achieving a greater environmental and business efficiency (eco-efficiency).

In this sense, some of the resources that enable reinforcing the knowledge of the company about the sector's key environmental aspects are the sector studies of the **Cleaner Production Regional Activity Centre (RAC/CP)** and the **Best Available Techniques Reference Documents (BREFs).**

- The **Cleaner Production Regional Activity Centre (RAC/CP)** offers to the Mediterranean industry a series of sector publications where the following sectors of industrial activities are included:
  - Tanning of hides and skins
  - Food preserving
  - Biotechnology
  - Dairy products
  - Printing and allied industries
  - Olive oil
  - Used oils
  - Textile
  - Surface treatment

- The Best Available Techniques Reference Documents (BREFs) mainly gives information about the environmental situation of a given sector and the techniques considered as BATs for the sector to which the BREF is addressed. The BREFs have their origin in the Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control -IPPC Directive- and they are the product of an exchange of information carried out with a dedicated Technical Working Group (TWG) constituted for the purpose. The sectors studied by the BREFs are the following (some still being elaborated and others already finished):

Table 4.5

Reference documents on best available techniques (Council Directive 96/61/EC)

REFERENCE DOCUMENTS ON BEST AVAILABLE TECHNIQUES (COUNCIL DIRECTIVE 96/61/EC)	
Cement and Lime production	Management of Tailings and Waste-Rock in Mining Activities
Ceramics	Monitoring systems
Chlor-Alkali manufacture	Non-Ferrous Metal processes
Common waste water and waste gas treatment and management systems in the chemical sector	Organic fine chemicals
Cooling Systems	Polymers
Economic and cross media issues under IPPC	Pulp and Paper manufacture
Emissions from storage of bulk or dangerous materials	Refineries
Ferrous Metal processing	Slaughterhouses and Animal By-products
Food, Drink and Milk processes	Smitheries and Foundries
Glass manufacture	Speciality inorganic chemicals
Intensive Livestock Farming	Surface treatment of metals
Iron and Steel production	Surface treatments using solvents
Large Combustion Plant	Tanning of hides and skins
Large Volume Inorganic Chemicals - Ammonia, Acids & Fertilisers	Textile processing
Large Volume Inorganic Chemicals - Solid & Others	Waste Incineration
Large Volume Organic Chemicals	Waste Treatments [Previously Waste Recovery/Disposal activities]

4.1.2 Key environmental aspects of the company

4.1.2.1 Production processes and auxiliary activities of the company

4.1.2.2 Associated environmental impacts

Knowing the key environmental aspects of the sector is a good starting point for identifying the key environmental aspects of the company, but every company has its particularities. And for this reason the company needs to make a diagnosis of its own initial and individual situation in relation to the environment.

The **methodology needed for identifying the key environmental aspects of a given company** is shown in the figure 4.3 and is structured in two well-delimited parts:

- **Assessment of the production processes and auxiliary activities of the company**, identifying and quantifying the environmental aspects of the company by using flow charts and material and energy balances.
- **To weigh up and valuate, in a quantitative or qualitative way, the associated environmental impacts of every identified environmental aspect** (what are the impacts, where are they generated, why are they generated and in what amount, associated risk, …).

The final valuation process identifies the most important environmental impacts and, therefore, the **key environmental aspects** of the company, considering its definition.

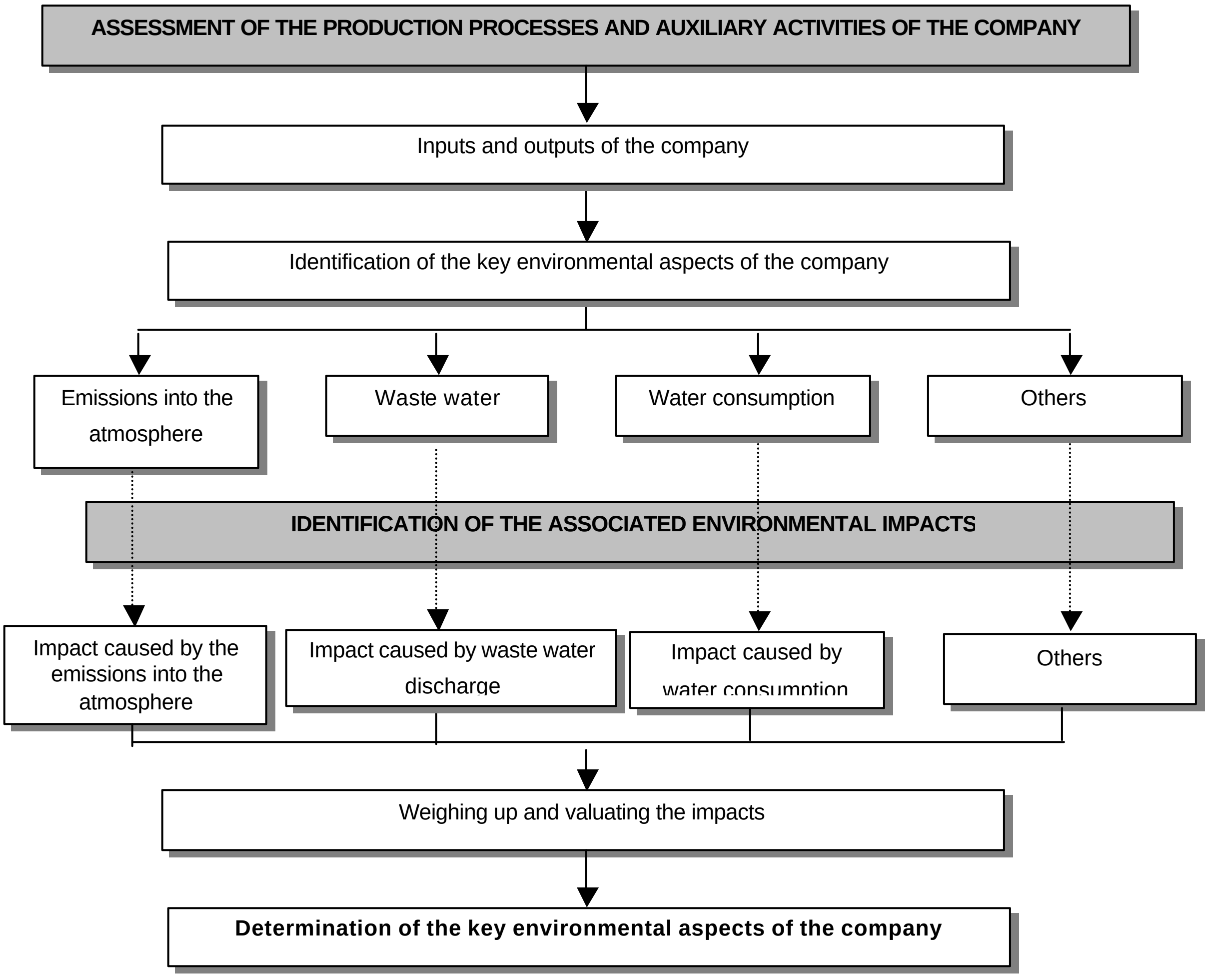

Figure 4.3 Methodology for determining the key environmental aspects of the company

At this stage, it has to be reminded that if the company has recently evaluated one or all the environmental aspects that may have environmental impacts and the results of these evaluations have been documented, there is no need to repeat this process. In this sense, some of the resources that include a diagnosis, more or less extensive, of the environmental aspects of the company are: the Minimisation Opportunities Environmental Diagnosis (MOED), the Good Housekeeping Practices Programme (GHPP), Life Cycle Assessment (LCA), Environmental Management System (EMS), among others.

4.1.2.1 Production processes and auxiliary activities of the company

The assessment of the production processes and auxiliary activities of the company involves a diagnosis of the current situation of the company, carried out from an environmental point of view, in order to identify the environmental aspects that take place in these processes and activities.

> The identification of the environmental aspects of the company would have to take under consideration normal, abnormal and emergency operating scenarios.

In order to carry out this diagnosis, it is recommended to elaborate flow charts of the company's activities (see figure 4.3) that determine the inputs and outputs of materials and energy of its production processes and its auxiliary activities (see table 4.6), understanding by:

- **Production processes:** every stage in which the production of a good or industrial service is divided into.
- **Auxiliary activities:** all the general operations that enable the production of the company but do not belong to any stage of this process: control, filter cleaning, lubricant change, access building, transport of products,…

Table 4.6

Materials and energy balance of the company

Inputs	Outputs
✓ Raw materials necessary to manufacture the product	✓ Final products which the company commercialises in the market
✓ Secondary materials that help carrying out the production process and may be part of the final product or not	✓ Intermediate products (partially elaborated) not finished, in any of the intermediate stages of the process. Generally, they are not significant for the methodology, but identifying them facilitates monitoring the process stages to the company.
✓ Auxiliary materials used in auxiliary activities to the production process, or also used at the production process but with obvious auxiliary functions	✓ By-products obtained by the company, without being the objective of the process, as a consequence of their production processes.
✓ Water and energy consumption	✓ Waste flows (either solid, liquid or gas) that are generated during the production process and that are not useful for the company.

As it has been mentioned, the identification of the processes and activities of the company, from the first stage to the last, has to be carried out under a perspective of generating impacts on the environment (where are these wastes being generated?, why?) not from the point of view of productivity, costs, quality, workforce, …

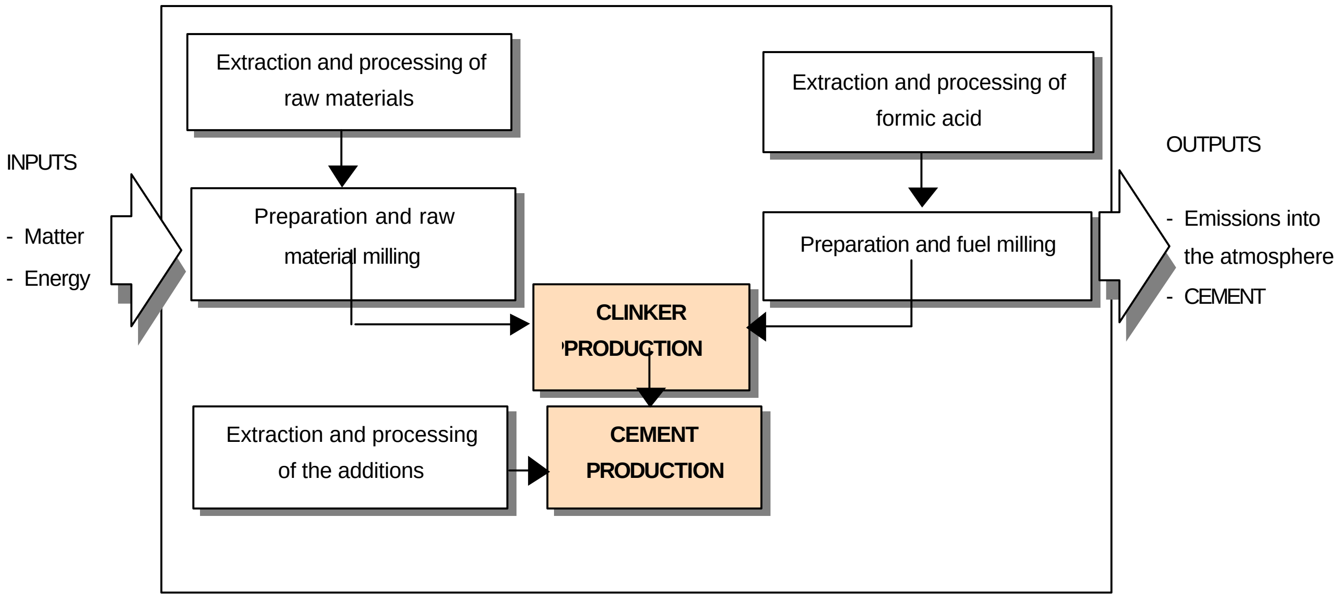

***Figure 4.4** Chart flow of the production processes of a cement factory that uses animal wheat as fuel. (Reference: Private Foundation Institut Ildefons Cerdà)*

Table 4.7

Material and energy balance of a cement factory company that uses animal flour as fuel (Reference: Private foundation Institut Ildefons Cerdà)

INPUTS				OUTPUTS			
Material	Calcareous	756,025	ton/ year	**Emissions into the atmosphere**	Particles	234	ton/year
	Clay	57,093	ton/ year		CO	760	ton/ year
	Plaster and cube spar	25,018	ton/ year		CO_2	466,645	ton/ year
	Puzzolana	13,821	ton/ year		CH_4	8	ton/ year
	Recycled materials	23,094	ton/ year		VOCs	17	ton/ year
Energy	Fuel-oil	2,919	ton/ year		NO_x	1,328	ton/ year
	Natural Gas	35,783	GJ/ year		NH_3	26	ton/ year
	Petroleum coke	17,576	ton/ year		SO_2	726	ton/ year
	Carbon	751,443	GJ/ year				
	Alternative fuels	178,915	GJ/ year		HCl	7	ton/ year
	Electricity	73.7	GWh		HF	0.5	ton/ year
				Cement Production		550,000	ton/ year

The objective of this diagnosis is not a detailed valuation of the production processes and the auxiliary activities. The companies do not have to valuate every product, component or raw material input. The companies can select categories of activities, products or services to identify those environmental aspects with a higher degree of possibilities to have a significant impact on the environment.

The fieldwork to obtain the necessary information to carry out this analysis could consist of, in an orientative way, the following steps:

- Compilation of general data: company's files, waste flow analysis, consumption data, process manuals, …

- Interviews with persons in charge of the process, operators, …
- Carrying out surveys with key personnel;
- Inspection of the activity and visits to the premises.

4.1.2.2 <u>Associated environmental impacts</u>

The production processes and auxiliary activities enable the identification of the environmental aspects of a given company. In the previous example, the environmental aspects of a cement factory would mainly be the consumption of petroleum coke as well as emissions of sulphur dioxide (SO_2) and NO_x.

The following step is to identify the environmental impacts associated to every environmental aspect of the company and, finally, **determine which are the most important ones in order to establish the key environmental aspects of the company, attending to its definition.**

According to these objectives the next stages that need to be carried out are defined below.

Identify the environmental aspects of a given company

↓

Quantitative or qualitative analysis of the environmental impacts of the company

↓

Valuation of the environmental impacts: final determination of the key environmental aspects

Figure 4.5 Final determination of the key environmental aspects

a. Identify the environmental aspects of a given company by knowing the key environmental aspects of the sector and a diagnosis of the initial environmental situation of the company.

Table 4.8

Environmental impacts of a company in the olive oil production industry (Reference: Pollution prevention in the olive oil production, Cleaner Production Regional Activity Centre – 2000)

Environmental aspects of an olive oil production factory		Associated environmental impacts
Solid wastes	✓ Conventional dregs of olive	✓ Have not been identified
Liquid wastes	✓ Oil-foot	✓ Death of fish ✓ Consumption of dissolved oxygen in rivers

There are derived impacts that can be considered as a direct impact of the company, but including them would make the methodology even more complex.

b. Quantitative or qualitative analysis of the environmental impacts of the company associated with the environmental aspects that have been identified in the previous stage**.**

The analysis of the environmental impacts of the company consists in weighing them up, in either a quantitative or qualitative way. It should be taken under consideration that for carrying out a reliable quantitative analysis of the environmental impacts, a clear, objective and internationally recognized methodology should be applied (for example the Eco-indicator 95, CML 1992, ...).

- **Quantitative analysis**

To quantify the company's environmental impacts associated with a production unit there is not a single methodology (Eco-indicator 95, CML 1992, EPS 2000, ...). The methodology to be used will be determined by the company's criteria. As an example, the following table describes the quantification of the environmental impacts associated to the activity of a cement factory using the Eco-indicator 95 methodology[6].

Table 4.9

Example of quantification of the environmental impacts of a cement factory using the Eco-indicator 95 methodology (Reference: Private Foundation Institut Ildefons Cerdà)

Environmental impact	Unit	Impact associated to the production of a ton of cement
Global warming	kg CO_2	1.25×10^3
Ozone layer depletion	kg CFC_{11}	$2{,}72 \times 10^{-4}$
Acidification	kg SO_2	7.4
Eutrophication	kg PO_4	0.457
Heavy metals	kg Pb	$2{,}99 \times 10^{-3}$
Carcinogenic	kg B(a)P	2.33×10^{-6}
Winter pollution	kg SPM	4.97
Photochemical smog	kg C_2H_4	0.175
Energy consumption	MJ LHV	5.10×10^3
Waste production	kg	8.78

- **Qualitative analysis**

There might be companies that cannot carry out this quantification due to a lack of resources, of knowledge required or due to other reasons. In these cases, every company may develop their own methodology for weighing up the impacts that can be more or less simple, depending on its necessities.

The main objective is to find a methodology that allows the company to weigh up in a more or less quantitative way, from numeric values (1, 2, 3) to valuation scales (high, medium, low), the different impacts associated to the environmental aspects of the company. The fact that this weighing up is qualitative does not necessarily reduce the efficiency of this stage.

The following table is the result of a qualitative weighing up.

[6] The Eco-indicator 95 is a method that measures the environmental impact of a material or process, developed by PréConsultants under the scope of the programme Dutch NOH. Detailed information on Eco-indicator 95 may be found at: http://www.pre.nl/eco-indicator95/eco-indicator95.htm

Table 4.10

Example of a qualitative weighing up of the environmental impacts of a company in the olive oil production industry

Environmental aspects of an olive oil production factory		Impacts associated to the olive oil production
Solid wastes	✓ Conventional dregs of olive	✓ Very low
Liquid wastes	✓ Oil-foot	✓ High

In both cases, the impacts that have to be included in this methodology have to be based, as much as possible, on scientific knowledge and, therefore, the impacts should be relevant and recognized.

c. Valuation of the environmental impacts: final determination of the key environmental aspects

Valuation is the stage where the different weighed up environmental impacts are evaluated as a whole, with the objective of finally deciding which are the most significant ones for the company (when questions like the following come up: is it low or high? is there a need to worry?).

The causes of the most significant environmental impacts will constitute what we have defined as the key environmental aspects of the company.

In this sense, there is subjectivity associated to the criteria for valuating the impacts. Therefore, one of the key elements of this task is transparency to make sure that all the presumptions are clearly explained and related.

> The LBS protocol enables extracting possible criteria for the weighing up, and specifically, in relation to the environmental impacts that are considered priorities in the Mediterranean region:
> - international impacts
> - impacts associated to toxic substances and with a tendency to bioaccumulate
> - …

Table 4.11

Determination of the key environmental aspects of the process of a paper company

Environmental aspects of the company	Environmental impacts associated	Specific Causes	Valuation	
			Legislation compliance	Generation (magnitude)
Water consumption	- Desertification - Decrease in the river's flow	- Nonesixtence of measures adopted by the company that optimise the industrial process	Low	High
Energy consumption	- Increase in global warming	- Emission of combustion gases (CO_2) associated to the utilisation of fuel-oil in the production process	Low	Medium
Waste water discharge into the marine environment	- Decrease in the level of dissolved oxygen in the w ater	- Amount of organic matter in the waste water	Low	Medium
Waste disposal (fibres, plastics, staples, ...)	- Risk of polluting ground water - Visual degradation and landscape impact - Waste of resources that could be reused or recycled in an adequate treatment plant	- Utilisation of paper used in the production process (recycling)	Low	Low

From this valuation, the water consumption was identified as the key environmental aspect of the process of a paper company.

