ECOSIND

GUIDE OF RECOMMENDATIONS FOR THE PLANNING AND MANAGEMENT OF INDUSTRIAL ESTATES THROUGH INDUSTRIAL ECOLOGY

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North East South West INTERREG IIIC

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1 Introduction to industrial ecology and circular economy

1.1. Definition

The term "industrial ecology" made its appearance in 1989 in the United States, in the prestigious journal "Scientific American". It was used in an article by **Robert Frosh** and **Nicholas Gallopoulos** [1], two engineers from General Motors.

Today, industrial ecology is a true scientific domain dedicated to sustainable development. The basic idea is to study the whole industrial society (industry, habitat, agriculture, infrastructures) as a "particular ecosystem in the biosphere".
This new viewpoint makes it possible to highlight mechanisms and interactions with the other systems of the Biosphere and thus, to identify effective solutions to manage these interactions.

In his thesis in 1992, Brad Allenby[2], one of the fathers of industrial ecology, highlighted that the way in which society works is based on an erroneous idea: that resources are unlimited and that the capacity of the biosphere to reprocess waste and to repair the damage caused by human activity is also unlimited.

Fourteen years on, this observation has been confirmed through the threats that are represented by global environmental and economic problems as well as climate change or the panic in the raw material market.
An operation of this type inevitably leads to an increase:

- In the depletion of natural resources until stocks are exhausted.
- In the biosphere, until its processing capacity is saturated.

The graphs on the following page show this critical situation as well as the transition to be effected between a Type I Ecosystem in which the resources and the waste are not limited, and a Type III Ecosystem then in which consumes almost no resources and has a quasi-cyclic material flow. Hence, every type of waste constitutes a resource for another entity.

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[1] FROSH R., GALLOPOULOS N., *Strategies for manufacturing*, Scientific American, September 1989.

[2]ALLENBY B., *Design for environment : implementing industrial ecology*, State University of New Jersey, New Brunswick, doctoral thesis, 1992.

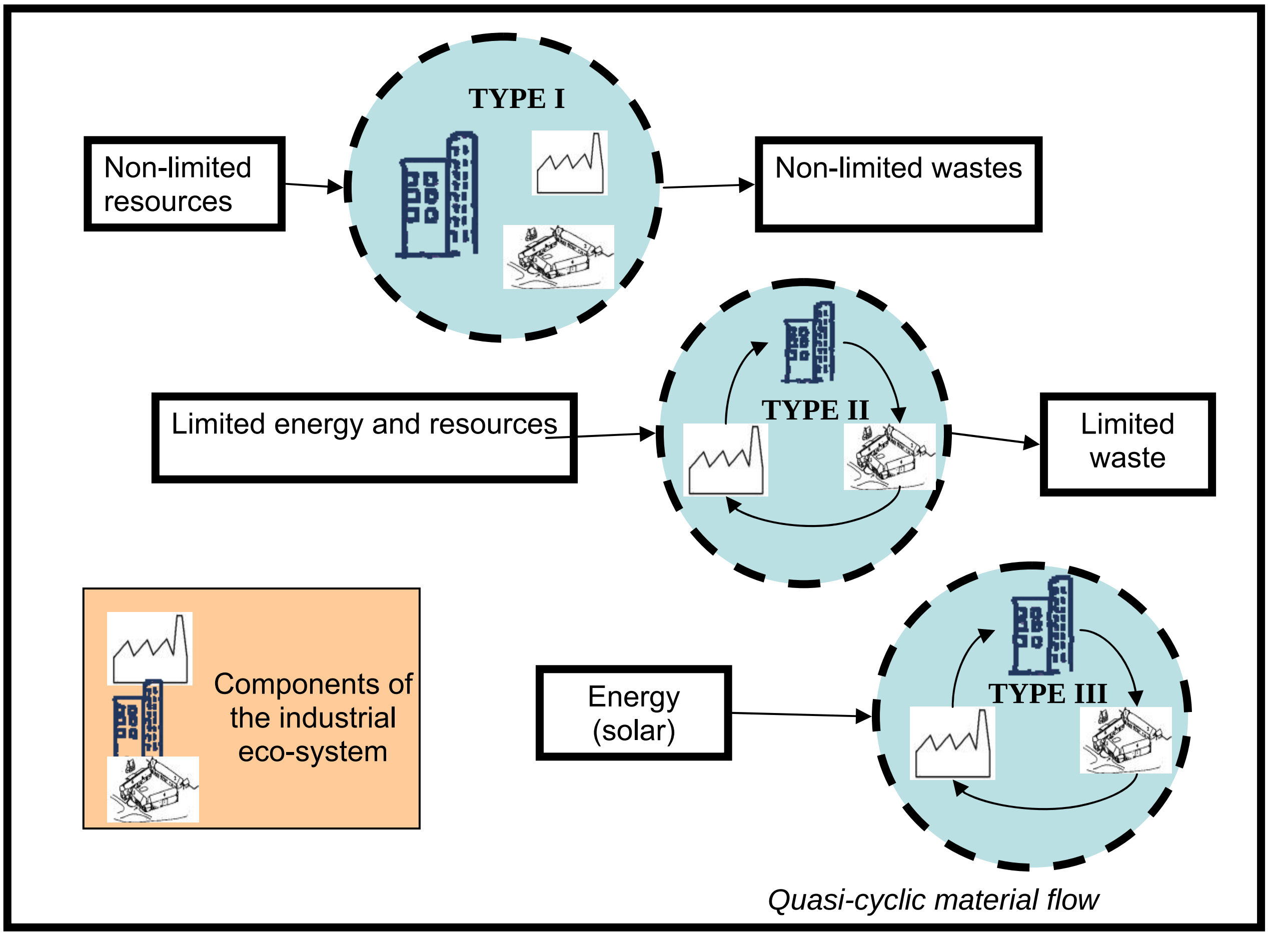

Figure 1: Representation of industrial ecosystems of Type I, II and III defined by Brad Allenby

From this point of view, there are two possible strategies for responding to the problematic situation caused by these consumptions of non-renewable resources and these discharges; according to Dr. C. Adoue[3], it is necessary to:

- ✓ Change the engine of the society, which is the economy of growth today, to imagine, have accepted and put in place "permanently" a type of society that is radically different from and better adapted to the capacities of the planet.
- ✓ Modify the organisation of society in order to disassociate the growth of the economy from that of the draining of natural resources and waste in the Biosphere.

One of the axes of industrial ecology suggests working on this second strategy to find a new organisation for the actors of the economy of growth.
By offering a **global vision** of the interactions between industrial society and the biosphere, the proposed approach makes it possible to integrate several disciplines, such as engineering, economy, regional planning, geography, ecology, law, etc., as well as several tools (Life Cycle Analysis, Material Flow Analysis, Geographic Information Systems, cleaner production).

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[3] ADOUE C., *Méthodologie d'identification de synergies éco-industrielles réalisables entre entreprises sur le territoire français*, University of Technology of Troyes, doctoral thesis, December 2004.

In addition, as shown by Cyril Adoue and Sabrina Dermine[4], French experts in industrial ecology, the proposed applications clearly constitute tools for the application of sustainable development.

1.2. Guiding principles

Here is the strategy developed by Suren Erkman[5], a renowned international expert in industrial ecology, in order to modify the functioning of industrial society.
It comprises 4 principal axes:

1) **Loop**: to recover waste and effluents
2) **Seal**: to minimise losses by dissipation
3) **Intensify**: to dematerialise the economy
4) **Balance**: to decarbonise energy

1.2.1. Loop water, materials and energy flows:

As occurs in the case of food chains in natural ecosystems, it is necessary to tend towards an industrial system where each type of waste becomes a resource for another company or another economic agent.
In particular, this requires the creation of networks for the use of the resources and waste in industrial ecosystems. It is necessary to seek the best possible types of industrial associations in order to optimise the use of resources. A certain number of examples already exist: recovery, re-use and recycling are not new concepts. It is necessary to try to develop this manner of thinking in a systematic way.

1.2.2. Seal: minimise losses by dissipation

Often, the environmental impact of phases of consumption and use of a product is more important than the environmental impact of the manufacturing phase. For example, products such as pesticides, solvents, paints, tyres, manures, etc., are partially or completely dissipated in the environment during their normal use. Thus when designing a product, it is important to consider these impacts in order to minimise or make quasi-inoffensive the dissipation of substances in the environment.

1.2.3. Intensify: dematerialise the economy

Dematerialisation consists of attempting to minimise total flows of material and energy while ensuring services which are at least equivalent. It is possible to

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[4] ADOUE C., DERMINE S., *L'écologie industrielle, un outil pour la mise en œuvre du développement durable*, SynerJIE, [on line], www.synerjie.org, consulted 17/05/2006.

[5] SUREN ERKMAN, *Vers une écologie industrielle, comment mettre en pratique le développement durable dans une société hyper-industrielle,* ISBN 2-84377-088-2, Editions Charles Léopold Mayer, 2nd enhanced edition, 2004

manufacture lighter objects in order to use fewer raw materials (eco-design) or, more generally, the most effective way to dematerialise is to provide a service in place of a product.
For example, a company which manufactures photocopiers can sell the service "to make photocopies" instead of selling the photocopier. Thus, on the economic plane, this company will be interested in renting a photocopier for this service that has the longest possible lifespan that is possible, and components that can be reused in other machines.

1.2.4. Balance: decarbonise energy

For a long time, fossil energy in the form of coal, oil and gas has been a vital element for the correct operation of the company. However its use is at the base of many current problems: increase in the greenhouse effect, oil slicks, acid rain, smog, war, geopolitical stakes, etc.
It is thus essential to minimise its use and to replace, gradually and in line with technological progress, the use of these fossil energies with energies which are less rich in fossil carbon.

1.3. An essential objective for the territories: the looping of water, materials and energy flows

1.3.1 Which interests?

The basis of industrial ecology is the study of flows and stocks of water, materials and energy within a clearly looped system (industrial estate, region, catchment area).
Thus, one of the objectives pursued is the maximal looping of these flows within the systems which make up industrial society. This objective concerns essentially territorial systems, and in this way effluents and production waste become potential resources for the other activities.
The flows of energy emitted into the environment (superfluous vapour, warm liquid or gaseous effluents) become potential sources of energy for nearby companies. Hence, raw materials, water and energy are saved, and the flows of waste to be treated decrease.
This type of approach associates environmental benefits to economic profits thanks to the reduction of waste treatment costs for companies and territories, as well as reduced supply costs.
On the social plane, the implementation of these loops of materials and energy create activity for the recovery and the transformation (clean-up, grading, repair) of flows prior to re-use.
Finally, these profits are shared by several types of actors: local government, companies and other economic actors, citizens.

1.3.2 How to loop the flows: the eco-industrial synergies.

The basic links of these loops of water, materials and energy are called **eco-industrial synergies.**
There are two types of synergies:

- ✓ Substitutions,
- ✓ Mutualisations.

As is shown in the figure below, the **synergies of substitution** consist of replacing the consumption of non-renewable materials, fresh water or fossil energy by the use of waste or by-products, used water or energy surpluses from other companies.
Thus, when two nearby entities consume an identical product, the pooling of their needs can reduce supply costs notably by rationalising the transport linked with delivery.
In case of close energy needs in vapour or in compressed air for example, the **mutualisation of production** can increase efficiency and thus reduce costs and environmental impact.
The **mutualisation of** waste **treatment** can yield sufficient quantities for more effective solutions for transport and more economic as the valuation.