4.1.3 Expected results at this stage

The elaboration of a brief report that identifies:

- **the key environmental aspects of the company and**,
- **a list of the main environmental impacts** originated by the company's activity.

With this evaluation, the company will be able to check whether, for example:

- There is dumping of materials that were unknown or had been underestimated.
- There are greater possibilities to improve the consumption of energy than what was previously assumed.
- Improvements of the premises, practices and processes can be made; improvements, that in many occasions require minimum actions but entailing to significant environmental benefits, specially in the case of introducing BEPs.
- There is the possibility of recycling at source materials and by-products that are currently being wasted.
- ...

4.2 Definition of the Specific Objectives of the Company

4.2.1 Fundamental concepts of the definition of objectives

4.2.2 Expected results at this stage

An example (following page 32)

According to the results obtained from the process followed by the company so far, and, more specifically, the determination of its specific key environmental aspects, the work team defined one objective to be reached by applying BATs, BEPs and CTs: to reduce the content of chromium in the waste water, generated during the production process.

In this sense, the company decided to positively value any improvement, and thus, it was decided not to establish a specific percentage to be reached in order to avoid excessive pressure on the workers affected. However, it was agreed that a significative percentage of chromium reduction in the wastewater would be valued.

Once the company has determined its key environmental aspects, it has to define the objectives to be achieved by implementing the BATs, BEPs and CTs. This is the second step of the methodology described in these guidelines.

> The objective at this stage is:
>
> **To define the specific objectives that the company wishes to achieve by implementing the BATs, BEPs and CTs**.

4.2.1 Fundamental concepts for the definition of objectives

The objectives are the aims or results where the company will have to address its activities. There has to be a link between the company performance and each specific objective in order to allow the consideration of the objective as an operative one and not a mere rhetorical formulation.

The following **benefits can be highlighted among those that may derive from the step of defining the objectives:**

- They create standards because they are a reference for the assessing the results in a productive process, a work place, a project, …
- They allow assessing changes, in this case, the implementation of the BATs, BEPs or CTs.

The **main criteria to establish the objectives** are:

- Acceptability: the objectives have to be established on a consensus basis, and that is why communication and participation in defining the objectives are necessary.
- Precision: the objectives have to be, as far as possible, precise, both in quantity and quality, as well as in time and cost.
- Viability: the objectives should not be too ambitious because this might entail a non-desired dissuasive effect. They should neither be too easy to achieve in order to avoid a disappointing effect.
- Coherence with the objectives of the other areas of the company.

The objectives can be classified differently according to the time period (short, medium or long-term objectives), the beneficiary (in these guidelines, mainly the company and its workers), their priority, reason by which it is advisable to identify the basic objectives of the company in order to prioritise them for the implementation of the BATs, BEPs or CTs.

Some examples for the definition of objectives are given below:

- A company devoted to producing dairy products, whose key environmental aspects are high water consumption as well as a high pollutant load of the wastewater, will have to consider the following objectives aimed at preventing pollution at source:
  - ✓ Reduction of water consumption.
  - ✓ Recovery of the final product retained in the pipes and facilities.
  - ✓ Reuse of by-products with high organic load.
  - ✓ Reduction of the pollutant load released.
- For a company devoted to production of cement and whose key environmental aspect were a high generation of wastewater with cement wastes, this could be a sufficient reason to consider the following objectives aimed at recovering and recycling the cement:

- ✓ 100% reduction of the cement waste current generation.
- ✓ Sort the cement components present in the cleaning water in order to reintroduce the water with thin solid, sand and gravel in the process.
- ✓ Reduce the water consumption in cement manufacturing and in the cleaning operations.

4.2.2 Expected results at this stage

The result to be obtained from this stage is a **list of objectives that the company aims to achieve by implementing the BATs, BEPs or CTs,** once identified the key environmental aspects, as it is a previous step to the identification of the options that will be directed to achieved those objectives.

4.3 Identifying Options to Address Successfully the Key Environmental Aspects

4.3.1 Priorities of the environmental policy

4.3.2 Description of the options

4.3.3 Expected results at this stage

An example (following page 41)

The working team had a meeting to propose different options for preventing and/or reducing at source the generation of waste water with chromium. Initially, one of the company's technicians proposed an enlargement of the waste water treatment plant, such as larger flows could be treated. But this option was rejected from the start, because not only it did not avoid the generation of chromium waste flows but it meant as well an additional economic cost to the company without any added value, an option that would not be suitable with more strict environmental requirements that may appear in the future. Thus, the coordinator of the working group reminded why the company's policy as defined by the General Manager contemplated the prevention at source of their key environmental aspects as a priority.

Afterwards, the working group had a brainstorming session resulting in ideas for good housekeeping practices, for example, installing a tank to collect waste waster in order to avoid peaks of waste water entering the treatment plant and to try to organize the emptying of the tanks by several steps.

Due to the chromium toxicity and the impact that a discharge could cause to the fauna of the river, it was decided to hire an environmental consultant with extensive experience in tanning companies.

The options proposed by the consultant were the following:

- *High exhaustion chromium techniques: This option allows increasing the fixation of the chromium through a combination of practices that lead to the reduction of the chromium concentration of the effluent in the waste water to minimum levels. The practices most commonly used are increase of temperature, reduction of chromium concentration in the pickle bath and bath ratio.*

- *Precipitation and recovery of the chromium: The purpose of this option is to decant the chromium by a treatment with alkaly, precipitate the chromium as a hydroxyl and afterwards dilute it with acid.*

Once the key environmental aspects and objectives are determined, the company is in a position to identify which options (either techniques, practices or technologies) will lead to an environmental improvement of the company.

The objective at this stage is:

Obtaining a list of the options selected to address successfully the environmental impacts of the company that have been detected at stage 1.

More specifically:

- For the research of the ***techniques and technologies*** that could later be considered as the BATs and CTs for that company in question, it can be useful to analyse the resources that are already available to the company (publications, basic bibliography, pioneer projects, other experiences,...). Chapter 5 describes some of the resources available to the companies to help identifying the options.
- To search for ***practices*** that can later be considered as BEPs for the company in question, existing resources like brainstorming can be used or simply imagination to work out possible solutions to the key environmental aspects
- Often, and specially in small and medium-size enterprises, there is not enough time nor the capacity to carry out an assessment as proposed in these guidelines. In these cases the ***collaboration of an external expert*** could be essential.

The number of options will vary significantly depending on the company. It is possible that in one company only two or three options are detected while in another one, 20 or more.

In all these cases, specially when the number of detected options is so high it is impossible to evaluate carefully every single one, priorities should be ranked and a number of options should be selected, in order that at least those options with higher expectations to successfully address the key environmental aspects of the company are assessed.

4.3.1 Priorities of the environmental policy

The environmental policy presented in these guidelines is in consonance with the reference framework (LBS Protocol, SAP and other instruments described in chapter 1), giving priority to pollution prevention at source instead of end-of-pipe treatments. Figures 4.6 and 4.7 show the priorities of the environmental policy that are proposed. Therefore, the identification of the options addressed to the key environmental aspects of the company should give priority to minimisation instead of end-of-pipe treatments.

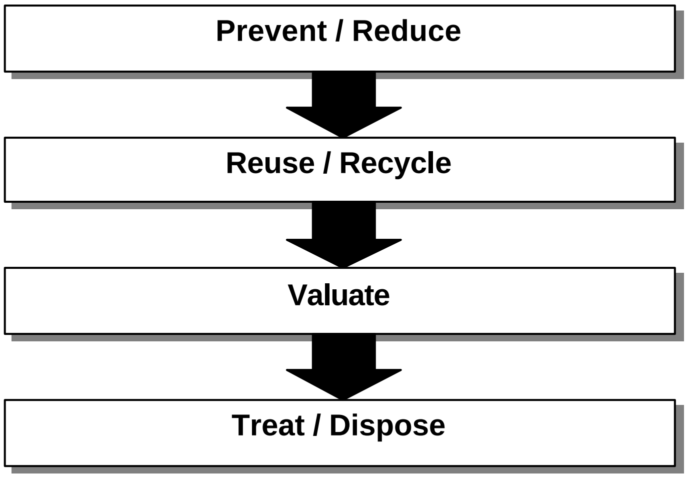

Figure 4.6 Priorities of the environmental policy (Reference: Minimisation Opportunities Environmental Diagnosis. Regional Activity Centre for Cleaner Production, 2000)

The **options aimed at minimisation enable preventing or reducing pollution** (or the risk of polluting the environment) before pollution is generated, through the modification of the production processes, the application of good operative practices, substitution of materials and products, use of technologies more environmentally sound, among others.

These preventions at source options, apart from contributing to environmental improvements, reduce the responsibility risk, improve the company's image, give a higher degree of protection to humans and the environment, and may yield considerable economic profits.

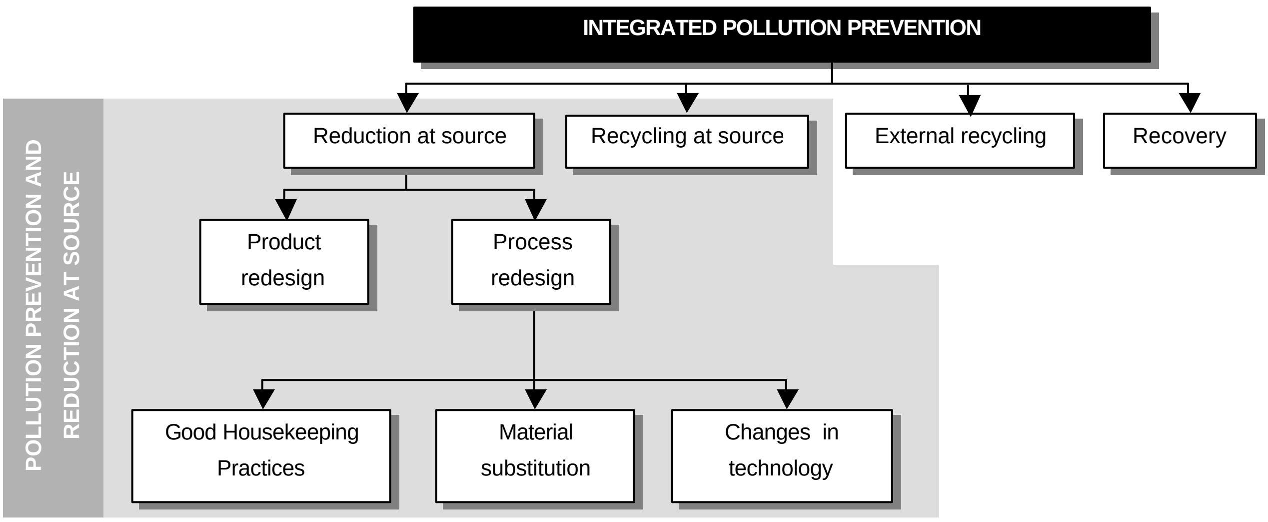

Figure 4.7 Pollution prevention and reduction at source (Reference: Minimisation Opportunities Environmental Diagnosis. Regional Activity Centre for Cleaner Production, 2000)

Once the minimisation options have been identified, the **options assigned for reusing or recycling** the waste flow that cannot be avoided in the production process or auxiliary activities of the company will be considered as a second option. And this procedure will be repeated successively on all the environmental policy stages, taking into account the hierarchy established on figure 4.6.

Once the reusing or recycling options have been identified, the **options devoted to valuation** of the waste flows of the company will be considered as the third option. These options enable the exploitation of the resources present in the waste flows without posing a risk to human health and without using methods that may be harmful for the environment.

4.3.2 Description of the options

The final objective of this stage is to identify the available options that address the key environmental aspects and obtain a general description of each one (technical information, suppliers and flow charts, among others).

There are resources that represent a starting point to identify them. Among others, the Best Available Techniques Reference Documents (BREFs) and the sector publications of the Cleaner Production Regional Activity Centre (RAC/CP). Also the collaboration of an external expert familiar with these resources is an assistance to take into account for accomplishing the objective of this stage.

4.3.3 Expected results at this stage

As a result of this process, the company will obtain a list of the options available, justifying the reasons why they are recommended. The options **will have to be prioritised according to the environmental hierarchy** proposed in these guidelines**.**

1. **Options to prevent or reduce pollution at source**
   - Raw materials
     - ✓ Substitution of toxic, hazardous or bioaccumulative substances
     - ✓ Purity of the raw materials used
     - ✓ Reduction in consumption
   - Modification of the production processes
     - ✓ Changes in equipment and machinery
     - ✓ Changes in technology
     - ✓ Changes in procedure and management
   - Modification of the auxiliary activities
     - ✓ Changes in maintenance, cleaning…
   - Modification or substitution of the product.
2. **Options for reuse or recycling**
   - Use of the waste flow as raw or secondary materials or auxiliary and/or by-products.
   - Recovery of a component from the waste flow and use at the same premises.
3. **Options devoted to valuation**
   - Energy recovery through waste reclaim as a secondary fuel in a industrial process: thermolysis, gasification, pyrolysis, biomethanisation, …
4. **Options devoted end-of-pipe treatment**
   - Waste water treatment plants.
   - Waste incineration facilities without energy recovery.

4.4 Assessment of the Options Identified

4.4.1 Environmental assessment

4.4.2 Technical assessment

4.4.3 Economic assessment

4.4.4 Results to expect at this stage

An example (following page 43)

Once the available options had been presented and with the assistance of the consultant, the working team evaluated the viability of the three detected options. The discharge of waste water containing chromium was critical for the company and they wanted to make sure that they were choosing a solution to this problem that could also reduce as much as possible the consumption of resources, in order to carry out the tanning process in a more competitive way.

In first place, an environmental assessment of the options was carried out, which is described in the following table:

Table 4.12

Assessment of the company's options. Environmental assessment

Environmental assessment	***Homogenisation of the waste water and tank emptying control***	***High exhaustion chromium techniques***	***Chromium precipitation and recovery***
Decrease in the amount of chromium in the waste water	*10 %*	*60 %*	*50 %*
Decrease in water consumption	*No*	*No*	*No*
Decrease in energy consumption	*No*	*No*	*No*
Decrease in chromium consumption	*0 %*	*8 %*	*50 %*
Decrease in consumption of new raw materials	*No*	*No*	*No*
Decrease in accident risks	*Medium*	*High*	*Medium*
Effects on human health	*No*	*No*	*No*
Legislation compliance with its application	*Yes*	*Yes*	*Yes*

Initially, the three options were giving positive environmental results, but the high exhaustion techniques of chromium were complying better with the criteria for preventing pollution at source achieving a higher reduction of most of the amount of chromium in the waste water. The following step consisted in carrying out an analysis of their technical viability, which is detailed in the following table.

Table 4.13

Assessment of the company's options. Technical assessment

Technical assessment	*Homogenisation of the waste water and tank emptying control*	*High exhaustion chromium techniques*	*Chromium precipitation and recovery*
Introduction phase			
Time necessary	*Immediate*	*Installing heat in the tanks. 1 month*	*Installing a precipitation reactor, sedimentation tank and filter press. 3 months*
New services needed	*No*	*Refrigeration water*	*pH analysis*
Adaptability of the current process	*Complete, does not affect the manufacturing process*	*Complete, it is an improvement easy to apply*	*Complete, there is enough space*
Exploitation phase			
Effects on the product's quantity	*No*	*No*	*No*
Effects on the product's quality	*None, because of the type of tanning carried out*	*If it is not done correctly it may affect the tanning process*	*If it is not done correctly it may affect the product's quality*
Personnel training and need	*Training the operators*	*Training the operators*	*Training the operators*
Maintenance and control needs	*Low*	*High*	*High*
Update or finalisation phase			
Flexibility towards future changes	*Possible necessity of redimensioning with an increase in production*	*Completely adaptable*	*Possible necessity of redimensioning with an increase in production*

Even though the first solution was technically the easier one to adopt, it was decided not to reject the other two, because their technical requirements were considered surmountable. Therefore, it was decided to analyse the economic viability of the three options (see table 3.13), in order to obtain complete information about each one before making the decision.

Table 4.14

Assessment of the company's options. Economic assessment

Economic assessment	*Homogenisation of the waste water and tank emptying control*	*High exhaustion chromium techniques*	*Chromium precipitation and recovery*
Investment (I)	*3,015.00 €*	*13,100.00 €*	*3,200.00 €*
Training expenditure (TE)	*1,000.00 €*	*3,600.00 €*	*2,800.00 €*
Total (I+TE)	***4,015.00 €***	***16,700.00 €***	***6,000.00 €***
Associated annual savings	*1,730.91 €*	*10,385.46 €*	*8,654.55 €*
Payback period (Total/ Associated annual savings)	***2.3 years***	***1.6 years***	***> 8 months***

From the analysis of the environmental, technical and economic assessments of the different options they reached the conclusion that all three were viable.

The objective of this stage is:

Assessing the options identified in order to facilitate the company's decision whether to introduce an option or not.

At this stage, the company already has a list of the options available to address its key environmental aspects. The aim of the assessment presented at this stage is to determine, in the most quantitative way possible, which options are viable for the company that is planning to carry them out.

This viability analysis plays a key role in the election of the BATs, BEPs and CTs of the company, disregarding those options, that either for environmental, technical or economic reasons are not viable. Therefore, the assessment of each option is composed of the criteria described in the following figure:

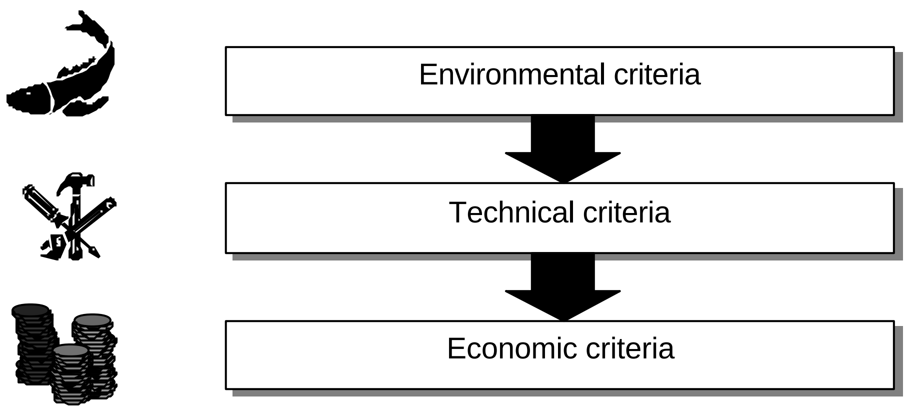

Figure 4.8 Basic criteria and constraints for analysing the viability of the options

The environmental assessment is the first to be carried out, because the options that do not carry significant environmental benefits have to be rejected right away. Afterwards, a technical and economic analysis of the options should be carried out to determine those options that may be viable to constitute the BATs, BEPs and CTs of the company in question. This methodological process involves searching for information about each option, which has to be done at this stage.

If the Administration collaborated in carrying out this methodology, its task could be supervising the identification of the key environmental aspects and options of the company, following up on the application of the methodology and the quality of the final report.