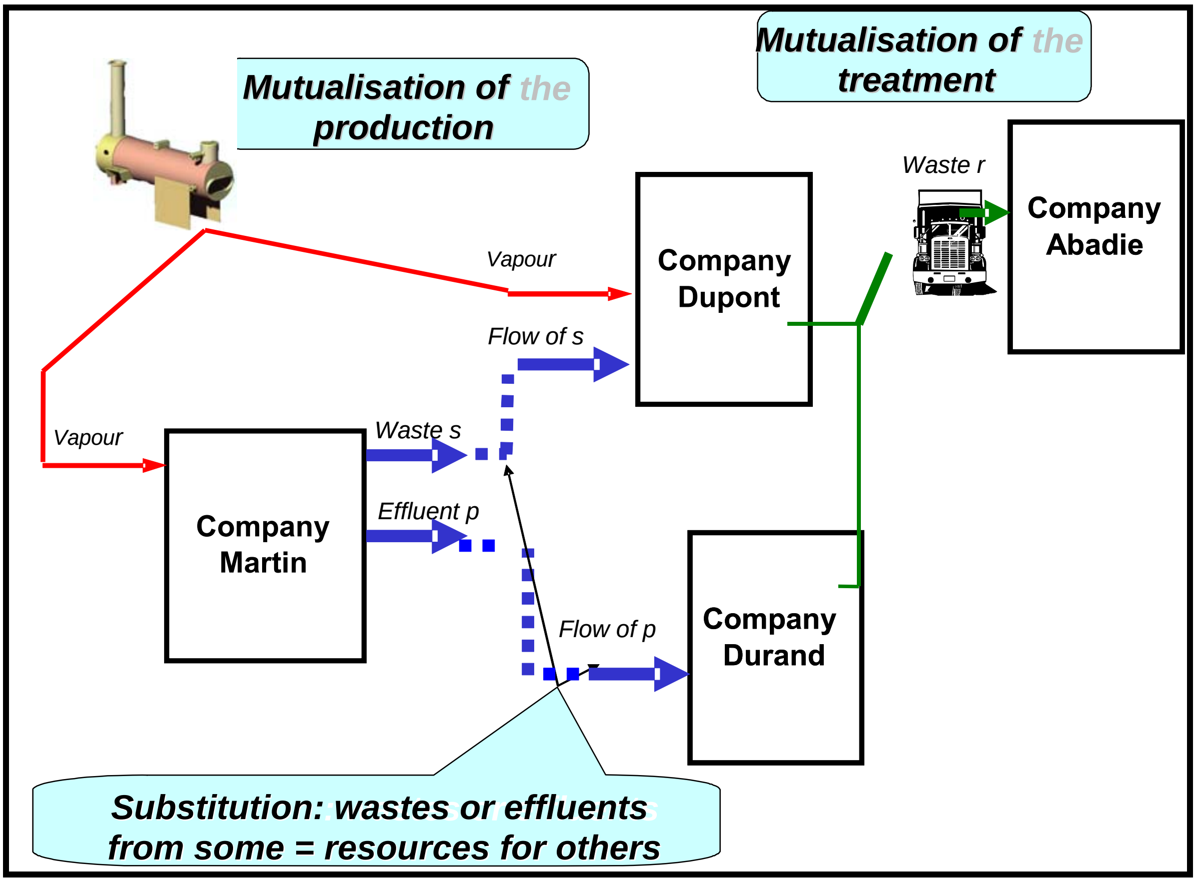

Figure 2: Examples of eco-industrial synergies

1.3.3 The industrial estate: adapted to industrial energy

The industrial estate is an element of the territory within which large quantities of water, materials and energy circulate. It is thus completely adapted to the implementation of loops of water, materials and energy. The economic interests of the synergies attract the manufacturers and become a factor for attracting new activities to the estate.

Numerous programs aimed at creating eco-industrial estates within these estates are proliferating all over the world: South Korea (national program supported by the State), Australia, United States in the 1990s, United Kingdom in the framework of the BCSD (Business Council for Sustainable Development), France in the framework of the Oree association, etc.

1.3. The circular economy in China derived from industrial ecology

In China, industrial ecology is developing under the name of circular economy.
The definition of the circular economy adopted by the **Chinese council for international co-operation on the environment and development[6],** links industry and services aiming to improve environmental and economic performance through environmental and resource management. Through co-operative efforts, the industrial company seeks a collective benefit which is more important than the sum of individual interests which each company, industry or community would pursue if they tried to optimise their performance individually.
This concept appears for a period when the forecasts for the Chinese economy coincide on a four-fold increase of its gross domestic product. This spectacular growth will have to deal with a lack of energy resources, as well as high levels of environmental pollution that have been building up since 1980.

The circular economy is perceived as a new model of industrialisation which constitutes the only solution for supporting the ultra-rapid economic growth, halting environmental degradation and limiting the risks of a shortage of raw materials.

In 2004, the Chinese government asked the Chinese council for international co-operation on the environment and development to draw up recommendations for an approach to the circular economy for industrialisation and durable development.

The fact of wanting to integrate this concept into the national legislative system is a world first, and shows the stakes which the looping of flows may represent within an economy.

Finally, the use of the term "circular economy" makes one wonder about the terminology in industrial ecology. Indeed, there are similar concepts defined by very different words which do not seem to have the same impact.

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[6] CCICED (China Council for International Cooperation on Environment and Development), *The circular (Recycling) Economy in China*, [on line], www.chinacp.com/eng/cppolicystrategy/circular_economy.html, consulted 10/05/2006.

2 Organisation of the guide

The objective of this guide is to lay down the foundations for a new strategy of sustainable industrial development adhering to the principles of industrial ecology.
The guide does not seek to present individual solutions for each company; rather it proposes actions of environmental cooperation to be set up between companies in an industrial estate.

This guide is the result of the experiences and work carried out within the framework of the ECOSIND project, which has been implemented by the Department of Environment and Housing of the Government of Catalonia.
ECOSIND permitted a rich exchange of experiences with:

- The Environmental Protection Agency - Tuscany Region (Italy).
- The regional government of Peloponnesus (Greece).
- The regional government of Abruzzo (Italy).

The ECOSIND framework programme is set within the community initiative of the European Regional Development Fund INTEREG IIIC for cooperation between the regions of the south of the European Union.

The guide is structured in four parts:

✓ **Part 1** consists in the analysis of the situation of the industrial estates of southern Europe.
From this analysis carried out for each of the 4 participant regions, the 4 main environmental problems of industrial estates of Southern Europe are explained.

✓ **Part 2** contains 13 recommendations for the sustainable development of industrial activities using industrial ecology principles. These recommendations are structured in two groups:

- **Recommendations for the planning of new industrial estates**. These recommendations constitute a particular interest for organisations and/or public administrations responsible for the planning of new industrial estates. They aim at integrating the concepts and the criteria of industrial ecology from the planning phase.

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- **Recommendations for the management of existing industrial areas**.
  These recommendations are particularly aimed at helping the managers of industrial estates to set up projects for environmental cooperation between the companies present. This aims at reducing the global environmental impact of industrial estates while maintaining their competitiveness.

✓ **Part 3** presents the main benefits and the key message to be retained for future experiences of each of the 13 ECOSIND sub-projects, as well as the final conclusions of ECOSIND at regional and European levels.

✓ **Part 4**. It includes 26 files that synthesise experiences and technologies from the ECOSIND sub-projects as well as from external ECOSIND projects. These files are strongly related to the recommendations of the second part; they make it possible to discover precise examples of their application.

PART 1: SITUATION AND PROBLEMS OF INDUSTRIAL ESTATES IN SOUTHERN EUROPE

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1 Evolution and current situation of industrial activities in Catalonia, Tuscany, Abruzzo and Peloponnesus

This first part seeks to analyse the situation of the industrial activities of each of the 4 regions involved in ECOSIND in order to verify what their specific characteristics and their common points are.

1.1. Evolution of industrial activities in Catalonia

Industry in Catalonia has grown strongly since the 1960s and currently plays an important role in the Catalan economy, providing 29% of workplaces.

The Catalan industrial sector is composed of a majority of small and medium-sized enterprises, concentrated in the Barcelona Metropolitan Area. In Catalonia there are around 2,000 industrial estates that occupy a total area of 21,257,100 m^2; the following map shows their distribution.