The identification of experiences where a specific option has been performed is a source of valuable information for carrying out these analyses. Also, the company has other resources available for determining the viable options, like the Minimisation Opportunities Environmental Diagnosis (MOED) or the Good Housekeeping Practices Programme (GHPP), which bring in several criteria, some of them similar to the ones presented in these guidelines.

The basic criteria and constraints assess the different options in an objective and individual way, but, afterwards and with the objective of choosing the BATs, BEPs and CTs, general criteria and constraints further developed on these guidelines should be considered.

To sum up: the basic criteria and constraints enable assessing, provide reasons to use a specific option instead of another and identify the contributing factors when the option is introduced.

4.4.1 Environmental assessment

The election of the BATs, BEPs and CTs of the company has to be aimed at those options that entail prevention of pollution from the generation of any type of waste (either solid, liquid or gas) and which reduce to the minimum the amounts of resources used.

This environmental assessment pretends to avoid the option from being just a transference of the pollution from one medium to another **(cross-media effects)**, this is specifically what the integrated pollution prevention and control principle tries to avoid. Moreover, the environmental assessment of the options should enable identifying the interdependence between different inputs and outputs, for example when the pollution reduction levels in water and air cannot be achieved at the same time.

The environmental assessment of each option should provide information to the company about the positive and negative changes that, from an environmental point of view, can take place regarding the initial situation. The advantages brought by the implementation of the options that are environmentally friendly should be direct and quantifiable, whenever it is possible. For example:

- Reduction in the generation of waste through a change in the manufacturing shelves process.
- Minimisation of water consumption in soluble coffee production.
- Recovering fibre in the cardboard production.
- Reuse of industrial cleaning waters.
- Minimisation of risk assessment.
- ...

The assessment of the different options should thus consider the following environmental criteria that should be assessed during the **option's whole life cycle**, since the option is designed until it is finished or updated[7]:

- **Environmental legislation**

  The legislation in force concerning environmental matters determines the emission limits in any environment that apply to a given territory. Those options that do not guarantee the compliance of the regulations in force will have to be directly rejected, with no need to carry out a technical and economic assessment for them.

  There may be countries where no legal framework exists concerning a specific environmental aspect. However, the option's application has to follow the eco-efficiency principle and not the simple objective of complying the legislation in force.

  Those options that involve less administrative paper work or operations in order to comply with the legislation will be preferred.

  It is also recommended to anticipate future changes in the legislation and determine how these changes may condition the election between different options and, therefore, if the option is flexible in front of future changes in the environmental legislation.

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[7] The final phase of some options may require the dismantlement of the installations or equipment that might have been necessary for the option's operation.

- **Consumption and type of water and raw, secondary and auxiliary materials**

The options that involve:

- the use of less amount of natural resources
- and/or the use of materials:
  - that are not toxic, persistent or liable to bioaccumulate;
  - that do not generate other toxic, persistent or liable to bioaccumulate compounds

are preferable to the rest of options. The following table is an example of a company that had to make a selection between 2 options that involved a reduction in water consumption in the cleaning operations of the premises.

Table 4.15

Water consumption in the cleaning operations of a given company. Environmental assessment of the options

Options	Reduction in the volume of waste water generated (m^3/d)
- Change from an open circuit to a closed one in the existing atomizers	100
- Change in the production arrangement - Elimination of unnecessary waste - Use of hose pistols	30

Option number 1 is environmentally the most suitable.

- **Energy**

The options that imply:

- a lower energy consumption,
- a greater energy efficiency,
- and/or the use of renewable or less polluting energies instead of traditional energies (fossil fuels)

are preferable to the rest of the options.

- **Waste flows (either solid, liquid or gas)[8]**

The preferable options will be those that prevent generating any of the substances from the categories contemplated in the LBS Protocol (Annex I C) and, when it is not possible, reduce the waste flows. This list of substances is detailed next.

- Organohalogen compounds and substances which may form such compounds in the marine environment. Priority will be given to Aldrin, Chlordane, DDT, Dieldrin, Dioxins and Furans, Endrin, Heptachlor, Hexachlorobenzene, Mirex, PCBs and Toxaphene.
- Organophosphorus compounds and substances which may form such compounds in the marine environment.
- Organotin compounds and substances which may form such compounds in the marine environment.
- Polycyclic aromatic hydrocarbons.

When applying this criterion the environmental assessment has to take into account the different **possibilities of waste flow management** when it is not possible to prevent them. Specifically, what type of treatment or management they require, being at source or by another authorized company: biological, physical, chemical treatment, energy recovery, ...

[8] Including any type of odour, noise and vibrations.

- Heavy metals and their compounds.
- Used lubricating oils.
- Radioactive substances, including their wastes, when their discharges do not comply with the principles of radiation protection as defined by the competent international organizations, taking into account the protection of the marine environment.
- Biocides and their derivatives.
- Pathogenic microorganisms.
- Crude oils and hydrocarbons of petroleum origin.
- Cyanides and fluorides.
- Non-biodegradable detergents and other non-biodegradable surface-active substances.
- Compounds of nitrogen and phosphorus and other substances which may cause eutrophication.
- Litter (any persistent manufactured or processed solid material which is discarded, disposed of, or abandoned in the marine and coastal environment).
- Thermal discharges.
- Acid or alkaline compounds which may impair the quality of water.
- Non-toxic substances that have an adverse effect on the oxygen content of the marine environment
- Non-toxic substances that may interfere with any legitimate use of the sea
- Non-toxic substances that may have adverse effects on the physical or chemical characteristics of seawater.

- **Effects on human health**

The industrial activities generate specific environmental impacts. Some of these impacts have more direct and measurable effects on human health than others. The main effects produced on health may be through the emissions into the atmosphere, the water and indirectly, the soil.

> Nowadays, the growing environmental awareness of the population demands developing new techniques, practices and technologies to reduce, among others, and to the extent that it is possible, the use of chemical products that can be toxic or hazardous.

This situation is specially important when:

- the installations are located in a heavily populated area and/or with a significant tourist activity;
- the occupational safety and health regulations do not guarantee an adequate health protection for the personnel of the company or, simply, there are no such regulations.

As a consequence, those options that cause fewer effects on human health (company's personnel and the local population) will be preferred from an environmental point of view to the rest of the options.

- **Risk assessment and accidents**

The environmental assessment does not have to be limited to the usual operations of the company, it should also take into account the possibilities of causing unintended impacts (**risk assessment**).

The risk assessment is the scientific process that estimates the odds of an impact happening, in this environmental case, adverse for people's health and the preservation of the natural ecosystems and the services that they provide.

For the risk assessment, two general strategies are presently being used:

- Carrying out of tests in laboratories or other facilities and using models that predict the effect of the different situations that might happen in the environment;
- Using ecological indicators present in natural ecosystems.

For each option, an identification should be carried out of the measures needed, if those are necessary, to reduce the risks and to respond to any accident that may happen in the company once the option is running.

The options with low or non-existing risk of accident are preferable to those that need measures or actions to control this risk.

- **Pollution control**

The control activities consist of the inspection and surveillance of the equipment and enable a preventive maintenance of the installations, accomplishing the following:

- Preventing or reducing the waste flows and/or the consumption of resources;
- Increasing the useful life of the CTs and improving the productivity of the production processes;
- Monitoring the degree of success as a consequence of running BATs, BEPs and CTs;
- ...

Those options that require lower control systems are preferable to the rest of the options.

The **results that the company will obtain** by carrying out the environmental assessment are:

- The **identification of those options that include significative environmental benefits.**
- The identification of those options that will have to be rejected because they are not considered as providing sufficient environmental benefits for the objectives to be achieved.

4.4.2 Technical assessment

Once the environmental assessment of the options has been done, the second step is analysing the technical viability of the environmentally viable ones. The objective of this technical assessment is the following (see figure 4.9):

1. Determine whether the option can be carried out with the **existing technical means** of the company
2. If this is not the case, identify the **technical implications that can be overcome** with new installations or additional measures for its technical viability or
3. If this is not the case, identify the **technical conditioning factors** that are **not easy to overcome**

Figure 4.9 Objectives of the technical viability analysis of the options

The already existing facilities will have more technical difficulties to adapt the options into their process compared to the new ones, because the latter are on a design stage and therefore can easily overcome any technical requirements related to a certain option.

The technical criteria that would have to be analysed at this stage are summarised in the following figure.

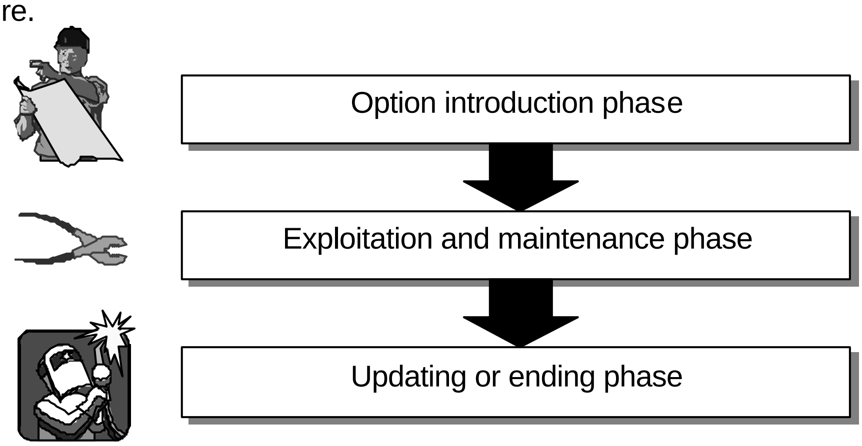


Figure 4.10 Structure of the technical assessment

This structure allows taking into account the whole option's process, since it starts until it is updated or finished.

- **Option introduction phase**

  - **Time necessary to start the option**

    Determine an approximate calendar of the option's introduction and initiation, during which the affected production line could remain closed. The options that imply stopping for less time the company's activity will be the ones preferred from a technical point of view.

  - **Need of new installations, services and others**

    This criterion allows identifying which are the necessities implied in initiating each option: installing new pipelines, electric materials, extending the capacity of the existing services, as well as determining the availability of these elements.

    The options that carry less necessities and/or a greater availability of the elements needed are preferable from a technical point of view. The following table is an example of the technical assessment of an option following this criterion.

Table 4.16

Technical assessment of a pollution prevention option of a company belonging to the food preserving industry

Description of the option	Needs	Availability of the requirements
Drying brines by solar energy	- Availability of a sufficient extension of land	- The company is located in a heavily populated area (13,000 inhabitants/km^2)
	- Location in places of high insulation	- The annual maximum temperature of the area does not exceed 15º C

This option is technically not too viable under this criterion

- **Adaptability to the production process**

Evaluate if for operating the installation it is necessary to:

- ✓ Redefine the production processes.
- ✓ Introduce changes in the use of raw, secondary and auxiliary materials that are currently being used.
- ✓ Improve the qualification of the personnel.
- ✓ Hire more personnel.
- ✓ Modify the existing equipments and auxiliary facilities in order to adapt them to the new production processes.

The options that imply a better adaptability to the company's production process are preferable from a technical point of view.

The following table is an example of a company that had to make a decision between two options that implied a decrease in water consumption used for cleaning the facilities.

Table 4.17

Technical assessment of the pollution prevention options of a company belonging to the food preserving industry

Options	Adaptability to the production process
- Structural cleaning with a high pressure system with foam	- From a hygiene point of view, this option is not recommended during production because it produces organic fog that could contaminate the surfaces in contact with the product
- Structural cleaning with a low pressure system with foam	- From a hygienic point of view, it does not involve the same inconvenient that high pressure cleaning does

The option number 2 is technically more feasible

- **Exploitation and maintenance phase**

- **Repercussion to the quantity and quality of the product**

This criterion allows evaluating the effects that the changes introduced by the option will bring to the:

- ✓ product's quality: durability, resistance, client's specifications, ...
- ✓ annual production capacity of the facilities,
- ✓ others.

The options most suitable from a technical point of view will be those that improve the products quality and/or increase the annual production capacity of the company. In any case, the options that reduce the product's quality and/or the annual production capacity will have to be rejected in order for the company to remain competitive.

- **Training and personnel need**

The perfect performance of an option requires a specific number of workers with a specific training level. The economic implications that these two factors bring have to be considered at the economic assessment, and have key importance in the selection of BEPs of a given company.

If what is necessary is to improve the skills of the operators, the company will have to define:

- ✓ the detected lack of training that would have to be carried out;
- ✓ the need to have expert collaboration to carry out the training (qualified teaching personnel);
- ✓ the personnel's time availability.

The technically most suitable options for the company are the ones that don't require any extra personnel training and/or an increase in the number of staff.

- **Maintenance and control of the activity**

The company has to determine if carrying out an option requires maintenance and control elements that were not needed before. For example:

- ✓ New equipment and means for the correct maintenance and control of the option introduced: laboratories, checklists, records; ...
- ✓ A larger area availability associated to this new equipment;
- ✓ Automatic and computerized process control systems;
- ✓ Specific personnel dedication;
- ✓ Courses and seminars addressed to update the knowledge of the company's maintenance and control personnel.

The options more technically suitable for a company are the ones that do not require a considerable change in the human and technical means needed for the maintenance and control of the production process.

- **Updating or ending phase**

  - **Flexibility towards future changes**

Those options that are more flexible towards future changes will be the most recommended from a technical point of view. The option's adaptation capability to the trends of the sector that the company belongs to should be analysed; new objectives, changes in the business strategy, new consumer requirements or the subsequent implementation of other options, among others.

Anyhow, it is recognized that the assessment of this criterion is very complex, difficult to quantify and has a certain degree of subjectivity.

The **results that the company will obtain** by performing the technical assessment are:

- The **identification of those options with technical implications that the company can overcome**; those will be considered technically viable.
- The identification of those options that involve technical difficulties for the development of the daily company's activity that the company cannot overcome; in this case, those will have to be rejected.

4.4.3 Economic assessment

Once the environmental and technical assessments of the options have been done, the third and last step of the methodology concerning the options assessment under basic criteria and constraints, is to analyse the economic viability of the options that are environmentally and technically viable.

The possibilities of economic profit are generally more immediate when selecting BEPs, as these can have a low investment cost or even non-existant, due to the change in working habits (turning off the water taps correctly, turning off the lights when there is no one in the

The ultimate objective of the economic assessment is to quantify the company's possible profits as a consequence of the implementation of a specific option as compared to its initial situation.

The purpose, then, of this section is to provide the companies with a basic methodology to carry out an economic assessment of the identified options that have proved environmentally and technically viable. The following parts constitute this methodology:

- **Relation of the necessary actions** to adopt an option. The investment capacity of the company in question will determine which options can be carried out (*the investment capacity is understood as the economic capacity that the company has at a given time to invest*). If an option happens to be not suitable, anyhow, it would be convenient to continue the process in order to find out its economic viability.

- **Determination of the annual savings** measured as the economic profit variation regarding the company's initial situation.

  ✓ In case that an option involves positive annual savings, the company will have to analyse its economic viability, together with other options that also have positive annual savings, under the same evaluation criterion.
  ✓ If the profit of the new situation (once the option is adopted) is less than the initial situation profit, the savings will be negative and, as a consequence there will be a loss. In these cases there will be no need to continue the economic analysis, this option will have to be rejected.

- **Determination of the economic viability** of every option, using different financial indicators which have been developed to obtain comparable values:

  ✓ Investment payback period (IPP)
  ✓ Net present value (NPV)
  ✓ Internal rate of return (IRR)

The steps to carry out an economic assessment of the options are shown in the following figure:

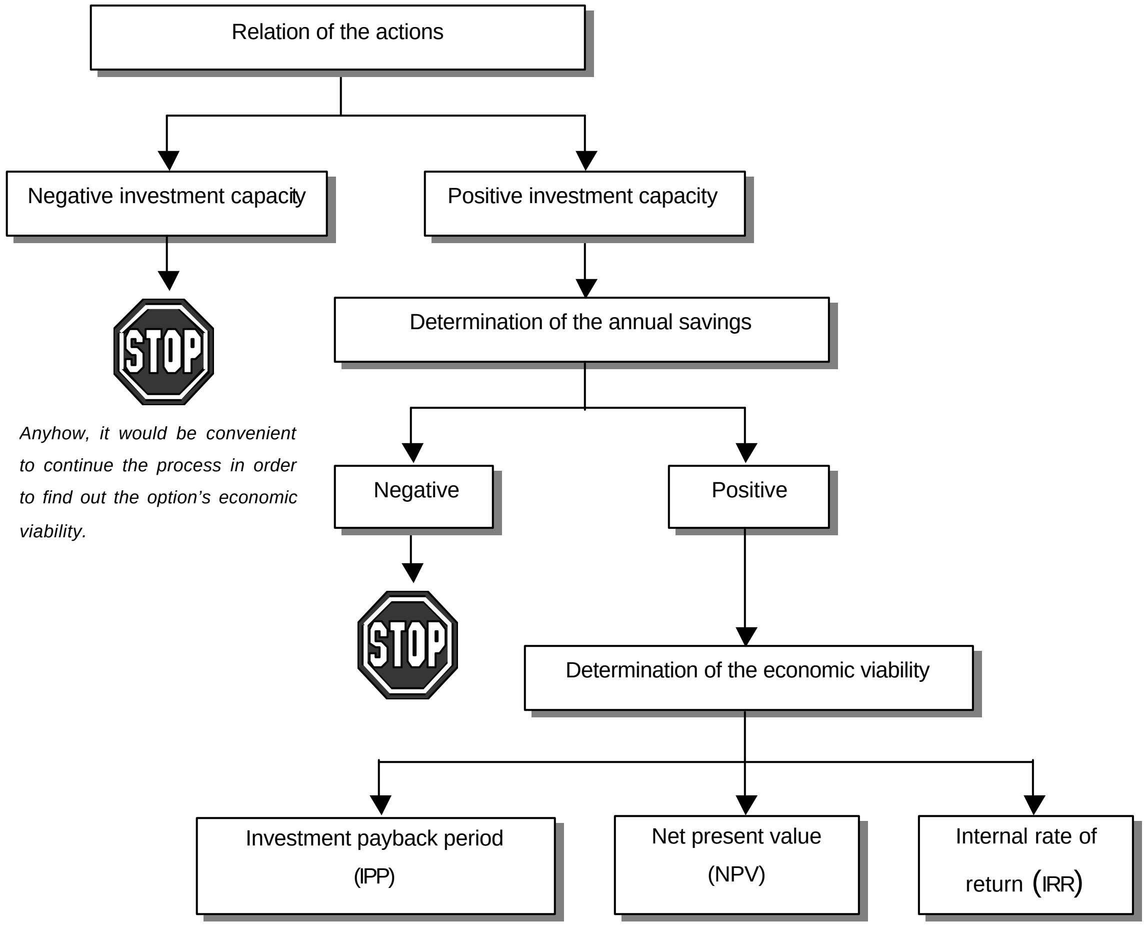


Figure 4.11 Economic assessment of the options

Some of the economic items included in these guidelines, which will be developed next, may not make sense with regard to the option that is being evaluated, and, on the other hand, there might be very specific items that do not appear in the guidelines, but imply significant costs to the company. It is recommended to add the expenditure or revenue items that are missing and to leave in blank the items that do not apply to the option evaluated.

- **Relation of the actions**

In first place the necessary actions for adopting each option will have to be determined, if there are any, for example:

> The options with a low investment pay back period (for example 3 months) are not always viable for the company. If it is a high investment, the small and middle-sized businesses may not have sufficient capital or financial capacity to make the initial investment required for the application of the option.

- Acquisition of distillers and storing tanks for reusing glycol in a synthetic fibre manufacturing company.

- Purchase of a tank and all the auxiliary equipment (pumps, pipes, filters, discharge spouts, among others) for the storage of varnish, for the reduction of the wastes generated in the storage of raw materials in a company dedicated to surface treatment.

Once the relation of actions is known and, in consequence, the associated cost of these actions, if the investment capacity of the company is positive, the following step will be the determination of the annual savings. When the company has a negative investment capacity, it would be convenient, anyhow, to continue the economic assessment in order to find out the economic viability of the option.

The possible grants or aids that may be obtained when carrying out any of the options that have been verified as BATs, BEPs or CTs of the company in question, will have to be deducted from the total investment, when they have been granted. The revenues obtained by the sale of the existing equipment will also have to be deducted.

The table presented next is a list of the possible actions necessary to adopt a certain option:

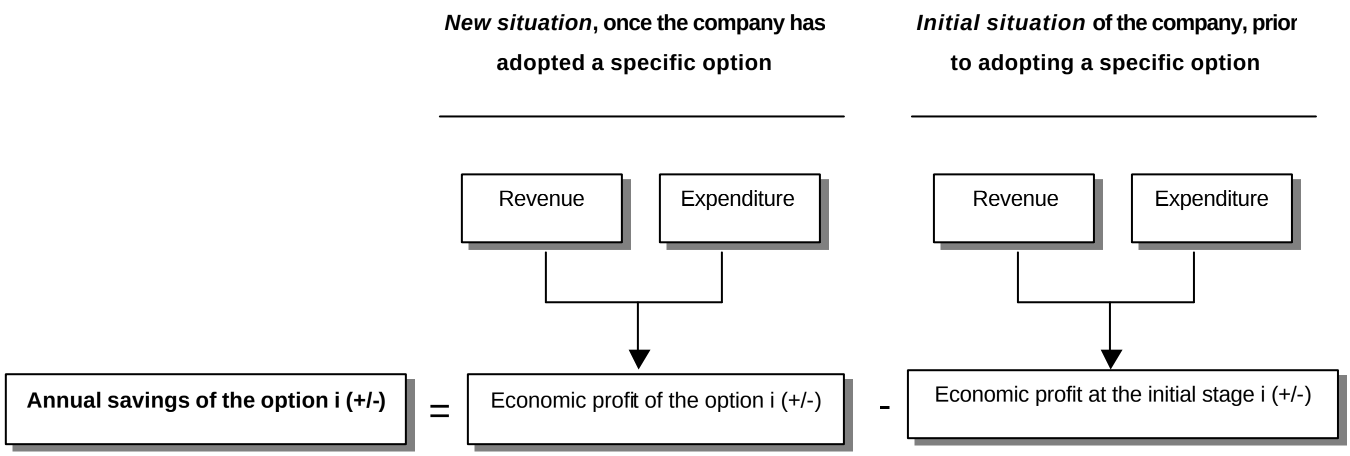
Table 4.18

Relation of the necessary actions to adopt a specific option

Concept	Examples	Cost
Purchase of equipment	✓ Prices, taxes, insurances, transport, ...	
Personnel	✓ Extra training of the personnel for initiating an option (courses, seminars, ...)	
Area adequation	✓ Purchase of land (if it is the case), sorting the place (demolition, dismantlement, ...), update the access to the installations, insulations, …	
Start-up	✓ Purchase of initial chemical substances, contingency resolution, contracting suppliers, contractors, electricians, ...	
Additional facilities	✓ Creating storage areas, offices, areas for production outputs, security, risk reduction, maintenance and control elements (laboratories, ...)	
Connection to basic services (water, electricity, ...)	✓ Installing pipes, electrical materials, extending the existing service capacity, ...	
External collaboration	✓ Contracting experts, engineers, consultants, …	
Administrative procedures	✓ Obtaining licenses, permits, ...	
Incidents	✓ Unexpected circumstances	
TOTAL		

- **Determination of the annual savings**

The objective is to identify the annual economic profit variation by comparing it to the initial situation of the company.



If the difference is positive, the annual savings will also be positive, but if the profit of the new stage (once the option is adopted) is lower than the profit of the initial situation, the savings will be negative, and as a consequence there will be loss.

- In case that an option entails positive annual savings, the company will have to analyse its economic viability, together with the rest of the options, under a same evaluating criterion.
- In those cases where the option entails negative annual savings, generally, there will be no need to continue the analysis process, this option will have to be rejected. However there might be companies that are inclined to assume the cost overrun of an option with negative annual savings, if, for example, environmentally it involves a series of intangible profits which the company consider sufficient.

The table presented next may help to calculate the economic savings that the adoption of a certain option might entail.

Table 4.19

Calculation of the annual savings that an option may entail

Concept	Examples	Initial stage	New option	Savings (+/-)
Pay-off costs of the equipments	✓ Process equipments and auxiliary facilities			
Operating costs	✓ Cost of the input materials: raw, secondary and auxiliary materials, basic services consumption (water, electricity,...), ... ✓ Purchases which are regularly needed, but that are not directly linked to the production, for example uniforms. ✓ Hiring of personnel and/or extra training (courses, seminars, ...)			
Maintenance, control and monitoring costs	✓ Maintenance of new equipment, additional facilities, cleaning, laboratories, security and control elements, ... ✓ Periodic inspections and laboratory analysis of the performance of the production processes and auxiliary activities of the company ✓ Installations for verifying the results and the implementation of continual improvement systems, ...			
Environmental managing costs	✓ Taxes, disposal and emission royalties, collection and internal treatment, storage, waste management, ... ✓ Complying with the administrative procedures (waste declaration and any type of information that the administration requests)			
Other	✓ Insurances, incidents, ...			
TOTAL COSTS				
REVENUE	✓ Tax profits, sales of by-products, increase in the product's price due to an increase in the product's quality			
ANNUAL SAVINGS OF THE OPTION				

- **Determination of the economic viability**

Once the options that entail positive annual savings have been identified, it is necessary to determine the viability of each one under the same evaluation criterion, since not all the options have the same useful life, for example, in the case of technologies.

There are different financial indicators that have been developed with the objective of analysing the economic viability of every option under comparable values. These indicators should comply with two essential criteria:

1. Take into account all the annual savings flow during the option's life.
2. Take under consideration the changing value of money over time, in other words, deduct adequately the future annual flow savings.

The Internal Rate of Return (IRR) and the Net Present Value (NPV) satisfy both criteria and are considered, along with the Investment Payback Period (IPP), suitable resources for carrying out this economic assessment, as it is shown in the Minimisation Opportunities Environmental Diagnosis Guide (may 2000), elaborated by the Centre for the Enterprises and the Environment and distributed in the MAP countries by the RAC/CP.

- **Investment Payback Period (IPP)**

It is defined as the necessary time to recover the original investment of an option.

It is calculated in the following way:

$$\text{IPP} = \frac{\text{INVESTMENT MADE}}{\text{ANNUAL SAVINGS}}$$

The result of this operation is a time period expressed in years.

The economic viability evaluation is more precise when the calculation is over options that have short-term benefits, because this calculation estimates parameters that will take place in the near future. In these cases the precision degree ot the estimation can be high, and it is important that the company requires itself to carry a very precise and rigorous analysis of the data used.

Table 4.20

Practical example for the calculation of the Investment Payback Period

Concept		Unit
Investment in a cleaner production option		80,000 €
Total production cost	Old process (1)	20,500 €/year
	New process (2)	4,750 €/year
Annual savings (1-2)		15,750 €/year
Investment Payback Period (investment/annual savings)		**5.08 years**

The IPP is the simplest technique to do a fast economic viability evaluation of an option. However, the following has to be taken into account:

✓ The normal IPP does not include the cost of capital (the interest rate), so that the cost of the debt and of the exploitation of their own resources used to carry out the investment are not reflected in the annual saving flows or in the calculation.

> The introduction of BEPs has usually an immediate or low payback period.

- ✓ If the annual savings take place with the expected rate until the IPP year, then the project will reach the equilibrium point from a monetary point of view, but this indicator does not take under consideration the positive annual saving flows that may take place after the payback period (IPP).

However, the payback period enables estimating the time that the resources of the company will be compromised to an option, and therefore, the IPP is normally used as an indicator of the option's cash flow.

- **Net Present Value (NPV)**

This method calculates the present value of every annual saving flow produced during the option's life, and it is deducted from the cost of capital of the company, also known as the cost opportunity for its financial resources.

The sum of the deducted annual saving flow constitutes the updated gross value implied by the implementation of the option, in another words, the annual savings generated during the option's life measured from the initial implementation time. Once we subtract the option's initial investment, we will obtain the NPV. The NPV is calculated with the following formula:

$$\textbf{NPV} = \sum_{i=1}^{n} \left[\frac{\text{ANNUAL SAVINGS (+/-) (i)}}{(1 + r)^{i}} \right] - \text{INVESTMENT}$$

r: interest rate (the cost of capital for the company, or the cost of the opportunity for its financial resources);
n: useful life of the option;
i: sum of all the years of an option's life (n), with the year when the investment was made being considered as 0.

If the NPV is positive it means that the option is economically viable, while if it is negative, it indicates that it is not, and so has to be rejected. When the economic availability is limited, as can happen in small and medium-size companies of the Mediterranean basin, or when there are several options in equal circumstances competing with each other, the option (either technique, practice or technology) with the higher NPV has to be selected.

Table 4.21

Practical example for the calculation of the Net Present Value

Concept		Unit
Investment in a cleaner production option		25,000 €
Total production cost	Old process (1)	15,300 €/year
	New process (2)	7,600 €/year
Annual savings (1-2)		7,700 €/year
Interest rate		4.00 %
Useful life of the option		5 years

Following the NPV formula, the payment of the initial moment investment must be subtracted from the addition of the updated savings that the investment generates:

$$\boxed{NPV} = \frac{7{,}700}{(1+0.04)} + \frac{7{,}700}{(1+0.04)^2} + \frac{7{,}700}{(1+0.04)^3} + \frac{7{,}700}{(1+0.04)^4} + \frac{7{,}700}{(1+0.04)^5} - 25{,}000$$

Net Present Value	**9.790** *(> 0, therefore, the investment is economically viable)*

- **Internal rate of return (IRR)**

The IRR method calculates the discount rate that equals the updated value of the expected annual saving flows of an option with the investment that it implies. In this way, the basic formula to calculate the IRR is to equal the NPV to zero.

$$\mathbf{0} = \sum_{i=1}^{n} \left[\frac{\text{ANNUAL SAVINGS (+/-) (i)}}{(1 + \text{IRR})^{i}} \right] - \text{INVESTMENT}$$

n: useful life of the option;
i: sum of all the years of an option's life (n), with the year when the investment was made being considered as 0.

Table 4.22

Practical example for the calculation of the Internal rate of return

Concept		Unit
Investment in a cleaner production option		10,000 €
Total production cost	Old process (1)	280,000 €/year
	New process (2)	273,000 €/year
Annual savings (1-2)		7,000 €/year
Interest rate		4.00 %
Useful life of the option		2 years

Following the IRR formula, the addition of the updated savings must be equal to the payment of the investment in the initial moment. For the example of the anterior table, the formula would be the following:

$$10{,}000 = \frac{7{,}000}{(1+IRR)} + \frac{7{,}000}{(1+IRR)^2}$$

Internal rate of return	**25.69%** *(> 4.00%, therefore, the investment is economically viable)*

It is said that an option is economically viable when the IRR obtained is higher than the monetary cost needed for financing the option (r). When different options compete with each other for limited resources under equal circumstances, the option with a higher IRR will have to be selected.

The **results that the company will obtain** by carrying out the economical assessment are:

- **the identification of those options that will mean economical benefits for the company,** enough to be able to return the investment done (in case it is necessary) in an acceptable time period for the company.
- the identification of those options that have been rejected under economical criteria.

4.4.4 Expected results at this stage

At this stage, a report including the viability analysis of the options will be obtained, with their respective environmental, technical and economic assessments. The order that these assessments should have been carried out, according to the hierarchy that these guidelines propose:

- In first place, the **environmental assessment** of the options. In case that the option does not provide significant environmental benefits, it will have to be rejected from the start. For all the environmentally viable options, the company will have to proceed to a technical assessment.
- The **technical assessment** of the options will enable finding what effect will applying an option have on the development of the company's daily activity and also knowing if the personnel needs extra training, equipment, within other things. The options that do not involve any technical difficulties that cannot be solved will be considered technically viable. In these cases, as a last stage the company will proceed to the analysis of economic viability.
- The **economic assessment** of the environmentally and technically viable options will have to identify the ones that provide economic profits, sufficient to pay back the investment made (in case that an investment was necessary) in a reasonable period of time. Therefore, it also identifies which options will be rejected under economic assessment.

The result of this assessment is a group of viable options for the company. If there are options that have resulted not viable, the report would have to include the corresponding justifications.

This non-exhaustive analysis will serve as the basis and as a working tool to carry out the following stage of the methodology: the election of techniques, practices and technologies that will be considered as the Best Available Techniques, Best Environmental Practices and Cleaner Technologies for the company in question.

4.5 Selection of BATs, BEPs and CTs for the Company in Question

4.5.1 Intangible benefits of each option

4.5.2 Local environment conditions and geographical location

4.5.3 Expected results at this stage

An example (following page 48)

Finally, the company had to decide which was the most suitable option for addressing the chromium content in their waste water. The three were viable options for the company, and up to this point only carrying out the good housekeeping practices by itself was rejected, because it had a very little environmental benefit compared to the other two.

The working group had a meeting again with the company's management in order to decide what option would be the most suitable. It was at this point that other type of criteria were introduced, which made the working group opt for one specific option. It was agreed that the following had to be taken into account:

- *The company was worried because it could not assure the compliance of the discharge waste water limits, and the best way was to reduce the maximum possible the use of chromium.*
- *The majority of the company workers lived in nearby villages, and therefore were aware of the environmental impacts associated to the industrial activity of the company. The Management decided to give priority to their workers, so that they could be proud to work in a company committed to the environment and their citizens.*
- *The high exhaustion of chromium techniques improved the quality of the finished product.*

With the application of these criteria, the working team decided that the best option to introduce was the high exhaustion of chromium techniques. At the same meeting the indicators for monitoring the success of the option were defined.

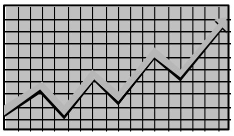
The objective at this stage is to:

Choose the techniques, practices and technologies that constitute the BATs, BEPs and CTs for the company in question, taking into account the basic criteria and constraints from the 4th stage as well as other general criteria and constraints for the decision making.

Having reached this point, the company will have carried out the following actions:

- The key environmental aspects of the company will have been identified (main waste flows, waste of resources as a consequence of a non-environmental friendly activity, among others).
- The definition of the objectives that the company wishes to achieve by implementing the BATs, BEPs and CTs.
- The opinion of everyone involved will have been listened to, including the experts that might have been consulted, to identify all the possible options that will improve the current situation.
- All the options will have been evaluated under environmental, technical and economic criteria and, as a consequence, the viable options will have been identified.

The guidelines wish to be a tool that facilitates the decision making in the companies, but they do not constitute a rigid and exact resource. The selection of the BATs, BEPs and CTs of the company is the most important stage of the methodology and, however, it can be the less exact and more qualitative stage. This will happen, mainly, in those cases where a high number of options have been detected. Even though the environmental, technical and economic assessments enable selecting some specific options, the final selection will also have to be subjected to:



Intangible benefits

Local environmental conditions and geographical location

The general criteria and constraints introduced in this selection make even more complex an election that is already complex for the company only considering the defined basic criteria and constraints.

The complexity appears when all the criteria have to be evaluated in a combined way, as it is shown in the following figure:

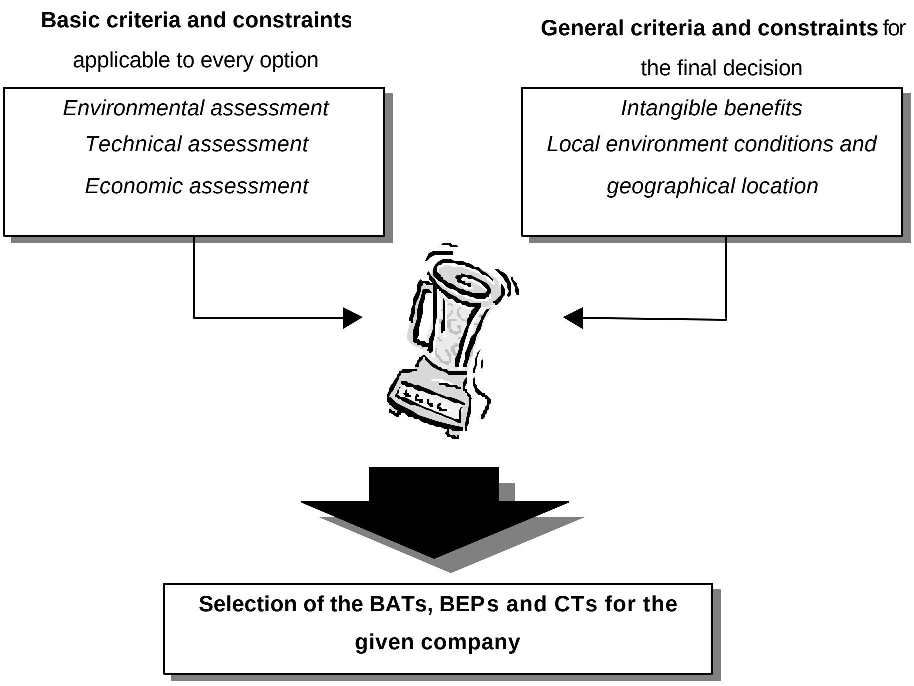


Figure 4.12 Selection of the BATs, BEPs and CTs in a given company

In this process it is necessary that the company makes anybody with responsibilities over the production processes that are being studied participate and takes into account all the opinions and information from the actors involved. Every option has to be considered carefully and the final decision has to be meditated and adopted taking under consideration all the determinant factors.

The adequate selection of the options (as techniques, practices or technologies), under the defined basic and general criteria and constraints, would have to enable determining which are the BATs, BEPs and CTs of the company in question and represents a key stage for achieving success. Resulting from this analysis, a list of options will be presented (techniques, practices and technologies), options that have been considered BATs, BEPs and CTs of the company according to the environmental policy and the priorities of the company.

> A too ambitious election that does not work out may compromise future implementations. Therefore it is recommendable to choose a reduced number of BATs, BEPs and CTs, but carry out the right selection. All the company's personnel will be more satisfied if they can see the results.

There are resources that contemplate the options selection stage as, for example, the Minimisation Opportunities Environmental Diagnosis (MOED) or the Good Housekeeping Practices Programme (GHPP), among others, and which can help the company to determine which are the general criteria and constraints that together with the basic, have to be taken under consideration in the election of BATs, BEPs and CTs of the company.

4.5.1 Intangible benefits of each option

As mentioned previously, at the time of making the decision to introduce a certain option, the company needs objective criteria. The environmental, technical and economic assessments of the options will have to be presented in a quantitative way, whenever possible.