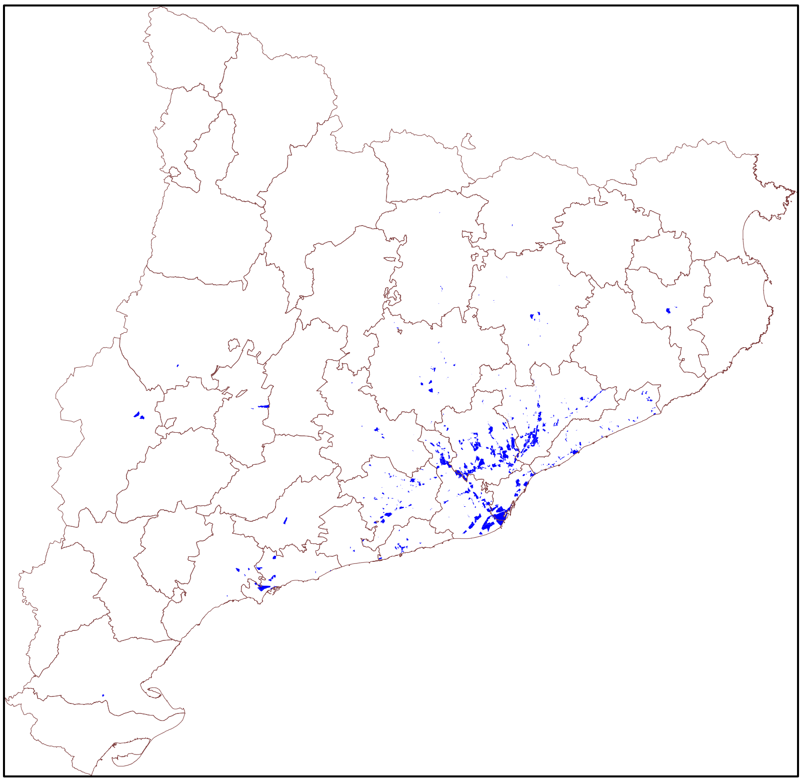

Image 1 : Distribution of industrial estates in Catalonia

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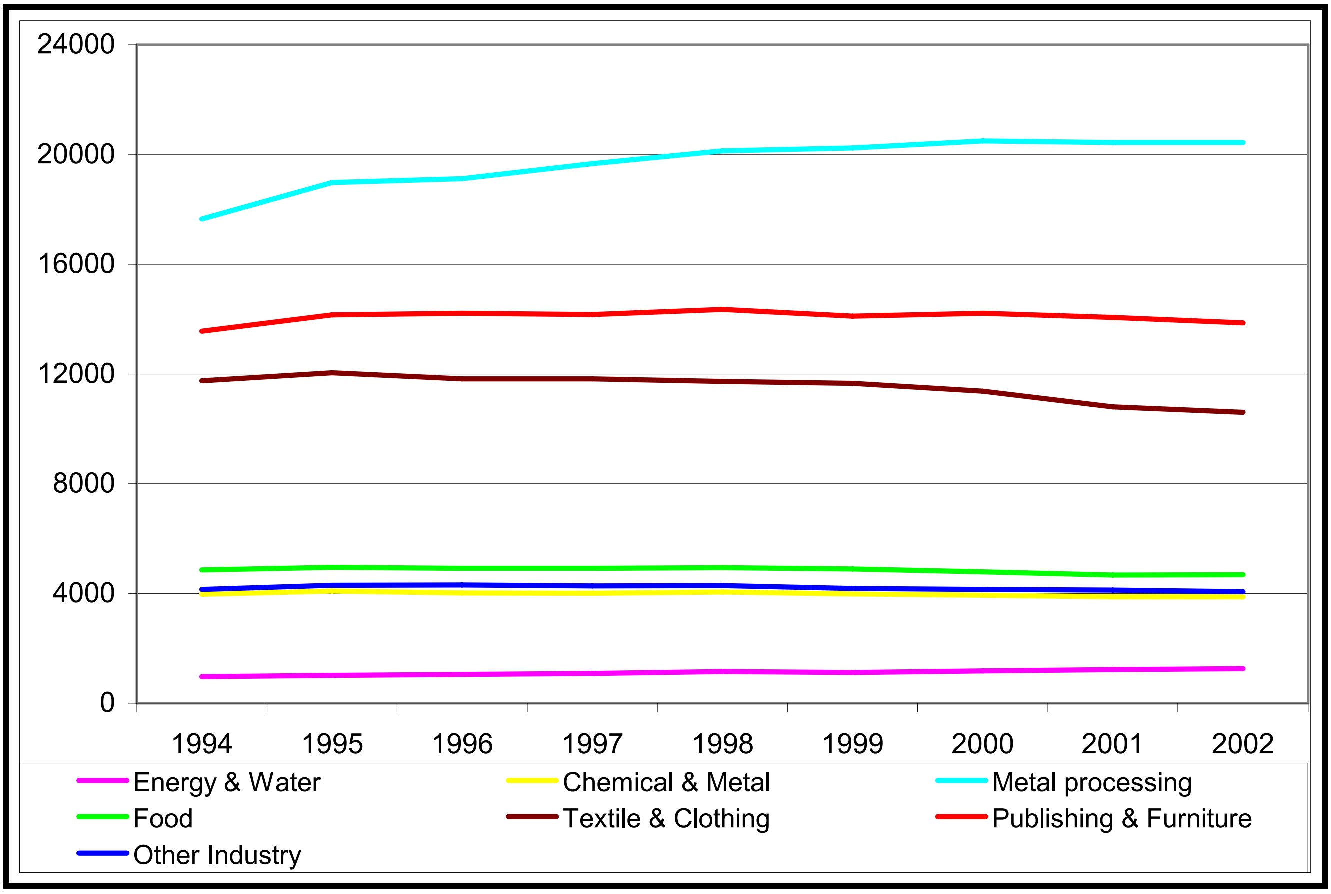
As can be seen, these estates are distributed along the main transport routes such as the AP7, Eix Llobregat and Maresme motorways, and concentrated in the Barcelona Metropolitan Area, El Vallès and the Tarragona chemical estate.

According to data from the Statistical Institute of Catalonia (IDESCAT), the largest industry, in terms of the number of companies, is metal processing, a sector that has seen recent growth. Second in importance are the publishing and furniture sectors, where the number of businesses has remained fairly constant in recent years.



Graph 1: Number of industrial companies (Source: IDESCAT)

Figure 1 shows the decline of the textile and clothing sector in recent years due to the opening of the Asian market. From 1994 to 2002 the number of businesses in this sector fell by 1,154 companies.

A study published in 2005 by the Department of Employment and Industry of the Government of Catalonia[7] reports that in Catalonia there are 42 local industrial production systems, open to competition and consisting of a total of 9,000 establishments (26% of the total) that provide work for 235,000 people

[7] HERNANDEZ J.M., FONTRODONA, J., PEZZI A., *Mapa dels sistemes productius locals industrials a Catalunya*, Department of Employment and Industry of the Government of Catalonia, 2005.