Anyhow, the company has to take into account a series of benefits, which are not easy to quantify, resulting from an option's implementation. These benefits can be defined as **intangible benefits**.

The company should not consider that these intangible benefits are less important than the others ones analysed, just because they are based on qualitative aspects. These aspects can be decisive to select options that initially did not represent sufficient or significant environmental, technical and/or economic benefits.

The intangible benefits, associated to introducing a certain option that is carried out to prevent pollution, are the most difficult to foresee. In general, the intangible benefits associated to the introduction of BATs, BEPs or CTs might be some of the following examples:

- Minimisation of the impact on the environment.
- Higher income due to a better product.
- A better image of the company or of its product.
- Improved quality of the product.
- Improved conditions at work, reduced risk of accidents and increase in the level of satisfaction and productivity of the personnel.
- Reduced possibility of fire in the chemical substances warehouse.
- Reduction in neighbour's complaints about the odours generated in the installations.
- Increase of the portfolio of clients.

4.5.2 Local environment conditions and geographical location

The **local environment conditions** (degree of pollution, protected natural areas or sensitive areas,...) and the geographical location (population density, water availability,…) to which a given company is subjected influence as well the election of BATs, BEPs and CTs, together with the intangible benefits, being therefore another element that contributes to the decision making. For example:

- The option that provides greater environmental and economic benefits to the company will not be implemented if it requires a high consumption of water in a territory with a scarce availability or with an irregular supply.
- For the same reason, an option identified by a company as the most suitable may remain just a possibility if it requires a high consumption of electricity in an area with serious energetic deficiencies.

The local conditions, to which a company located in the Mediterranean region might be submitted to, are the following:

- Population nearby the industrial activity.
- Water availability.
- Presence of endangered marine species.
- Pollution degree of the Mediterranean region.
- Energy availability.

- **Population nearby the industrial activity**

The Mediterranean region is characterized for being one of the larger population densities in the world, which becomes accentuated during the summer with the arrival of tourism:

- The resident population of the Mediterranean basin was 285 millions of habitants in 1970, and in year 2000 reached 427 million; this means that it increased 142 millions in a period of thirty years. The last demographic projection developed by the Blue Plan calculated that this amount would increase to 523.5 millions by year 2025. The population density is higher in the coastal areas, and specially near big cities like Barcelona, Rome, Cairo, …
- The Mediterranean basin is the main destination for tourists in the world, representing 30% of the international tourist arrivals and a third of the income generated by international tourism. The sea and sun tourism is mainly seasonal and increases every year[9].

This concentration of population in areas with high industrial activity could have significant effects on human health in the short or long term.

- **Water availability**

The main water resources for human, industrial and agricultural use, among others, are the lakes, rivers and underground water. Often, the water available is far away from the consumption points, making its use more complex.

The distribution of water coming from other regions has several significant environmental impacts, as for example:

- the reduction of the existing ecosystems in the natural water reservoirs;
- the loss in distribution systems;
- ...

The unequal distribution of the quantity and quality of water mainly affects the economic development of:

- the north African countries, where some of the worst draughts of the world occur;
- certain regions of Spain, Italy or France, have low precipitations, extensive irrigation agriculture areas and high level of industry. These countries, where water is less abundant than in northern Europe, the water consumption of the agricultural sector is much greater than in the other sectors, around 80% compared to the 20% of industrial and urban[10] consumption.

- **Presence of endangered marine species**

The decrease in habitats caused by human pressures, one of them being the industry, involves a reduction of the biodiversity and changes in the ecosystems. Even though no general disappearance of species has been detected in the Mediterranean basin[11], a reduction of habitats has been registered that could lead to the extinction of endangered species.

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9 State and pressures of the marine and coastal Mediterranean environment (European Environment Agency, 1999)

10 Global Environment Outlook 3. UNEP

11 State and pressures of the marine and coastal Mediterranean environment (European Environment Agency, 1999)

Any industrial activity that may have direct or indirect effects on the natural habitats of the Mediterranean basin should take into account the presence of marine and fresh water species that are threatened or endangered in the Mediterranean basin.

In this sense, Annex II of the Protocol concerning specially protected areas and biological diversity in the Mediterranean, adopted in the Barcelona Convention in 1996, and revised in the Bern Convention in 1998, establishes a list of the marine and fresh water species that are threatened or endangered in the Mediterranean region.

- **Pollution degree in the Mediterranean region**

The evaluation of the degree of marine pollution includes the pollution of all parts of the Mediterranean basin: mainly the marine environment, rivers, the coast and gulfs. When selecting a specific BAT, BEP or CT, the company should consider the current conditions of the quality of the environment potentially affected.

And special attention should be given to the areas called hot spots, usually located in bays and gulfs: these areas are characterized by being semi-enclosed and near important harbours, major cities as well as industrial areas, and probably represent the main pressure in the Mediterranean region. Some of these areas with higher economic costs for remedial actions are shown in the following table, according to the information available from the year 1998 included in the MAP technical report No. 124 (Identification of priority pollution hot spots and sensitive areas in the Mediterranean)[12]:

Table 4.23

Priority hot spots with economic costs for remedial actions (Mln €[13]) higher than 97,51 Mln€ (Reference: MAP Technical Reports Series No. 124 "Identification of priority pollution hot spots and sensitive areas in the Mediterranean", United Nations Environment Programme and Mediterranean Action Plan, 1998)[14]

Hot Spot	Country	Source of pollution	Estimated economic costs for remedial actions (Mln €)
Gt Beirut Area	Lebanon	Domestic and industrial	136.5
Gabes	Tunisia	Domestic and industrial	128.7
Inner Saronic Gulf	Greece	Domestic and industrial	126.8
Tripoli	Lebanon	Domestic and industrial	123.4
Porto Marghera (VE)	Italy	Domestic and industrial	117
Marseille	France	Domestic	107.3
Abu-Qir Bay	Egypt	Domestic and industrial	98.6+
Bari-Barletta	Italy	Domestic	97.5

[12] It should be noted that the aforementioned report was being updated during the development of these guidelines and thus, it might be possible that the new report on hot spots and sensitive areas comes out before these guidelines are presented. The figures shown in table 3.19 are included as being the only reference available when the guidelines were being carried out.

[13] 1 USD = 0.9751 €

[14] + signs after figures mean more input, not quantified

- **Energy availability**[15]

  The energy consumption in the Mediterranean region represents 9% of the world energy consumption; Mediterranean Europe consumes 80% of the total energy consumption of the Mediterranean countries. But while Europe registers a growth of the energy demand equal or lower than an annual 1.5%, most of the south and east Mediterranean countries register growths in the energy demand higher than an annual 4%.

  On the other hand, the consumption structure of the Mediterranean countries depends directly on fossil fuels, which represent over 80% of the energy consumed, and it is foreseen that the important role of these fuels in the Mediterranean energy structure will remain the same. In this sense, the selection of the BATs, BEPs and CTs of the company in question will have to give priority to the options that are environmentally more adequate, such as the options entailing a reduction in energy consumption, a better energy eco-efficiency or the use of renewable energies (solar energy, wind power, ...).

4.5.3 Expected results at this stage

Once the company has reached this stage, the methodology used will enable to select a list of techniques, practices and technologies that represent the **best available techniques (BATs), best environmental practices (BEPs) and cleaner technologies (CTs) of the company** in question. For this selection, the company will have taken into account the basic criteria and constraints applicable to every option, and general criteria and constraints for the final decision:

- **Basic criteria and constraints** applicable to every option: environmental, technical and economic criteria.
- **General criteria and constraints** for the final decision: intangible benefits, local environment conditions and geographical location.

The BATs, BEPs and CTs will have to be compiled and documented in a report in which the company, necessarily, justifies the action made. As it has been mentioned before, the reasons may either be quantitative or qualitative, but will have to be in consonance with the essence of the guidelines, and more specifically, with the principle of integrated pollution prevention.

4.6 Implementation of BATs, BEPs and CTs in a Given Company

4.6.1 Parameters to be taken into account for a correct implementation

4.6.2 Expected results at this stage

An example (following page 65)

The implementation of the high exhaustion chromium techniques took a month, as it had been planned. During this month, the staff responsible to introduce them was specially careful in avoiding any change in the tanning process and in the quality of the final product, as consequences of implementing these techniques.

The techniques were totally adaptable to the process given that they were of easy application. However, during the first week of implementation of the techniques, training of the workers was needed, which was done by technical seminars.

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15 Portfolio “Eficiència energètica” No. 141 (Catalan Institute for Energy –Government of Catalonia–, 1997)

Once the BATs, BEPs and CTs of the company have been selected, the implementation of the options depends on several determining factors that need to be analysed.

The objective at this stage is to:

Prepare the ground and ensure a successful implementation of the BATs, BEPs and CTs previously selected.

In order to implement the BATs, BEPs or CTs that have been chosen, the company would have to lay the ground to ensure a successful introduction of those options in its daily activities. At this stage, the company can introduce modifications in its usual performance, by an eventual series of trials and tests, if needed.

The success of this process depends on a set of parameters or factors. The guidelines provide a set of recommendations that can be found next concerning those factors.

4.6.1 Parameters to be taken into account for a correct implementation

Implementing the selected BATs, BEPs or CTs in a company is a process that, among others, depends on the following factors:

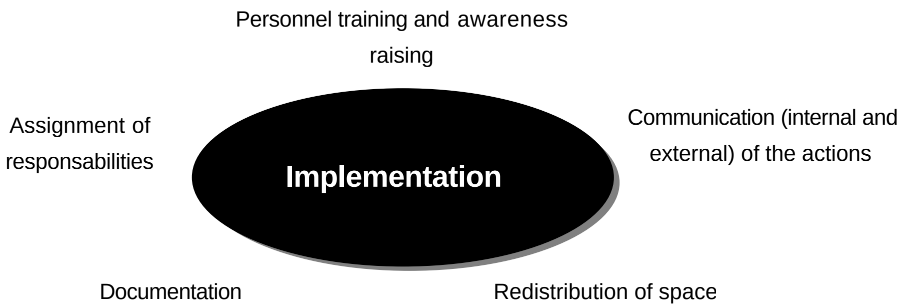


Figure 4.13 Parameters to be taken into account for a correct implementation

- **Assignment of responsibilities**

  The correct implementation of the BATs, BEPs or CTs that have been chosen requires defining previously the role and functions of the workers involved in the implementation, their responsibilities, the authority and the necessary resources to carry out this stage of the methodology.

  The responsibilities of the staff involved in the implementation stage should not be limited and should reach the rest of the organisation, in order to obtain a commitment from all the workers of the company.

  This commitment has to begin with the Head of the company, which has to make sure that the selected option (BAT, BEP or CT, or a combination of them) is correctly implemented by the appointing the necessary human, technological and financial resources.

  In small and medium-sized companies, the designation of responsibilities might be sufficiently covered by assigning a single responsible person that assures the implementation of the option or the set of options selected by the company.

However, regardless of the company's characteristics, the person having the maximum responsibility and authority in the implementation process should have to fulfil, as far as possible, the following requirements:

- Have an appropriate environmental training.
- Have capacity to supervise and coordinate work teams.
- Have knowledge about the organisation and needs of the company.
- Have sufficient authority and power to act, given by the company's manager.
- Have knowledge or experience on the implementation of processes and machinery in general.

▪ **Training and awareness raising of the personnel in charge of applying the implementation**

The company should satisfy the needs of training and awareness raising of the personnel in charge of implementing the BATs, BEPs or CTs, and assess the results obtained.

The training activities should be specific and appropriate for each kind of option to be implemented, depending on whether it is the implementation of a new complete process, practices, a technology, …

▪ **Communication of the project**

It is important to inform periodically about the implementation of the BATs, BEPs or CTs in the company. Specially, when the implementation is planned to go on for a specific time period (months). This communication has to be both internal (within the company) and external (the company with external parties). In both cases, the communication process has to:

- Transmit clear, trustworthy and objective information.
- Stimulate reciprocal communication (feedback).

Internal communication can be done through informative documents, a news board and internal periodic publications, among others. In this sense, motivation of the personnel can be obtained when reaching the objectives and goals established is recognised and published through the communication process.

External communication is the one established between the company and the external interested parties concerning environmental aspects. Communication with the Public Administration is included here.

▪ **Elaboration of the relevant documents where the processes and actions are registered**

Implementation of the BATs, BEPs or CTs of the company will have to be reflected in documents constituting the support of the system or process.

The characteristics of this documentation will differ depending on the size and complexity of the company, but it is recommended to avoid excess of documentation as it is little operative and reduces agility to the performance of the system. This documentation can be in form of handbooks, instructions, registries, …

In any case, the documentation will have to be characterised by the following.

- Being understandable, easy to find and identified with a code or specific denomination.
- Being reviewed when necessary and approved by the authorised personnel.
- Being available and updated.
- Stating the date, name of the department of the company and people who registered the information and authorised it.

The use of computer resources is highly recommended with the aim of systematising this flow of information and managing it with the highest possible efficiency.

- **Redistribution of space at the facilities of the company (especially when implementing BATs or CTs)**

Redistribution of the workforce and the machinery in the working area may be necessary during the implementation of BATs or CTs in a company. The physical rearrangement of industrial elements will include elements such as minimum-required space between the equipment, machinery, storage and other activities or services.

The rearrangement of space as a consequence of the company's BATs or CTs implementation should consider, among other things, future enlargements. A good relocation of the facilities and equipment may yield several of benefits for the company, such as:

- Reduction of health risk and increase in worker's safety.
- Increase of the useful capacity of the industrial facilities.

Doing lay-outs and technical documents for space relocation enables a minimum guarantee of success in the task of implementation. These studies will have to include not only the localisation of the BATs or CTs of the company, but also the realignment of the electrical, hydraulic networks and all other systems that can be affected in this stage of the methodology.

New companies and companies in the designing stage will have less difficulties in implementing BATs or CTs, as they can plan in advance the distribution of space and the facilities through lay-out.

4.6.2 Expected results at this stage

At the end of this stage, **the company will have laid the ground to ensure a successful implementation of the BATs, BEPs or CTs**. Namely, the company will have appointed the people in charge of the implementation process and their responsibilities, carried out eventual personnel training, designed a communication strategy and the documentation system to be used, studied space redistribution, and performed eventual trials and tests, if needed.

4.7 Monitoring and Continual Improvement

4.7.1 Verification of the results

4.7.2 Redefining the BATs, BEPs and CTs of the company

4.7.3 Expected results at this stage

An example (following page 71)

A year after the introduction of the high exhaustion chromium techniques, the working group had a meeting to analyse the results obtained from carrying out these techniques. The reduction of chromium in the waste cleaning water had reached 57%, similar to what was expected. Anyhow, the company decided to carry out again the same methodology applied a year before in order to identify the pollution prevention options that could help addressing successfully its environmental impacts.

The objective at this stage is:

Carrying out a **periodic monitoring of the BATs, BEPs and CTs introduced in the company** for verifying the degree of accomplishment of the expected results and, if this was not the case, for redefining the BATs, BEPs and CTs of the company.

The integration of the environment in the company is a process in constant evolution, due to the appearance of new options for preventing and reducing pollution at source. This is how it is presented in Annex IV of the LBS Protocol, where it mentions that what is currently considered as BAT, BEP or CT of a company for certain production processes may change with time, keeping up with technological, economic and social progress as well as with changes in scientific knowledge.

For this reason, the implementation of the BATs, BEPs and CTs of a company is not the result of applying a methodology at a specific and static moment in time. This implementation is associated to a **continual improvement process** (see figure 4.14) which has to be kept continued through:

- assessing the results, by using eco-efficiency indicators, and,
- updating the techniques, practices and technologies of the company, according to the scientific progress and changes in the socio-economic framework.

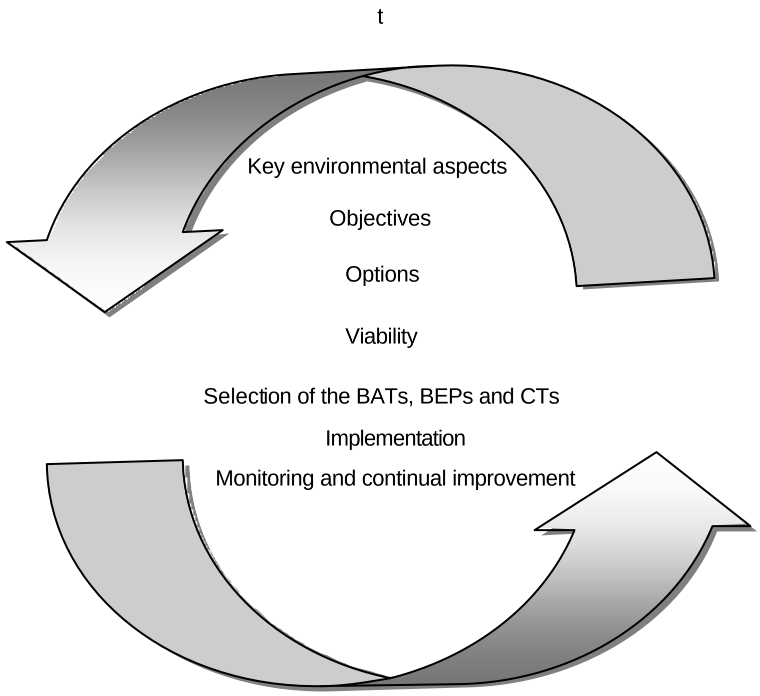


Figure 4.14 The concept of monitoring and continual improvement

4.7.1 Verification of the results

Once the BATs, BEPs and CTs of the company have been selected and a gradual procedure to introduce them has been carried out, it is convenient to carry out a **periodic monitoring of the BATs, BEPs and CTs operation which will allow to verify the accomplishment degree of the expected results.**

> The GHPPs, during the evolution of the results of the BEPs of a company, introduce habit indicators. These indicators provide information about the degree of the BEPs introduction into the daily activity.

The verification process of the results should be:

- measurable, if the options were chosen by the company with quantitative criteria and
- evaluated in a subjective way by the Management in case that the options were chosen for qualitative aspects.

If we are dealing with a quantifiable evaluation, and therefore objective, the results have to be expressed in values comparable to the initial situation, either in:

- environmental units, such as: percentage of reduction of solid, liquid and gas emissions, consumption rates, or
- economic units, as for example: assessing the decrease in the cost of the corresponding waste flow management, the cost of cleaning the equipment, the cost of water and energy consumption,…

> The changes introduced in the production processes as a consequence of the implementation of the viable options may provide new minimisation options that were not viable before.

Furthermore, production will have to be monitored in order to assess the implications of implementing the BATs, BEPs and CTs.

Table 4.24

Examples of indicators for the pursuit and process of continual improvement

Units	Examples
Environmental units	- Energy consumption, being in form of fuel-oil, natural gas, coal, …(J) per kg of product - Water consumption (m3) per kg of product - Raw material consumption (litres or kg) per kg of product - Emission rate of CO2 per production unit at a given time - Wastewater generation emission (litres) per water consumption (litres) - Annual generation of industrial wastes (kg) per annual invoicing (€) - Wastes devoted to reutilisation, recycling and recovery (kg) per annual generation of industrial wastes (kg) - kg of product per quantity of wastes reused in the same company or in others (kg) - ...
Economic units	- Maintenance cost of the waste water treatment plant (€) per kg of product - Maintenance cost of the emissions control facility (€) per kg of product - Cost of the complete management of wastes (€) per kg of product - Cost of the environmental sanctions (€) per kg of product - ...