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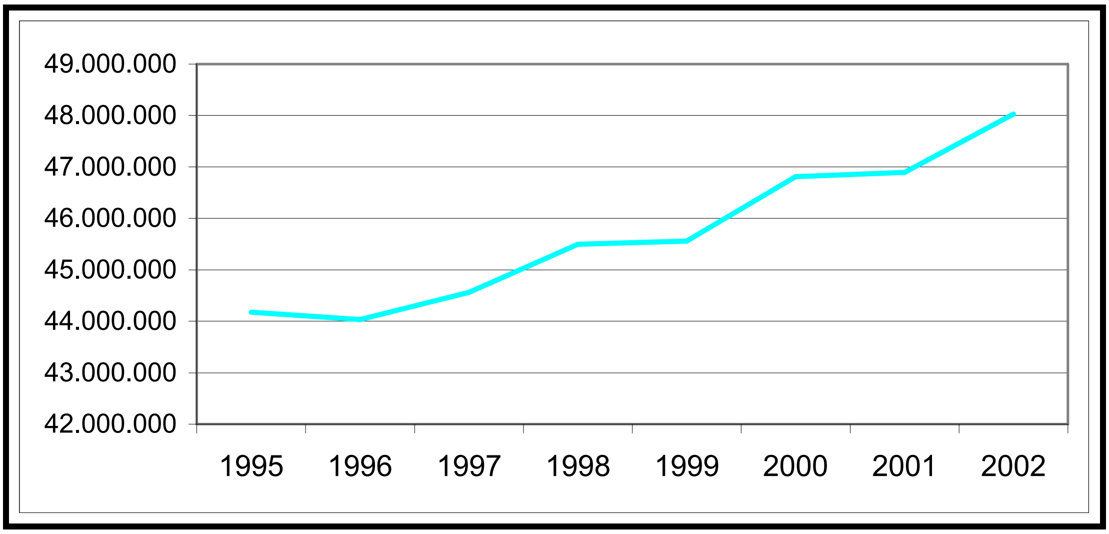
(36% of employment) and generate 39% of turnover of Catalan industry. These systems represent almost all sectors.

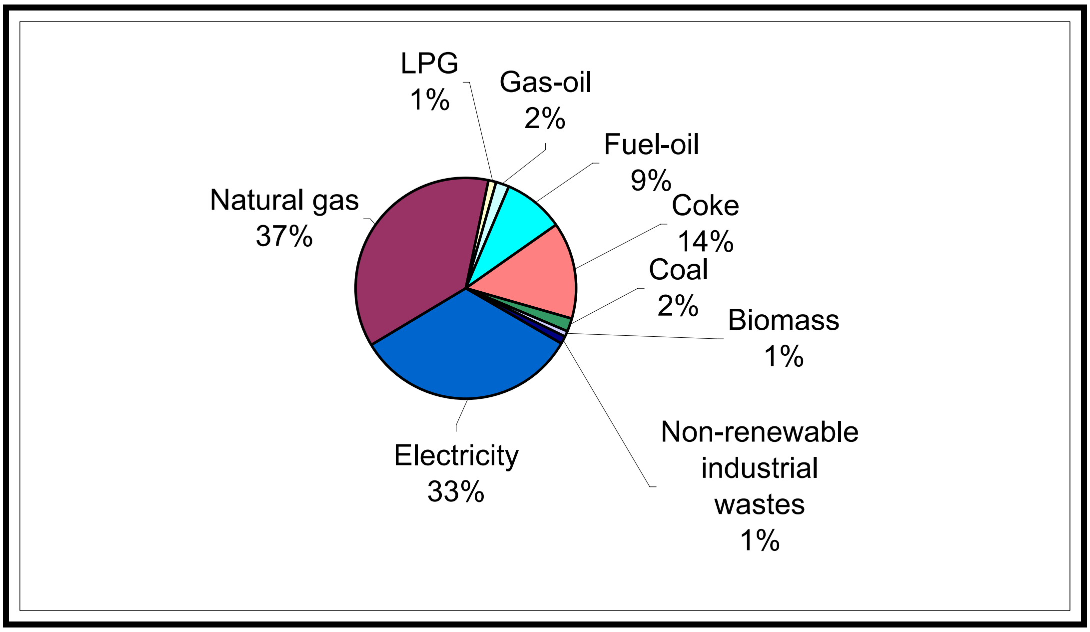
According to IDESCAT data, the area occupied by industrial sites has increased gradually in recent years, reaching 48,000,000 m^2 in 2002. This figure is the area occupied by industrial sites, including built-up areas and open areas that form part of the installations, such as warehouses, loading and unloading estates, etc.



Graph 2: Industrial surface area in m2 (Source: IDESCAT)

- ***Energy consumption***

The traditional sources of energy consumption in industry, besides electrical energy, are coal and petroleum derivatives. Since the 1970s and 1980s natural gas has been replacing these fuels. Figure 3 shows the source of the energy consumed by industrial sector based on data from the Energy Institute of Catalonia (ICAEN).



Graph 3: Consumption of the Industrial Sector by energy source (Source: ICAEN)

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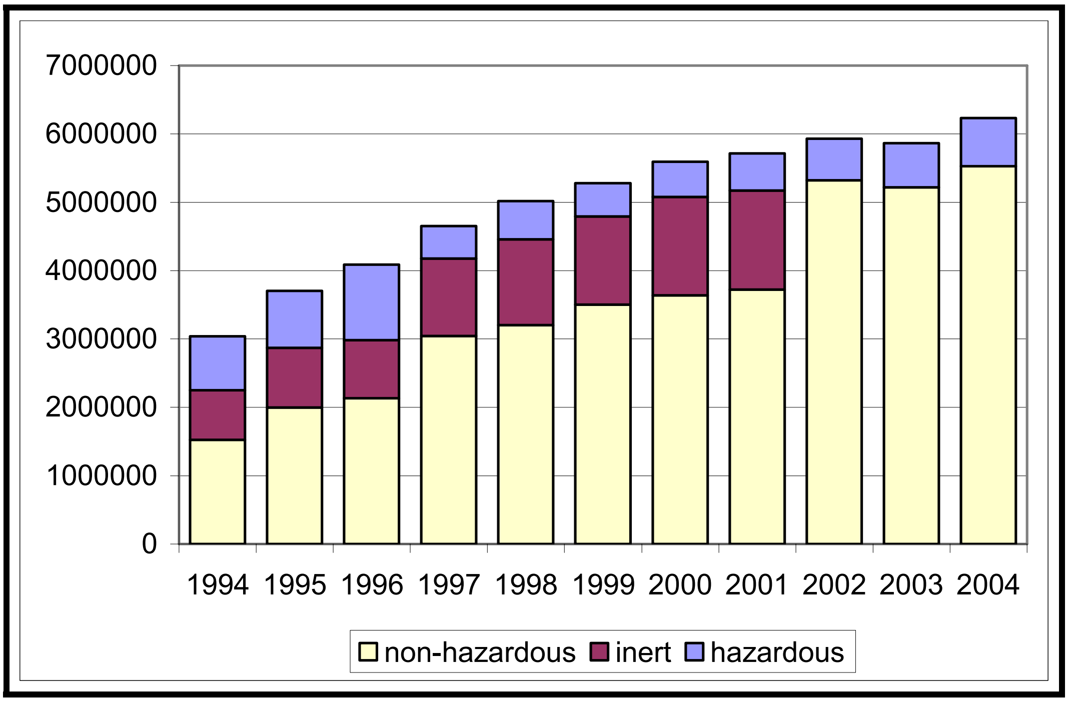
➢ ***Industrial waste production***

With regard to the environmental impact of industrial activity, Figure 4 shows the tonnes of waste generated as obtained from the annual waste declarations made to the Waste Agency of Catalonia (ARC).