The results obtained should be communicated to all the workers of the company, either to encourage them in case of positive results, or to inform them that the BATs, BEPs and CTs of the company are not being exploited correctly, in case of negative results, and then take the necessary measures for its correction and improvement.

There are resources like the Minimisation Opportunities Environmental Diagnosis (MOED) or the Good Housekeeping Practices Programme (GHPP) that allow a systematic, documented, periodic and objective assessment of the options to determine the degree of accomplishment of the expected results.

Every successfully implemented option becomes a solid argument for applying new options and to extend the methodology of the guidelines to the rest of installations of the company. In this sense, it is advisable to transfer any experience in these aspects to other projects that the company carries out in other installations.

4.7.2 Redefining the BATs, BEPs and CTs of the company

The redefinition of the BATs, BEPs and CTs of a company can take place in any of the following scenarios:

- when there are deviations with respect to the expected results, either quantitative or qualitative. In these cases, if necessary, the company would have to apply the appropriate corrective measures;
- when more innovative options appear (either techniques, practices or technologies) and, therefore, new business opportunities, it is advisable to question the suitability of the BATs, BEPs or CTs implemented before;
- when the improvements (mainly environmental) introduced in the production process and in the auxiliary activities of the company, as a consequence of implementing the BATs, BEPs and CTs of the company, yield new and different options that might become more attractive and viable than before running the BATs, BEPs and CTs of the company;
- legislation changes which result in new requirements.

4.7.3 Expected results at this stage

Once running the BATs, BEPs and CTs of the company, the monitoring and continual improvement of its production processes and auxiliary activities is a stage of the methodology that allows to:

- Verify the accomplishment degree of the expected results which should be quantifiable or qualitative.
- Identify the necessities to redefine the BATs, BEPs and CTs of the company if, for any reason, it has not produced the expected results.

> The framework affecting a company is in continuous evolution. The legislation in force (environmental, occupational, ...), the product's market, the economic framework, ... are all under a changing process and what is suitable today may not be suitable tomorrow.

- Assure a continual improvement of the environment situation of the company.

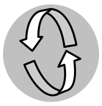
5. RESOURCES FOR THE IMPLEMENTATION OF THE METHODOLOGY

The objective of this chapter is to describe a series of resources which are complementary to the methodology presented in chapter 4 of these guidelines, and that may facilitate its application.

In this sense, the chapter is **not an exhaustive list of resources available** and reduces its scope to some representative resources that have been considered interesting for the companies in the MAP countries to carry out the selection of the BATs, BEPs and CTs:

Minimisation Opportunities Environmental Diagnosis (MOED)

Good Housekeeping Practices Programme (GHPP)



Life Cycle Assessment (LCA)

Institute for Prospective Technological Studies
ipts

Best Available Techniques Reference Documents (BREFs)

Regional Activity Centre for Cleaner Production

Sector studies of the Cleaner Production Regional Activity Centre (RAC/CP)

It should be noted that some of these resources can be more suitable for the improvement of processes or services (for example, the MOED, the GHPP, the BREFs or RAC/CP sector studies) and others, for products, such as the case of the LCA.

Furthermore, throughout the process of carrying out the methodology, the assessment of an expert in the subject is highly recommended.

Expert support

In the description of these resources, their use in the different stages of the methodology presented in these guidelines is specified.

5.1 Minimisation Opportunities Environmental Diagnosis (MOED)

This methodology has been developed by the Centre for the Enterprises and the Environment, (Ministry of the Environment, Government of Catalonia), although the elaboration and dissemination in MAP countries of the guidelines including the methodology to carry out a MOED (MOED, Minimisation Opportunities Environmental Diagnosis, 2000) has been done by RAC/CP.

According to this publication, the MOED is defined as a *tool available to the businesses which enables assessing an industrial activity to detect potential opportunities for preventing and reducing pollution at source* (BATs, BEPs and CTs)*, and that has the objective of providing the business with sufficient data for it to orientate its policy towards cleaner techniques, practices and technologies that are technically and economically viable*.

The MOED can be carried out in just a part of a company, diagnosing only the production processes and the auxiliary activities that the company considers convenient for its key environmental aspects, or it can be carried out in all of the premises.

The final objective of the MOED is to provide the company with a group of **tools for preventing and reducing pollution at source that are economic and technically viable**. The methodology used to carry out a MOED enables achieving these results at a low cost for the company and in a relatively small period of time (between one and three months depending on the company's size).

This resource may be helpful when carrying out the guidelines' methodology and, specifically, for the following stages:

- **Identifying the key environmental aspects of the company (stage 1)**

  The MOED carries out a structured treatment of the information by means of **black boxes**. This treatment consists in assigning a box to every process or subprocess of production or auxiliary, depending on the degree of detail previously defined in the MOED. For carrying out the material balances associated to these processes and activities, in each box, the inputs and outputs are identified and quantified. They are analysed in a similar way as to an input-output balance.

  With this treatment, the production processes and the auxiliary activities with possibilities of improving environmentally will be identified.

  Therefore, the MOED can help in the analysis of the *Production processes and auxiliary activities of the company* (section 4.1.2.1) of the methodology developed in these guidelines, and more specifically, in the identification of the *key environmental aspects of the company* (4.1.2). Nevertheless, it should be noticed that the MOED does not contemplate the identification of the *Associated environmental impacts* (section 4.1.2.2) as a specific stage of its methodology, but they are implied in the identification of the key environmental aspects of the company.

- **Identification of the options to address successfully the key environmental aspects (stage 3)**

  The MOED describes every option identified for preventing and/or reducing pollution *(*see *Study of the specific options, MOED).*

  When carrying out the MOED, although the identification and description can be performed by the company's own personnel, an expert that knows well the sector and its key environmental aspects normally executes it. Therefore, it will be the expert who presents to the management the list of options to assess.

  In this case, and in reference to the methodology presented in these guidelines, the assistance of an expert is one of the contemplated ways for identifying the options with which to address the key environmental aspects of the company.

- **Assessment of the options identified (stage 4)**

  The MOED introduces in its methodology the environmental assessment and the assessment of technical and economic feasibility of each identified option.

  The MOED does not pretend to be a detailed project and, therefore, the options assessment is orientative. Thus, if the company is interested in introducing some of the proposed options, a more detailed and specific study of the selected options will have to elaborated.

- **Selection of the BATs, BEPs and CTs for the company in question (stage 5)**

  The MOED is a made-to-measure diagnosis for the company and, therefore, the assessment integrates all the aspects known by the expert that is carrying it out. More specifically, the local geographical aspects and those specific aspects of the company that have been detected during the visits to the company and/or have been explained by the company's workers.

  However, it is the company who has all the strategic information necessary to give priority and choose the options that provide more benefits both to the company and to the environment.

- **Monitoring and continual improvement (stage 7)**

  The MOED proposes elements and systems for monitoring and carrying out a continual improvement of the options selected by the company that are perfectly adaptable for monitoring and updating the BATs, BEPs and CTs.

  ✓ Assigning a person in charge of the internal monitoring and redefining duties.
  ✓ Creating registers for verifying the accomplished improvements.
  ✓ ...

5.2 Good Housekeeping Practices Programme (GHPP)

A GHPP is an instrument developed for applying the BEPs in the industry. Applying a GHPP consists in analysing the current environmental situation of a company, which will allow identifying, choosing and carrying out the BEPs applicable to the company.

The methodology for applying a GHPP has been elaborated, published and disseminated in the MAP countries by the RAC/CP (Good Housekeeping Practices Programme design and application in industry. 2001).

It needs to be pointed out that **this methodology is specifically for the BEPs and does not consider the identification of other types of options.** While as a first step, in the same way as the MOED, the GHPP includes an analysis of the environmental situation of the company, it differs in the process of the option's identification because the MOED considers also the identification of the BATs and CTs.

On the GHPP, the BEPs identification is carried out through a brainstorming session by the key personnel and external experts (in the case that it has been chosen to have external collaboration).

A GHPP has four basic stages that are carried out in the following order, as it is reflected on figure 5.1:

- Knowing the initial situation of the company's relation to the environment, as a consequence of its production processes and auxiliary activities.
- Identify the possible good practices and select the company's BEPs that are meant to be put into operation.
- Communicate and train the company's personnel about initiating the BEPs.
- Evaluate the results obtained from the GHPP.

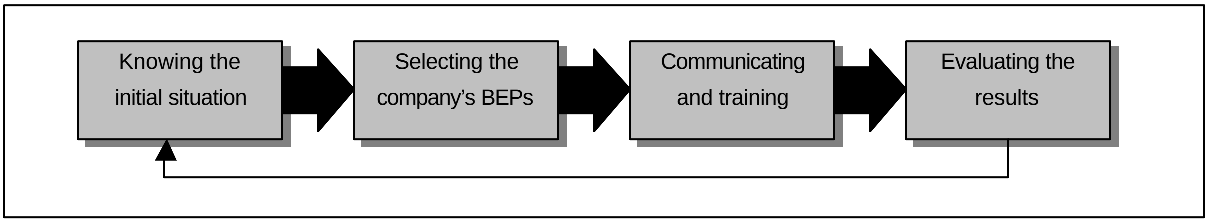


Figure 5.1 Stages that compose the Good Housekeeping Practice Programme

This resource may represent a support when carrying out the methodology presented in the guidelines when it comes to BEPs and, specifically, for the following stages:

- **Identifying the key environmental aspects of the company (stage 1)**

  The first step of a GHPP is the identification of the key environmental aspects, which have to be addressed with the objective of preventing and/or reducing the generation of waste flows and the consumption of resources, by applying environmentally-friendlier practices.

  On appendix 1 of the publication *Good Housekeeping Practices Programme design and application in industry* there are detailed examples of what could be the methodology that should be followed for identifying the key environmental aspects (see T1E1, T1E2, T1E3 and T1E4 of the publication).

- **Definition of the specific objectives of the company (stage 2)**

  The second step of a GHPP is the BEPs selection. In order to do this selection, the company has to previously define the objectives it wishes to achieve and the resources which are available. The BEPs finally chosen will have to be devoted to achieving these objectives.

- **Identifying the options to address successfully the key environmental aspects of the company (stage 3)**

  For identifying the possible BEPs that will enable improving the environmental situation of the company, a brainstorming session is carried out by the different people involved and, in some cases, with the collaboration of external experts.

- **Assessment of the options identified (stage 4)**

  In the GHPP case, this assessment considers environmental criteria when defining the BEPs to be introduced, because these type of options generally do not involve high investments or important technical difficulties. On the other hand, it is very important in a GHPP to define the training necessities of the personnel.

Therefore, as it has been said during the GHPP description, this methodology may be useful when the options studied are practices.

- **Selecting the BATs, BEPs and CTs for the company in question (stage 5)**

  On appendix 1 of the publication *Good Housekeeping Practices Programme design and application in industry* (see T2E2 of the publication) there is a detailed example of what could be the methodology that could be followed to prioritise and select the BEPs that are going to be implemented.

- **Implementation of BATs, BEPs and CTs in a given company (stage 6)**

  For the correct implementation of a company's BEPs, the GHPP places special emphasis in the training programmes and communication to the company's personnel. When the personnel does not know a new practise or is not conscious of its relevance, the GHPP contemplates the need of establishing and doing a training programme in order to ensure the correct implementation of the company's BEPs.

- **Monitoring and continual improvement process (stage 7)**

  The fourth stage of a GHPP evaluates the effectiveness of the programme, by means of an analysis system and by monitoring the results obtained, that checks that the BEPs of the company are successfully being implemented. And if this was not the case, the GHPP determines the necessity of establishing adequate corrective measures.

  On the other hand, to guarantee a continual improvement, the GHPP recommends to repeat periodically the methodology described for updating the BEPs in the company in question. This continuous application of the methodology is useful to keep actively aware of scientific changes and experiences that may take place in the field of cleaner production.

5.3 Life Cycle Assessment (LCA)

Using the Life Cycle Assessment (LCA) technique, specially due to its global character, fits in with the philosophy of the methodology presented in these guidelines.

The LCA basically consists of a group of techniques which are articulated in an objective and systematic procedure for identifying, classifying and quantifying the pollution loads or environmental impacts and the material and energetic resources associated to a product, process or activity from its conception to its elimination[16].

The LCA aims to avoid (or when that is not possible, reduce) the environmental impacts associated to a product, process or activity by starting other options focused on minimising the consumption of materials, water and energy as well as emissions into the environment.

The methodology scheme of an LCA is composed of four essential stages:

1. **Defining the objectives and scope of the study**
   This first stage of the LCA is basically composed of the following elements:

   - defining the purpose of the assessment;
   - identifying the scope of the assessment;
   - establishing a functional unit to which the environmental impacts are referenced to (*i.e.* a production unit) and

[16] Fullana P. Et al, Análisis del Ciclo de Vida del Producto, Tecnoambiente No. 49, April 1995.

- establishing a process which guarantees the quality of the data.

2. **Inventory**
   The inventory stage basically consists in registering the different environmental impacts caused by the system being studied. According to this concept, each stage or individual process from the life-cycle is considered as a subsystem. For each subsystem, the company carrying out the inventory has distinguish the materials used as raw, secondary and auxiliary materials as well as the energy sources used, water consumption and the emissions into the environment.

3. **Impact evaluation**
   The impact evaluation stage of the LCA aims to evaluate the significance of the potential environmental impacts using the results obtained at the inventory. The detail level, the selection of the evaluated impacts and the methodology used should have been defined at the stage objectives and scope of the study.

4. **Improvements evaluation[17]:**
   This is the last stage of the LCA and where the options to address the environmental impacts or loads of the system being studied are identified and evaluated, considering only environmental criteria.

It needs to be pointed out that the LCA scope goes far beyond the industrial activity. The life-cycle of a product, process or activity has its origins in the extraction and process of the materials, going through the production, transport, distribution, use and reuse, maintenance, recycling and disposal of the product's refuse.

In the case of the methodology for selecting the BATs, BEPs and CTs, the evaluation of each options has to be carried out taking under consideration the whole life-cycle of the option and of the industrial facilities.

This resource may be a support when carrying out the guidelines' methodology, and more specifically, in the following stages:

- **Identifying the key environmental aspects of the company (stage 1)**

  ✓ The inventory stage of an LCA basically consists in quantifying the different environmental impacts exerted by the studied system. According to this concept, each stage or individual process of the life-cycle is considered as a subsystem. For every subsystem, the company has to distinguish all the raw, secondary and auxiliary materials used as well as the energetic resources and the environmental emissions.
  The LCA philosophy can be a good reference when taking under account the criteria for determining which may be the industrial activity impacts and the effects of the selected option.

  ✓ The impact assessment in a LCA aims to assess the importance of the potential environmental impacts using the results obtained in the inventory.

[17] The SETAC (Society of Environmental Toxicology and Chemistry) definition does not include socio-economic factors.

- **Identifying the options to address successfully the key environmental aspects (stage 3)**

  Evaluating improvements is the last part of a LCA and consists in systematically evaluating the necessities and opportunities to address the environmental impacts associated to energy, use of materials and emissions during the whole life-cycle of the product, process or activity.

  This analysis may include quantitative and qualitative improving measures as well as changes in the design of the production processes or auxiliary activities, in the raw materials use,…Naturally, these changes should be evaluated in combination with the other determinant aspects that are not included in the LCA like the costs estimation or the technical feasibility.

5.4 Best Available Techniques Reference Documents (BREFs)

The **Council Directive 96/61/EC of 24 September concerning integrated pollution prevention and control (IPPC)**, which gives priority to the application of the pollution prevention principle in the operation of the industrial facilities in the European Union, establishes measures to avoid, or at least reduce, the emissions of these activities into the atmosphere, water or soil, including waste, in order to achieve a high level of protection of the environment considered as a whole.

In the specific framework of these guidelines, one of the interesting aspects of the European Directive is the regulation of emission limits according to the best available techniques (BATs), the technical features of the facilities and its geographical location. In this sense, it establishes that if there are changes in the BATs it will be convenient to revise the emission limits.

According to the prescriptions of this Directive, the European Commission has constituted an information and consulting system for defining the BATs on a European scale, in a consensus way between all the State members of the European Union. The **EIPPCB (European IPPC Bureau)**, hosted by the Institute for Prospective Technological Studies (IPTS), constitutes the catalyst body of this information and reference exchange, and is responsible of the reference documents elaboration (BREFs) that compile the existing techniques in each industrial sector that is regulated by the Directive and determines which are the BATs for each sector.

In this sense, **even though the Directive only applies to the EU countries, the BREFs are a useful resource for all the industries in the MAP countries** when carrying out the methodology presented in these guidelines. The industrial sectors that the European Directive regulates are shown in the following table:

Table 5.1

Reference documents on BATs (Reference: Council Directive 96/61/EC)

REFERENCE DOCUMENTS ON BEST AVAILABLE TECHNIQUES (COUNCIL DIRECTIVE 96/61/EC)	
Cement and Lime production	Management of Tailings and Waste-Rock in Mining Activities
Ceramics	Monitoring systems
Chlor-Alkali manufacture	Non-Ferrous Metal processes
Common waste water and waste gas treatment and management systems in the chemical sector	Organic fine chemicals
Cooling Systems	Polymers
Economic and cross media issues under IPPC	Pulp and Paper manufacture
Emissions from storage of bulk or dangerous materials	Refineries
Ferrous Metal processing	Slaughterhouses and Animal By-products
Food, Drink and Milk processes	Smitheries and Foundries
Glass manufacture	Speciality inorganic chemicals
Intensive Livestock Farming	Surface treatment of metals
Iron and Steel production	Surface treatments using solvents
Large Combustion Plant	Tanning of hides and skins
Large Volume Inorganic Chemicals - Ammonia, Acids & Fertilisers	Textile processing
Large Volume Inorganic Chemicals - Solid & Others	Waste Incineration
Large Volume Organic Chemicals	Waste Treatments [Previously Waste Recovery/Disposal activities]

The *IPPC BREF Outline and Guide (2000)* is a guide that aims to facilitate the tasks of elaboration of the BREFs and gives guidelines about the structure and content of these documents that are shown in the following table:

Table 5.2

Structure and general content of the BREFs (Reference: IPPC BREF Outline and Guide, 2000)

Chapter	Content
General information	This section provides general information about the industrial sector to which the BREF addresses to: evolution of the sector, worldwide production, number of workers, consumptions, …
Applied processes and techniques	Description of the processes and techniques often used in the production of the industrial sector. For example, in the cement industry case, this chapter is structured in the following way: winning of raw materials; raw material storage and preparation; fuel, storage and preparation; clinker burning; cement grinding and storage, packing and dispatch.
Current emission and consumption levels	Report of the emissions range and usual consumption levels observed in the global process and all its subprocesses: raw materials consumption, energy use, emissions, waste, noise, odour, monitoring, …
Techniques to consider in the determination of BAT	This section provides a catalogue and a description of the most beneficial environmental techniques which have to be considered when determining the BATs in the European Union.
BATs	The chapter determines which are the BATs of the sector, taking into account the environmental, technical and economic considerations, and points out that it is necessary to consider the local and geographical conditions as well as other factors in each single case.
Emerging techniques	Identification of the most recent techniques about the pollution prevention and control that may imply future environmental and economic benefits.
Conclusions and recommendations	Conclusions of the process of elaboration of the BREF, sources of data used, the consensus reached in the elaboration process of this document, deficiencies of this document and recommendations.