Graph 4: Production of industrial waste in tonnes (Source: ARC)

For the above graph it is important to note that the increase in the quantity of waste generated is due to the increase in the number of industrial sites that, as required by the ARC, have made waste declarations. This has increased from 9,822 sites in 1994 to more than 22,000 today. Since 2001 when the inert classification was withdrawn these wastes have been categorised as non-hazardous.

➢ ***Wastewater management***

Regarding the management of industrial wastewater, according to 2004 data from the Catalan Water Agency[8], industry generated a pollutant load of 43,702 tonnes of COD during 2004. The chemical sector produced the largest part of this pollutant load with 28%, followed by the food sector with 19% (figure 5).

[8] CATALAN WATER AGENCY, *Report 2004*.

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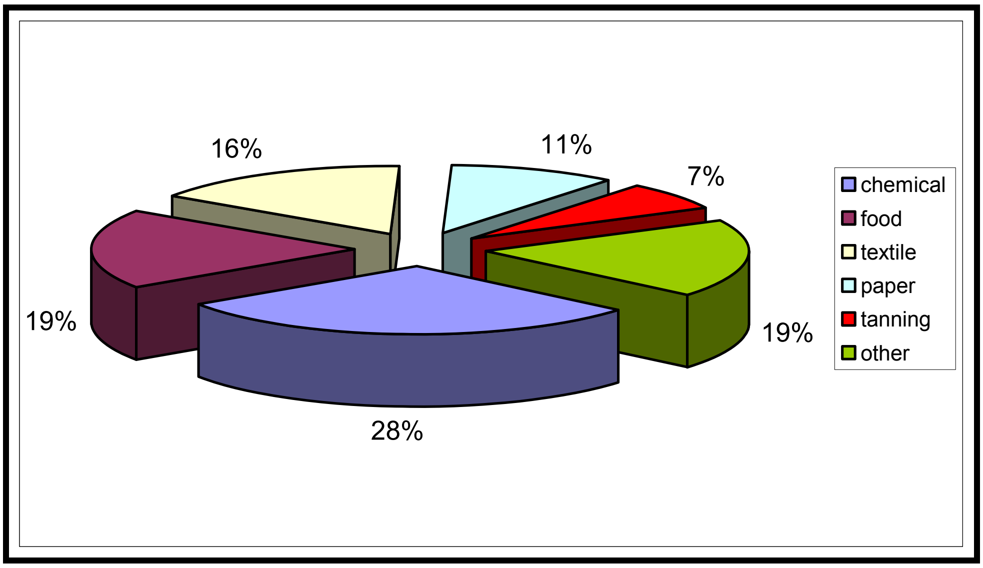
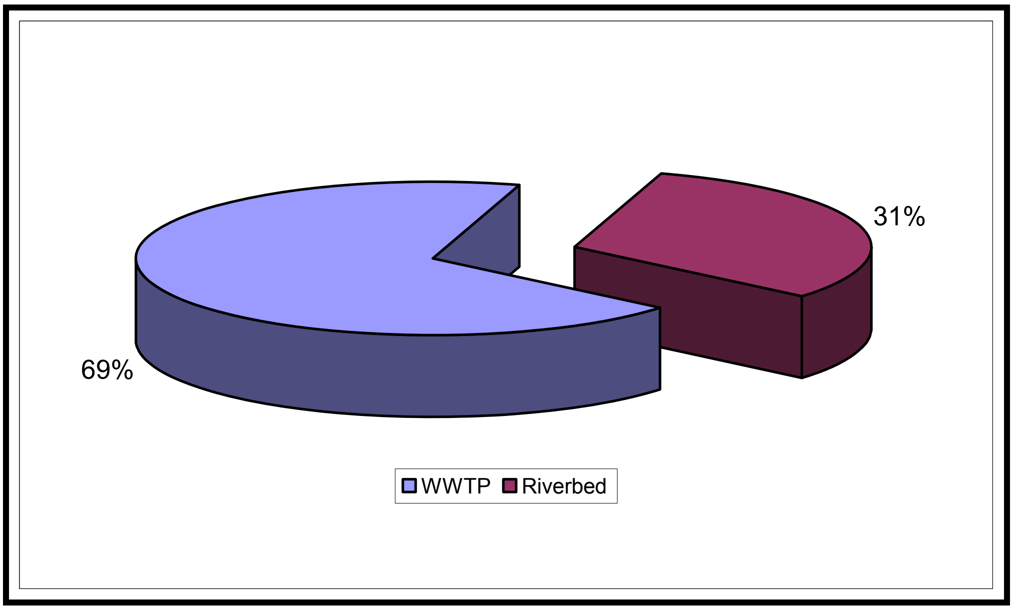


Graph 5: Contribution of each sector to the pollutant load released in 2004 (Source: ACA)

According to other data from the same source, 69% of this pollutant load is released into a sewer connected to a wastewater treatment plant (WWTP); while the remaining 31% is released directly into public riverbeds (Figure 6).



Graph 6: Distribution of the pollutant load discharged according to destination in 2004 (Source: ACA)

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1.2. Evolution of the industrial activities in Tuscany[9,10]

The Tuscan economic system is characterised by a common presence of specialised local district systems in traditional light industry sectors, situated in inter-provincial fields where a high presence of manufacturing companies congregate, made up of small and medium-sized enterprises with productive spinneret, social and institutional strong relations.
These industrial districts, together with local productive systems, have been detected by a resolution passed by the regional Council no. 69/2000.

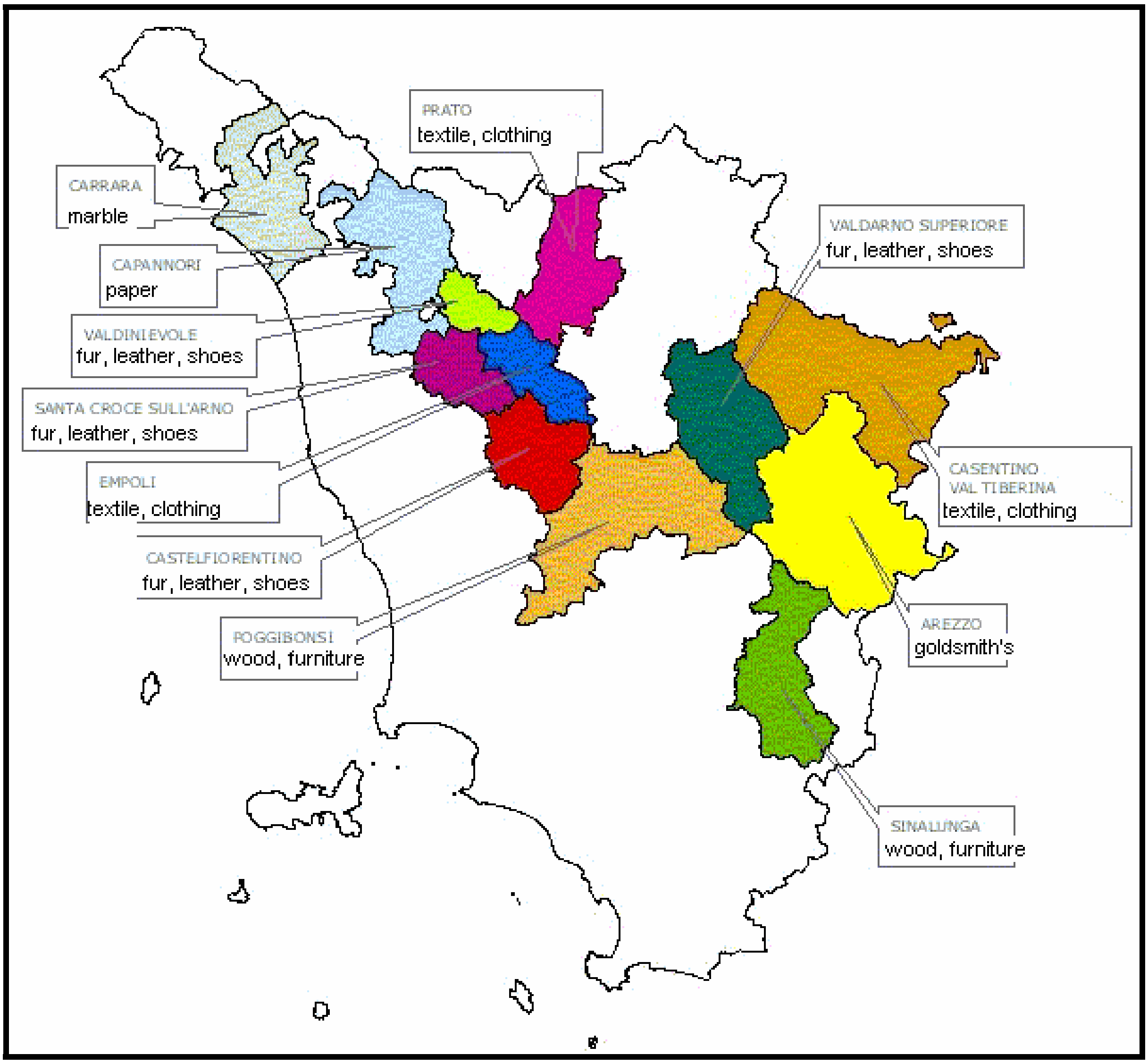

Figure 3: Map of local productive systems in Tuscany

[9] Region of Tuscany, General Agency for environmental and territorial policies, environmental signals in Tuscany 2006, EDIFIR 2006

[10] Peretto (edited by), Tuscany 2020, a region towards the future, IRPET (Regional Agency for Tuscany's Economic Planning / Istituto Regionale di Programmazione Economica Toscana), 2005

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The productive qualification of the region is bound to traditional industrial sectors such as:

- ✓ **The textile sector – clothing** (21%, of which 82% of working units are situated in the area of Prato),
- ✓ **The tanning and shoe sectors** (13.7%, of which 80% of working units are situated in the district of Santa Croce),
- ✓ **The paper sector** (5.4%, of which 22% of working units are in the area of Lucca),
- ✓ **The goldsmith sector** (3.9%, of which 49.7% of working units are in the area of Arezzo). (Source: IRPET census data processing, ISTAT 2001).

However, a tendency towards district economic growth outside the spinneret and qualification sector is emerging, passing from the almost exclusive production of consumer goods to the production of median goods (mechanical sector), which is leading the district to transform itself into aggregates that are more heterogeneous, in sectional terms, being open to technological innovations.

The plan for regional development for the coming three-year period stresses the centrality of regional manufacturing systems and local productive systems characterised by creativity and versatility that must be inserted within a wider framework of industrial policies at a national and European level.

Therefore, a new regional development model is proposed, based on a Regional Integrated District, a system that is capable of connecting all the productive components on a regional scale, in order to increase the efficiency of the productive processes and the their capacity of interaction with qualified services.

➢ *Pressures and environmental impacts*

Tuscany is among the Italian regions with the greatest economic activity, and yet the environmental pressures arising from these activities are lower than the national average. The most significant environmental impacts are produced by economic activities regarding:

- **Energy production**.
- **Transport and mobility** due to the amounts of emissions released into the atmosphere.
- **Agriculture.**
- **Food-processing industries,** which affect the organic load of water.
- **The manufacturing industry,** which affects several environmental backgrounds in different ways: emissions released into the air, water pollution, waste production.
- **The iron and steel sector** for the emissions released into the atmosphere.

➢ *Energy consumption of Tuscan industries*

Energy consumptions as a result of economic activities are a significant indicator of environmental pressures produced by productive settlements.

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Recently, a slight improvement in the energy efficiency of the manufacturing sector has been registered, especially in the chemical and non-metalliferous ore sections, and this is due to the phenomenon of outsourcing and dematerialisation of productive processes.

An example of the level of energy consumption of Tuscan companies is the data collected on the consumption of the companies present in the 1st Macro-allotment of the Community of Prato, an industrial area situated in the textile district:

Textile Industrial Area I° Macro-allotment – Prato 300 Companies (small and medium-sized enterprises)	
General data	
Operators *(quantity)*	approximately **3,000** (2006 data)
Main activity	**Textile and Manufacturing** (with 32 companies at humid cycle: dye works and finishing) (2006 data)
Area (hectares)	**150** (of which 55 from productive establishments) (2006 data)
Energy	
Electric energy (GWh/year)	**100** (1997 data)
TOTAL (GW/year)	**100 (1997 data)**
Methane (Nm^3/an) (industrial activity)	**33,000,000** (2001 data)
Methane (Nm^3/an) (heating/houshold)	**3,000,000** (2001 data)
TOTAL (Nm^3/year)	**36,000,000** (2001 data)
On energy consumption data in textile and tanning districts, compare experience file "EXP 5 C3", regarding MIT CO2 demonstrative project.	