As mentioned previously, the BREFs constitute a useful resource for the Mediterranean industry, both for the companies that the Directive applies to as for the ones that it does not. The interests the BREFs may have to carry out the stages of the methodology presented in these guidelines are shown next.

- **Identifying the key environmental aspects of the company (stage 1)**

  The BREFs bring forward information about the key environmental aspects of the sector and its environmental impact. This is a starting point for identifying afterwards the key environmental aspects of the company.

- **Identification of the options to successfully address the key environmental aspects (stage 3)**

  The BREF is a very valuable source of information for knowing the BATs, because it compiles the available techniques to prevent pollution in a given sector.

  Therefore, for those sectors that have seen published the corresponding BREF, it is a very useful source of information for identifying the existing techniques to address the key environmental aspects (stage 3). However, before deciding the implementation of an option, a viability study will have to be carried out for each particular company.

- **Assessment of the options identified (stage 4)**

  The BREF analyses one by one the possible options that may constitute the BATs of the sector through environmental, technical and economic criteria.

  Specifically, the criteria used for analysing every technique in order to determine afterwards if they can be considered as BATs or not, are the following:

  - ✓ Description of the technique.
  - ✓ Main environmental benefits achieved through implementing the technique.
  - ✓ Operational data (performance data on emissions and consumption associated to the technique as well as information on how to operate, maintain and control the technique).
  - ✓ Cross-media effects (effects on the environment considered as a whole).
  - ✓ Applicability (if the technique is applicable considering the age of the plant, size and other factors that might be a constraint).
  - ✓ Economics (costs and savings).
  - ✓ Driving force for implementation (why the technique has been implemented to date).
  - ✓ Literature and example plants.

- **Selection of the BATs, BEPs and CTs in a given company (stage 5)**

  Finally, the BREFs determine which techniques have been considered BATs for each industrial sector of the European Union defined in the European Directive 96/61/EC. The BATs are determined for the whole sector in the EU and not company by company. Therefore, the BREF is conscious that what will have to be considered as BAT for a whole sector, may not be so for some specific companies (the techniques considered as BATs not being viable for some reason).

  However, what the BREFs repeatedly point out is that, for determining what the BATs will be for a specific company, it should be taken under consideration the particular and specific local conditions, as it is proposed in the methodology of these guidelines.
- **Implementation of BATs, BEPs and CTs in a given company (stage 6)**

As it has been said previously, the BREF analyses one by one the possible options that may constitute the BATs of the sector through environmental, technical and economic criteria.

In this sense, the BREF mentions those techniques that have been implemented up to that moment. Therefore, the description that a BREF does of a technique and, in particular, its implementation degree, may allow the company to know the actions that should be carried out in order to successfully implement the BATs inside its organisation.

- **Monitoring and continual improvement process (stage 7)**

  As the best available techniques change with time, the BREFs are documents that should be revised and that will be modified with the evolution of the techniques and the appearance of new technologies. The BREF documents are permeated by this concept of continual improvement and changing process. These are a good source of information for becoming aware of the new techniques when carrying out the monitoring and continual improvement process that the methodology establishes.

The current situation concerning the BREFs elaboration is very diverse. While some BREFs about certain industrial activities have been formally approved, others have just started to be elaborated. The available BREFs can be consulted on the EIPPCB official website:

http://eippcb.jrc.es

5.5 Sector Studies of the Cleaner Production Regional Activity Centre (RAC/CP)

The Cleaner Production Regional Activity Centre (RAC/CP) is one of the six regional activity centres that constitute some of the bodies through which the MAP gives answer to the human and economic pressures exerted on the Mediterranean basin.

Each of these operative units addresses a specific thematic area. The main objective of the RAC/CP is promoting and disseminating pollution prevention and reduction at source in the industrial sector, as well as giving technical support to the MAP countries and the public authorities and, through them, to the companies which desire promoting the implementation of more eco-efficient practices (for example applying the BATs, BEPs and CTs in their activity). RAC/CP is located in the city of Barcelona (Spain).

Among others, the RAC/CP carries out sector studies to identify the pollution prevention opportunities in certain industrial sectors and to analyse other general subjects concerning pollution prevention, like for example, which are the agents, the tools, or the legal framework through which cleaner production is promoted in the MAP countries, or the circulation of manuals for the implementation of resources like the MOED and the GHPP.

Some of the sector studies that have been published are:

- Tanning of hides and skins
- Food preserving
- Biotechnology
- Dairy products
- Printing and allied industries
- Olive oil
- Used oils
- Textile
- Surface treatment

These studies may be a helpful resource when carrying out the methodology of these guidelines, and specifically, for the following stages of the methodology:

- **Identifying the key environmental aspects of the company (stage 1)**

The sector studies describe the production processes of the sector and the associated environmental impacts.

These are aspects needed by the methodology of these guidelines for identifying the key environmental aspects of the company and/or sector and are valid for the Mediterranean companies of the sector.

- **Identifying the options to successfully address the key environmental aspects (stage 3)**

The sector studies present some of the existing options in a certain sector for preventing pollution.

The following table is an example of the content of the RAC/CP sector studies concerning options identification:

Table 5.3

List of some options for pollution prevention in the tanning of hides and skin sector

Type of options	Examples of options
Control in the plants and changes in the procedure	- Methods of preservation free of chemical products and salts - Segregation of the sulphur in the effluents - Use of trivalent chromium - Recycling the liquors from the vegetal tanning - Chromium substitution - Correct determination of the weigh in the whole process - Use of short bath systems - ...
BEPs	- Management just-in-time - Periodic washing for controlling the odour problems - Observation and control of the water use - ...
Improvement of the efficiency from external complementary facilities	- Waste recycling for the production of fertilizers - Reuse of by-products from green fleshing - ...

- **Assessment of the options identified (stage 4)**

In the sector studies some of the existing options for preventing pollution are described, a description that may include data of environmental, technical and economic aspects.

In these sector publications real cases of operating a certain option in companies of the MAP countries are described as well. The information these experiences contain focuses, among other aspects, in identifying the environmental benefits, costs and economic savings associated to the option. These data are also a good starting point or support for the company that is planning to introduce the same technique, practice or technology.

- **Selection of the BATs, BEPs and CTs of the company (stage 5)**

  The experiences that the sector studies bring forward may provide orientation in some cases about the qualitative aspects that influence the selection. The identification of these aspects is complementary information for the selection of the BATs, BEPs and CTs of the company.

- **Implementation of BATs, BEPs and CTs in a given company (stage 6)**

  As it has been said previously, in the sector studies some of the existing options for preventing pollution are described, a description that may include data concerning technical aspects. This technical description may include information regarding the implementation degree of an option aimed at preventing pollution at source or even information about conditioning factors to be taken into account during its implementation in a company.

The sector studies elaborated by the RAC/CP can be consulted at their website:

http://www.cema-sa.org

5.6 Expert Support

The process of selecting the BATs, BEPs and CTs of the company may require, during all the stages defined in the methodology that is presented in these guidelines, the collaboration of experts who are familiar and know with certain depth the existing industrial activities, practices and technologies for pollution prevention.

A real expert has the possibility of accumulating this knowledge more easily than many companies. Sometimes, and specially in small and medium-size companies of the MAP countries, there are no resources (human and technical) or access to the information about new options. For example, the research of new options (stage 3) requires good knowledge of the existing techniques, practices and technologies, and of the suppliers of the equipment associated to these options (option's availability).

Some of the advantages that the collaboration of an expert may bring are:

- The expert has the information and the capacity for using and applying it.
- Complying the agreed deadlines for carrying out the tasks.
- Obtaining new points of view, external and objective.
- Equal or higher efficiency concerning the application of the guidelines' methodology.
- Time saved for the company's personnel.

For selecting the experts, the company should have among others, the following contrasted information:

- The professional record of every expert.
- The roles that the experts were assigned where they developed their professional activity.
- The evaluation of the expert made by some companies where they worked and/or collaborated.
- Academic and complementary training of the expert.

The external collaboration will have to be complemented with the support or collaboration of the internal persons in charge assigned by the company.

RAC/CP facilitates the countries of the Mediterranean region with a list of Mediterranean professional experts structured in various categories, who may provide support to the companies or institutions that are interested in carrying out cleaner production projects. This list of experts, together with their *curricula vitarum*, are compiled in the Mediterranean experts database of RAC/CP, which may be consulted on its website:

http://www.cema-sa.org

6. CASE STUDIES OF INTRODUCING BATS, BEPS AND CTS IN THE MAP COUNTRIES

This chapter presents case studies of industries established in the MAP countries and having applied BATs, BEPs or CTs.

During the whole chapter, 6 case studies are presented: one about application of BATs, two about introducing BEPs and three about CTs implementation in companies belonging to different industrial sectors in the Mediterranean region.

Specifically, the studied sectors are the following:

- Sector 1: Chemical
- Sector 2: Food
- Sector 3: Textile
- Sector 4: Paint application
- Sector 5: Surface treatment
- Sector 6: Chlor-alkali

These case studies are presented in files, where the following information is included:

- Industrial sector
- Associated manufacturing process
- Key environmental aspects
- Description of the BATs, BEPs or CTs applied
- Environmental assessment
- Technical assessment
- Economic assessment
- Final balance.

FILE number 1	CT, CLEANER TECHNOLOGY

<table>
<tr><th colspan="4">Modification of an established production process in order to generate less waste in a chemical industry</th></tr>
<tr><td>Industrial sector</td><td colspan="3">Chemical industry. Production of chemical products for the protection of crops and intermediate products for pharmaceutical and biotechnology industries.</td></tr>
<tr><td>Associated manufacturing process</td><td colspan="3">Purification of cacodylic acid of high graduation
Chloride elimination was made with isopropanol. The chloride salt obtained was a waste saturated with cacodylic acid and alcohol. The chloride salt paste obtained was treated with water in order to recover the cacodylic acid and the alcohol. The water evaporated and the alcohol and cacodylic acid were recovered. The efficiency of the recovering process was approximately 50%. The treated chloride salt was sent to a chemical waste treatment plant.</td></tr>
<tr><td>Key environmental aspects</td><td colspan="3">- Raw materials consumption: Even though the cacodylic acid was recovered, there was a considerable loss of this compound and of alcohol. Liquid nitrogen was used in the evaporation process.
- Energy consumption: The additional water to treat the chloride salt had to be evaporated. This generated an additional operational and energy cost.</td></tr>
<tr><td>Description of the CT applied</td><td colspan="3">The separation of chlorides is carried out by electrodialysis. This process eliminates the chlorine that feeds the cacodylic acid aqueous solution.
The elimination of chlorides feeding the cacodylic acid aqueous solution makes unnecessary the use of alcohol and the process of adding water into chloride salt. The efficiency of this process reaches 95-98%.</td></tr>
<tr><td rowspan="4">Environmental assessment</td><td>Parameter</td><td>Old process (ton/year)</td><td>New process (ton/year)</td></tr>
<tr><td>Consumption of liquid nitrogen</td><td>7.2</td><td>0</td></tr>
<tr><td>Loss of cacodylic acid</td><td>0.5</td><td>0.05</td></tr>
<tr><td>Isopropanol consumption</td><td>8.2</td><td>0</td></tr>
<tr><td>Technical assessment</td><td colspan="3">The technical assessment resulted positive. The technical benefits of this action were mainly a reduction in the number of personnel needed in recovering alcohol and acid.</td></tr>
<tr><td rowspan="8">Economic assessment</td><td>Parameter</td><td colspan="2">Savings</td></tr>
<tr><td>Consumption of liquid Nitrogen</td><td colspan="2">3,636 ?/year</td></tr>
<tr><td>Loss of cacodylic acid</td><td colspan="2">6,464 ?/year</td></tr>
<tr><td>Isopranol consumption</td><td colspan="2">10,100 ?/year</td></tr>
<tr><td>Operational costs (energy, salaries...)</td><td colspan="2">30,300 ?/year</td></tr>
<tr><td>Annual savings</td><td colspan="2">50,500 ?/year</td></tr>
<tr><td>Total investment</td><td colspan="2">59,388 ?</td></tr>
<tr><td>Payback period</td><td colspan="2">14 months</td></tr>
<tr><td>Final Balance</td><td colspan="3">The important reduction of the operation costs and the improvement achieved in the security control of the process by eliminating the alcohol were decisive factors for the CT implementation.</td></tr>
</table>

Reference: Med Clean file number 38

FILE number 2	BEP, BEST ENVIRONMENTAL PRACTICE

Cleaner production in a small-scale slaughterhouse	
Industrial sector	Food industry. Meat processing.
Associated manufacturing process	**Meat processing:** The slaughter processes are semiautomated. The animal carcasses are cut and their bones are removed at the plant. The meat with no bones is sold at the three sale points of the company. The company also performs further processing (steaks, roasts, preserved meat, smoked meat, ...).
Key environmental aspects	- **Water consumption:** The main aspect associated to meat processing is the high water consumption. - **Waste water discharge:** This water has a high polluting load with blood, fat, dung, non digested stomach contents, meat and extracts, dirt and cleaning agents. The waste water from the slaughterhouse is discharged into the river after going trough a septic tank system that is not efficient enough to treat the effluents adequately.
Description of the BEPs applied	The actions that were proposed focused mainly in eliminating the polluting organic agents from the waste water and in reducing water consumption. ▪ **Process modification:** 1. Increasing the bleeding time up to at least 7 minutes, significantly reducing the polluting load of the effluent 2. Construction of a blood collection system in order to substitute the manual collection of blood and to separate blood from the waste water 3. Introduction of controlled manure composting in order to avoid the current practice of disposing of them in the riverbanks ▪ **Equipment modification:** 1. Adapting the water hose regulators: using appropriate hoses, regulators and water diffusers for a more efficient cleaning of the floor and other areas 2. Covering the drains with screens and/or lids to prevent the entry of solids into the effluents ▪ **Good housekeeping practices:** 1. Keeping the working areas tidy to avoid accidents 2. Improving the inventory controls and keeping the consumption records updated to avoid waste 3. Training the personnel in good cleaning practices and water savings 4. In cattle reception: Avoid feeding the animals before being slaughtered, reuse the waste water which is relatively clean of the refrigeration systems to clean the yard floors and the lorries, dry clean the yard holders instead of cleaning them with water, ... 5. In hide removal and dressing, control salt consumption 6. In cleaning processes: always carry out a dry cleaning process instead of cleaning with water, clean the floors with an angle up to 60º before rinsing with cold water, ... Only the actions requiring low or no investments were carried out from the ones proposed.

Cleaner production in a small-scale slaughterhouse			
Environmental assessment	**Parameter**	**Old process**	**New process**
	Water consumption	1,831 m^3/year	1,557 m^3/year
	Salt consumption	3 ton/year	1.2 ton/year
	BOD_5	3,520 mg O_2/l	2,052 mg O_2/l
Technical assessment	The BEPs applied did not have any technical inconvenience, they were completely adaptable to the production process and its application did not bring excessive technical requirements (additional personnel, space, ...).		
Economic assessment of the BEPs applied	**Parameter**	**Old process**	**New process**
	Water costs	2,849.22 ?/year	2,422.92 ?/year
	Salt costs	412.41 ?/year	164.98 ?/year
	Cost of emptying the septic tanks	378.08 ?/year	192.98 ?/year
	Waste water tax	312.78 ?/year	247.46 ?/year
	Annual total cost	3,952.49 ?	3,027.99 ?
	Annual savings	924.50 ?	
	Annual investments	58.45 ?	
	Payback period	< 1 month	
Final balance	In first place the company decided to choose as their BEPs those options that required a low investment. The good environmental and economic results accomplished have might lead the company decide to implement the rest of the proposed options soon.		

Reference: Med Clean file number 35

FILE number 3	CT, CLEANER TECHNOLOGY

Recycling at source a desizing bath with enzymes	
Industrial sector	Ennobling of a manufactured garment (jeans) for a third party
Associated manufacturing process	**Desizing by means of amylases and cellulases:** Every cotton finishing process requires previous desizing so that the processes that the garment has to go through afterwards, will be effective. When the size used is starch, the best -and easier- desizing process is the one carried out with enzymes, specifically amylases and cellulases. Amylases degrade starch destroying the size of the warp of the fabric while the cellulases degrade the cellulose from the cellulose fibres -like cotton- in order to increase the softness, intensify the colours and eliminate the dirt. The combination of amylases and cellulases in the desizing improves the final result.
Key environmental aspects	- **Raw material consumption:** In an 800 l water bath, 800 ml of amylases and 2 kg of cellulases are added. These substances are expensive. - **Waste water:** The enzymes are organic substances basically made of carbon, hydrogen and oxygen that constitute a high polluting load in the waters. The COD at the end of the desizing process can reach 9,000 mg O_2/l.
Description of the CT applied	The CT applied consisted in **recycling the desizing baths**. An additional discharge system enabled emptying the desizing bath once the process was finished and conducting it to a storage tank where all the baths originating from the different running machines are accumulated. Automatically the necessary amount for the next machine that is started is measured out and a volume of recycled desizing bath is sent, adding into this bath 30% of the enzymes that would have been used if a new bath had been prepared, and 100% of the auxiliary ones. This process was repeated 20 times every day, 5 days a week. Once a week all the desizing baths are renewed discharging them into de waste water treatment system of the company.

Environmental assessment

Parameter	Old process	Current process
Enzyme consumption (cellulases, in kg)	710,284 kg/year	3,285 kg/year
Enzyme consumption (amylases, in l)	4,114 l/year	1,394 l/year
Water consumption	4,113,600 l/year	600,000 l/year
Consumption of other bath components	5,142 l/year	5,142 l/year
COD discharged	37,022 kg of O_2/year	5,400 kg of O_2/year

Technical assessment	The recycle of baths did not affect the product's quality and there was no technical difficulty when implementing the CT.

Recycling at source a desizing bath with enzymes			
Economic assessment	**Parameter**	**Old process**	**Current process**
	Enzymes cost	116,364.84 €/year	37,596.41€/year
	Water cost	3,807.38 €/year	555.33 €/year
	Cost of other bath components	4,291.16 €/year	4,291.16 €/year
	Waste water treatment cost	3,708.48 €/year	540.91 €/year
	Total cost	128,171.86	42,983.81 €/year
	Savings	85,188.05 €/year	
	Investment	57,276.45 €	
	Payback period	0.7 years	
Final balance	Recycling at source the desizing bath with enzymes has enabled important savings in raw materials and water, and also a reduction of approximately 70% of the polluting load (COD) of the waste water in the company's waste water treatment plant, leading to a reduction in the economic and environmental costs of the company.		

Reference: Fitxa de Producció + Neta number 17

FILE number 4	CT, CLEANER TECHNOLOGY

Overspray reduction in paint application			
Industrial sector	Paint application		
Associated manufacturing process	**Painting of pieces:** The pieces prepared to be painted are hanged on the frame and go into the painting cabin. Inside the cabin, a base coat is applied, another one of paint and a last one of varnish. The painting cabin has a closed water circuit to avoid the paint coming out to the exterior. Before the CT implementation, the pulverized paint was made with conventional pistols installed in the cabin.		
Key environmental aspects	**Raw materials consumption:** With the conventional pistols, the percentage of paint transfer to the surface is not very good, because the paint comes out with a high pressure and an important part of the paint rebounds (overspray) and does not stick to the piece's surface. Therefore, an extra quantity of paint is consumed. **Solid wastes:** The excess of paint is collected with the cabin's water screen. These cabin waters are treated before going back to the system for eliminating the raw material traces collected as sludge.		
Description of the CT applied	**HVLP pistols (High volume/low pressure):** The difference between the HVLP pulverization process and the conventional one is that the former uses a large volume of paint and air at low pressure in order to atomise the paint. The reduced exit pressure of the paint and the low speed of the particles increase the efficiency of coating transfer and a reduction of up to 30-40% of overspray is achieved.		
Environmental assessment	**Parameter**	**Old process**	**New process**
	Raw materials consumption	425.55 ton/year	297.88 ton/year
	Cabin sludge management	284.70 ton/year	199.29 ton/year
Technical assessment	The CT implementation required stopping the painting installations. The pistols were therefore changed and the process adjusted during the summer. There were no more technical requirements that affected the decision to implement the CT.		
Economic assessment	**Parameter**	**Old process**	**New process**
	Raw materials consumption	2,300 ?/year	1,610 ?/year
	Cabin sludge management	51,000 ?/year	36,000 ?/year
	Annual savings	15,690 ?/year	
	Investments	30,320 ?/year	
	Payback period	2 years	
Final balance	The savings obtained by reducing the consumption of the main raw material convinced the company to apply the same CT to the rest of their factories.		

Reference: Private Foundation Institut Cerdà

<table>
<tr><th colspan="4">Position of parts in the frame, reduction of the output speed of the bath and increase of the dripping time</th></tr>
<tr><td>Industrial sector</td><td colspan="3">Surface treatment</td></tr>
<tr><td>Associated manufacturing process</td><td colspan="3">Alkaline zinc-coating of iron pieces:
The pieces are hanged on the frames and introduced in the bath. The time spent in the bath is calculated in order to assure a good coating of the pieces. Afterwards the piece is lifted and it is left dripping during a short period of time, depending on the operator's criteria and on the working load.</td></tr>
<tr><td>Key environmental aspects</td><td colspan="3">Waste water:
The pieces are positioned on the frame randomly and sometimes in a way that, when the pieces are removed from the bath, part of the liquid of the process is trapped inside the piece. This liquid is eliminated by a double rinsing process after the zinc-coating, adding zinc traces to the rinsing water. This plus the dragging produced by the small amount of rinsing time causes that a high amount of zinc is present in the rinsing water.
Water and raw material consumption:
Even though the washing of the pieces is made countercurrent, a high quantity of water has to be used to assure a good washing. Moreover, very often the zinc solution has to be refilled to compensate the loss due to the dragging.</td></tr>
<tr><td>Description of the BEPs applied</td><td colspan="3">The action carried out consists of the implementation of a series of BEPs:
1. Position of the frame pieces: the operators became aware, due to the training activities, of the importance of an adequate positioning of the pieces. After the training activities, it has been observed that the operators are careful when placing the flat pieces, in order to drag the less possible quantity of liquid.
2. Increase of the dripping time : A specific dripping time was established depending on the type of treated pieces.
3. Reduction in the extraction speed of the pieces: The operators were trained for reducing the extraction speed, by making them aware of the importance of reducing the dragging.</td></tr>
<tr><td rowspan="3">Environmental assessment</td><td>Parameter</td><td>Old process</td><td>New process</td></tr>
<tr><td>Raw materials consumption</td><td>47 ton/year</td><td>28.2 ton/year</td></tr>
<tr><td>Water consumption</td><td>8,300 m^3/year</td><td>4,980 m^3/year</td></tr>
<tr><td>Technical assessment</td><td colspan="3">In order to assure the success of the BEPs application many training hours were invested, with courses and continuous training to each and everyone of the operator. For these training tasks an external expert was hired. The practical training beside the machines, apart from resulting very effective, reduced the operator's necessary extra hours.</td></tr>
</table>

Position of parts in the frame, reduction of the output speed of the bath and increase of the dripping time			
Economic assessment	**Parameter**	**Old process**	**New process**
	Raw materials consumption	42,400 ?/year	25,400 ?/year
	Water consumption	1,800 ?/year	1,100 ?/year
	Annual savings	26,400 ?/year	
	Investments	6,800 ?/year	
	Payback period	3 months	
Final balance	Since the BEPs implementation, the operators’ degree of awareness increased significantly. Due to the success of the performance, it was decided to open a direct working line with the operators to identify possible environmental improvements.		

Reference: Private Foundation Institut Cerdà

FILE number 6	BAT, BEST AVAILABLE TECHNIQUE

Modification of the electrolysis process in the chlor-alkali manufacture			
Industrial sector	Chemical industry (chlor-alkali).		
Manufacturing process	**Electrolysis of an aqueous sodium chloride solution (brine)** The traditional technology used in Spain (and in Europe) is "mercury amalgamation", a product that coats the iron cathode using titanium anodes. As a result of the electrolysis, chlorine and caustic soda are produced, the concentration of soda is 50%.		
Key environmental aspects	- **Raw materials consumption:** In the amalgamation process mercury is consumed, a highly toxic substance. - **Energy consumption:** The energy consumption necessary for carrying the electrolysis of the salt is high.		
Description of the BAT applied	At the new company's plant, the "membrane" technology was applied. The membrane is a layer of polymers derived from Teflon, which separates the anode and cathode compartments where the reactions take place, and it is selective about the sodium ions going through. This technology produces chlorine and caustic soda with a 30% concentration compared to the 50% concentration obtained with the amalgamation process. "Membrane" cells have been installed in 30% of the premises. Furthermore, the salt from the waste recovery from the potassium exploitations in Catalonia is used, although it needs a higher purification to reduce the calcium and magnesium impurities (basically from ppm to ppb).		
Environmental assessment		**Old process**	**New process**
	Electric energy consumption	3,550 kwh/ ton Cl_2	2,730 kwh/ ton Cl_2
	Salt consumption	2.0 ton/ ton de Cl_2	2.3 ton/ ton de Cl_2
	Water consumption (without treatment + demineralised)	1.5 m^3/ ton Cl_2	4.4 m^3/ ton Cl_2
	Waste	0.03 kg/ ton Cl_2 (non hazardous waste + active carbons which go to mercury recovery or to hazardous waste management)	0.03 m^3/ ton Cl_2 (inert waste)
	Waste water	4 m^3/h	14 m^3/h
Technical assessment	This BAT has been applied on new premises. Therefore, the technical difficulties (lack of space, supply necessities, water, ...) have been considered on the global design of the facilities.		

Modification of the electrolysis process in the chlor-alkali manufacture			
Economic assessment	**Parameter**	**Old process**	**New process** [18]
	Electric energy cost	--	- 23%
	Water cost	--	+ 66%
	Raw materials cost: salt	--	+ 15%
	Waste management cost	--	- 20%
	Water discharge tax	--	+ 250%
	Maintenance cost	--	Lower
	Membranes cost per ton of chlorine	--	27 €/ ton chlorine capacity
	Investment	500 - 600 €/ ton chlorine capacity	
	Payback period	5 years	
Final balance	The membrane technology enables to eliminate the consumption of a very toxic compound like mercury, and it is the technology proposed in the BREFs concerning the chlor–alkali sector. That is why it has been selected as the company's BAT even though the economic assessment is not very favourable at a first glance. This is an example of how sometimes the intangible benefits described in the guidelines' chapter 4, and in this specific case, the interest of the company to respect the environment and work in a sustainable way make companies assume the effort of carrying out operations with long payback periods.		

Reference: Private Foundation Institut Cerdà

[18] % variation with respect to the old process.

7. CONCLUSIONS AND RECOMMENDATIONS

This methodology has been developed to contribute to the accomplishment of the regional objectives determined by the Strategic Action Programme (SAP) (see chapter 1.4 General framework*)*, addressed to reduce the impact caused by the land-based activities on the marine environment. This programme contemplates integrated pollution prevention and control as a priority for the reduction of industrial pollution.

In this sense, the methodology presented in these guidelines aims to be a practical tool to give assistance to industries in the incorporation of the principle concerning integrated pollution prevention and control and more specifically, in the identification and application of their BATs, BEPs and CTs.

Some of the aspects of these guidelines that make them interesting for any company of the Mediterranean region need to be pointed out. These aspects are the following:

- **The protection of the marine environment is a priority environmental objective of the Mediterranean Action Plan.** By applying the methodology defined in these guidelines, the companies will be able to adapt efficiently their manufacturing processes to reduce the environmental impact of their activity.

- **Environmental criteria become increasingly key when valuing a company's image.** Adapting to the requests of the clients and market trends, employees, administrations and of the society in general, are key aspects for a company to remain competitive.

- **The environmental policy included in the methodology presented enables business interests to be compatible with environmental protection.** Integrated pollution prevention and control takes into account the whole production process when looking for solutions for an environmental improvement. In this sense, this methodology enables optimising environmentally, technically and economically the company's processes and activities. Even though the main objective of applying BATs, BEPs and CTs is an environmental improvement, this improvement is accomplished by increasing the efficiency of the processes. The efficiency of processes leads to production with smaller amount of resources and less waste flow generation and, therefore, implies an increase of the company's competitiveness.

- **The methodology presented is applicable to any company regardless of its size.** Its flexibility enables to define the degree of detail with which the methodology will be applied, according to the human, technical and economic resources of the company. However, it is important to point out that no matter what degree of detail the company chooses, all the sequence of the stages defined in these guidelines should be carried out. If not, a reliable BATs, BEPs and CTs selection cannot be guaranteed.

- **The methodology presented is applicable to any company regardless of the industrial sector to which it belongs.** Any industrial sector is capable of an environmental improvement. There are sectors that because of their characteristics require more sophisticated technologies, practices and techniques, and there are others with more simple manufacturing processes. The complexity of the BATs, BEPs and CTs of each sector will be defined by their intrinsic characteristics, but with the help of these guidelines, any company will be able to identify their BATs, BEPs and CTs regardless of the sector they belong to.

- **The methodology presented enables identifying the key environmental aspects of the company.** This makes it easier to assure that the resources are being efficiently applied to the aspects of the company that are more likely to cause a higher environmental impact.

- **The methodology presented facilitates the identification of improvement options that are viable to the company.** A correct application of the methodology will enable identifying viable and adequate solutions for every key environmental aspect. This methodology does not end with the definition of a list of theoretical options but with an assessment of every option to identify those that are viable for a specific company.

It needs to be pointed out that, even though these guidelines present a common methodology for all the companies, the application of the methodology will be carried out differently in each company. In this sense, and for adapting correctly the methodology in every specific company, **a series of recommendations to take into account are presented next:**

1) Identifying the key environmental aspects

At the stage of identifying the key environmental aspects, no environmental aspect should be rejected before valuing the associated environmental impacts. Carrying out correctly this first methodology stage will assure consistency with the rest of the stages.

2) Definition of the specific objectives of the company

For the definition of the objectives that the company wishes to achieve with the implementation of its BATs, BEPs and CTs, it should be highlighted that the objectives will have to be established on the basis of consensus, and that they have to be acceptable, precise, viable, and coherent with the objectives of the other areas of the company.

3) Identifying the options to address successfully the key environmental aspects

In the same way as in the last stage, no option should be rejected before evaluating it. In some occasions, options that at first glance had a doubtful viability may be viable after assessing them, both by their own or combined with complementary options.

4) Assessment of the options identified

As it has been pointed out in chapter 4, but is important to emphasise, the environmental assessment of the options has to take under consideration that the options proposed do not transfer pollution from one medium to another (cross-media effects). The techniques, practices and technologies that will be studied have to provide a global pollution reduction at source of the company.

In the technical assessment stage the participation of a multidisciplinary team is very advisable. The team should count at least with the support of the persons in charge of the manufacturing, maintenance, engineering and quality areas. In this way, the options can be assessed from the company's different points of view and the participation of the implicated areas will be assured, in the option's technical viability assessment.

The importance of carrying out the economic assessment needs to be pointed out because every company needs to know its own economic capacity before carrying out any action, and not all the companies can choose the same options as their BATs, BEPs and CTs. However, implementing a BAT, BEP or CT and the savings associated to its implementation may contribute in turning viable those options that, previously and in isolated valuation, were not economically viable.

5) Selection of the BATs, BEPs and CTs

Every particular company will have to choose between the different options which are environmentally, technically and economically viable. This selection will be carried out taking into account the specific criteria of the company (intangible benefits, local conditions, …) and its geographical location (lack of water resources, climatology, ...). In this sense, incorporating these concepts into the methodology described in these guidelines makes the guidelines more applicable to the companies from any country of the Mediterranean region.

6) Implementation of the BATs, BEPs and CTs

During the implementation of the BATs, BEPs and CTs of the company, some aspects that play an important role in this stage should be taken into account: assignment of responsibilities, training and awareness raising among the workforce, communication of the actions (internal and external), redistribution of space, and documentation where this process will be registered.

7) Monitoring and continual improvement

In the presentation of the methodology it is clear that a non-viable option cannot be adopted as a BAT, BEP or CT of a company. However, the options that at a certain time were non-viable for the company may become viable later, either because a particular situation of the company has changed or because emergent technologies, techniques and practices consolidate in the market.

Therefore, to assure the implementation of suitable BATs, BEPs and CTs in the company, it is necessary to apply periodically the methodology presented in these guidelines, identifying possible changes in the company's environmental aspects and its associated impacts, and also being up-to-date regarding new techniques, practices and technologies adaptable to the company.

The need of updating the BATs, BEPs and CTs of the company will require capacity building programmes that will lead to a continual improvement of the skills and technical resources of the company, as well as of the company's management, and therefore, will entail environmental, technical and economic benefits for the given company.

Finally, the usefulness of these practical resources such as the methodology presented in these guidelines should be pointed out in order to achieve the objectives of industrial pollution prevention and reduction in the MAP countries. The dissemination of the methodology through these guidelines wishes to make available to the companies a tool applicable to any company of the Mediterranean region, in order to help them remain competitive and develop their activity in a sustainable way.

8. GLOSSARY

- **BAT. Best Available Technique**

  The term "best available techniques" means the latest stage of development (state of the art) of processes, of facilities or of methods of operation that indicate the practical suitability of a particular measure for limiting discharges, emissions and waste.

  - best: shall mean most effective in achieving a high general level of protection of the environment as a whole;
  - available: techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the member state of MAP in question, as long as they are reasonably accessible to the operator;
  - techniques: shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

  References: United Nations Environment Programme/Mediterranean Action Plan (2001), *Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities.* Council Directive 96/61/EC of 24 September concerning integrated pollution prevention and control (IPPC).

- **BEP. Best Environmental Practice**

  The application of the most appropriate combination of environmental control measures and strategies.

  Reference: United Nations Environment Programme/Mediterranean Action Plan (2001), *Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities.*

- **BREF. Best Available Techniques Reference Document**

  A BREF or Best Available Techniques Reference Document is a compilation of what are considered to be best available techniques in a general sense for a specific sector under the IPPC Directive (Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control). The aforementioned Directive is of application in the countries of the European Union and the BREFs are elaborated with the aim of assisting the member States in implementing the Directive.

  Notably, the preparation of a BREF is done through an exchange of information between experts from the EU member States, industry and environmental organisations (constituting a dedicated Technical Working Group or TWG), under co-ordination of the European IPPC Bureau.

  The sectors concerned by the BREFs are those included in Annex I of the IPPC Directive.

  Reference: European IPPC Bureau (2000). *IPPC BREF Outline and Guide.*

- **CP. Cleaner Production**

  The continuous application of an integrated preventive environmental strategy applied to processes, products and services to increase overall efficiency and reduce risks to humans and the environment.

  - With regard to production processes, cleaner production includes conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes.
  - With regard to products, the goal of the strategy is to reduce negative impacts during the life cycle of a product, from the raw materials extraction to its ultimate disposal.
  - With regard to services, this includes incorporating environmental concerns into designing and delivering services.

Cleaner production requires changing attitudes, responsible environmental management and evaluating technology options.

Reference: United Nations Environment Programme.

- **CT. Cleaner Technology**

Cleaner Technology may be thought of a subset of Cleaner Production activities with a focus on the actual manufacturing process itself and considers the integration of better production systems to minimise environmental harm and maximise production efficiency from many or all inputs.

Clean Technology may be an impossible or difficult goal as it can be considered as the ultimate of the search for an inherently clean technology with no unwanted by-products, total use of inputs and full efficiency. On the other hand it may be used as a comparative term, and just be better than another technology. For example, considering membrane technology as inherently clean although even this technology produces waste streams.

Reference: United Nations Environment Programme (1998). *Working Group for Cleaner Production in the Food Sector*.

- **Eco-efficiency**

Eco-efficiency can be defined as being achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the Earth’s estimated carrying capacity.

Reference: World Business Council for Sustainable Development (1992). *Publication “Changing Course”.*

- **Environmental Impact**

Consequences to human health, flora and fauna or the future availability of the natural resources, attributable to the input and output flows of a system.

Reference: Ministry of the Environment. Government of Catalonia (1996). *Iniciació a l’Avaluació del Cicle de Vida.*

- **EMS. Environmental Management System**

The part of a general business management system which includes the organisation structure, the responsibilities, the practices, the procedures, the processes and the resources to determine and carry out the environmental policy of a company.

Reference: Ministry of the Environment. Government of Catalonia (1997). *Guia per a la implantació i el desenvolupament d’un sistema de gestió mediambiental.*

- **Environmental aspects**

Elements or characteristics of an action, behaviour or activity related with the environment or that may interact with it.

Reference: Ministry of the Environment. Government of Catalonia (1997). *Guia per a la implantació i el desenvolupament d’un sistema de gestió mediambiental.*

- **GHPP. Good Housekeeping Practices Programme**
  Programme of continuous training of the personnel of the company, in order to include the good housekeeping practices in their daily working activity. This attitude or behaviour change will help to improve the company's efficiency, its environmental management and its competitiveness.

  Reference: Regional Activity Centre for Cleaner Production. Ministry of the Environment, Government of Catalonia. *Good Housekeeping Practices Programme, Design and Application in Industry*.

- **LCA. Life Cycle Assessment**
  Combination of articulated techniques in an objective and systematic procedure in order to identify, classify and quantify the polluting loads or the environmental impacts and the material and energetic resources associated to a product, process or activity from its conception to its elimination.

  Reference: Ministry of the Environment. Government of Catalonia (1996), *Iniciació a l'Avaluació del Cicle de Vida*.

- **MOED. Minimisation Opportunities Environmental Diagnosis**
  Assessment of an industrial activity in order to detect possible pollution prevention and reduction at source opportunities, and to provide the company with sufficient data for them to guide their own policy towards cleaner practices and technologies that are technically and economically viable.

  Reference: Regional Activity Centre for Cleaner Production, Ministry of the Environment, Government of Catalonia (1999). *Minimisation Opportunities Environmental Diagnosis.*

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