Table 1: General data and energy consumption of a textile industrial estate in the Prato

- ***Industrial waste production in Tuscany***

The production of urban waste from the manufacturing industry reaches 20%, while this percentage reaches 57% of particular, dangerous and non-dangerous waste products. One of the greatest criticalities, in terms of environmental impact produced by the industry, is the production of waste, and it is expected that this will be higher than that from the manufacturing production in the coming years.

During 2004, a total of 2,500,000 tonnes of urban waste was produced. Data from the last 5 years reveal the production of a continuous per capita increase of urban waste of 15.9%.

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Still in 2004, there was an increase of 33.42%, in the percentage of selective collection of waste, which is close to the objective of 35% established by national regulations.

Particular waste production and management data, developed on MUD (Environmental Statement Form / Modello Unico di Dichiarazione Ambientale) statements regarding producers and managers, reveal that the amount of waste produced and declared in 2003 was in the region of 7,400,000 tons, of which:

- 40% was produced by manufacturing and extractive activities,
- 40% was from sewage disposal and waste processing,
- 17% was constituted by construction and demolition waste.

PROVINCES	Waste production in 2003 (MUD data in tons per year)		
	Special waste	Dangerous waste	TOTAL
1- AR	413,425	22,614	436,039
2- FI	1,175,282	93,083	1,268,365
3- GR	631,048	16,724	647,773
4- LI	977.7	48,288	1,025,988
5- LU	1,063,157	17,124	1,080,281
6- MS	751,752	18,617	770,369
7- PI	1,076,503	36,312	1,112,815
8- PO	320,83	8,882	329,712
9- PT	357,688	7,275	364,963
10- SI	327,436	9.25	336,686
TOTAL	**7,094,821**	**278,17**	**7,372,991**

Table 2: Particular waste production, 2003 (MUD statements – draftings: ARPAT Regional section of waste register)

➢ *Management and production of water in Tuscany*

The region of Tuscany endowed itself with a new instrument for regulating its water resources at a regional level. The Plan for Water Protection, endorsed in 2003 in operation of national and EC regulations, provides for planning instruments, programming and management of water and the jurisdiction of the parties involved in it. This Plan, which was organised for catchment basins, singles out the steps required to attain the stated qualitative and quantitative objectives in observance of the principles “polluter pays”, “sustainable water use” and “ water body protection”.

The regional territory is subdivided into Optimal Territorial Fields (Ambiti Territoriali Ottimali, ATO), created to manage water services, and is instituted by Field Authorities, which are institutions that have jurisdiction over the releasing of industrial and urban waste into public sewers. The volume of water, registered by managers at a regional level, is approximately 255,000 m^3. However, these data do not reflect the total amount of the resource that has been delivered.

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It has been revealed, in connection with the levels of water resource that the organic burden is ascribable to:

- 49% from productive activities.
- 23% from agriculture.
- 27% from households.

The most influencing manufacturing activities are those from the food-processing and paper industries, followed by those from chemical, textile and tanning industries. Instead, industries from the primary sector are the leading subjects responsible for the trophic burden.

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1.3. Evolution of the industrial activities in Abruzzo

The year 2004 saw continuing uncertainty in the economy of the Abruzzo. According to Prometeia (Association for Economical Forecasts) estimates, the regional Gross Domestic Product (GDP) fell by 1.9% over the course of 2004 due to poor performance by services and industry.

The regional GDP grew by an annual average rate of 1.1% from 1996 to 2004, which is lower than the Italian average (+1.5%) and that of the southern regions (+1.7%).

Figure 4 : Map of the Abruzzo region

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➢ *Local units in Abruzzo*

The ISTAT survey of 2001 recorded a total of 96,315 local units (businesses, institutions, self-employed) in Abruzzo, a significant increase over the previous decade.
The table below details the number of local units according to province and type. As can be seen, the leading sector in number of local units is trade, which is especially prevalent in the provinces of Pescara and Chieti.
Thus, manufacturing, the second sector, is essentially concentrated in the provinces of Chieti and Teramo,.

Province	Agriculture, hunting, silviculture	Fisheries and related activities	Mineral extraction	Manufacturing	Prod. / distr. of electricity, gas and water	Construction	Trade (wholesale and retail); auto and motor repair, personal goods	Hotels and restaurants
L'Aquila	122	3	38	2148	51	3025	6698	1806
Teramo	172	200	27	3987	21	3348	7093	1785
Pescara	90	90	31	2715	20	2629	8276	1259
Chieti	196	67	40	3781	40	3262	8780	1657
Total:	580	360	136	12631	132	12264	30847	6507

Table 3: Number of local units in Abruzzo by province and type

Employees of local units in 2001 totalled 316,448, there having been an upward trend since the decrease recorded in 1996. The sector which employs most people is manufacturing, followed (at a good distance) by trade. As noted, manufacturing is generally speaking the sector which has the greatest impact on the environment.

On the basis of the 2001 ISTAT survey, the leading areas in manufacturing and industry in Abruzzo are, in descending order of importance:

- **The textiles and clothing industries**, mainly present in Tramano province.
- **Metallurgy and manufacturing of metal products and electrical machinery**, prevalent in Chieti province.
- **Manufacturing of electrical and optical appliances**, principally in Aquila province.
- **Foods, beverages and tobacco**, principally in Tramano and Chieti.

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The average number of employees per local unit is 2.3, with a peak of almost 16 employees in manufacturing. The fragmentation of the productive fabric entails the need for more environmental controls.
Abruzzo remains more fragmented than Italy as a whole, as the national average is around 3.8 employees per business.

In Abruzzo, there are 22 high-risk companies, 11 of which represent a higher hazard. The density of high-risk companies in Abruzzo is around 2 companies per 1,000 km^2. Most of these companies are located in the provinces of Aquila and Chieti, although most companies which represent the highest risks are in Pescara. High-risk activities in Abruzzo predominantly take the form of LPG (liquid petroleum gas) storage facilities, followed by chemical plants.

Manufacturing mainly affects the environment in the form of waste, emissions and the consumption of raw materials.

➢ *Evolution of different sectors of industrial production*

The state of the Abruzzo economy has to be interpreted in the light of the overall loss of competitiveness of the national economic system and, more importantly, growing pressure from international competition in the traditional “made in Italy” segment, on which a good part of the region’s productive fabric is predicated. However, the overall trend conceals a wide range of situations in the different sectors. The table below illustrates the evolution the different industrial sectors in Abruzzo between 2002 and 2004:

Sector	2002	2003	2004
Foods	2.2	4.5	2.1
Textiles	-11.9	6.9	1.7
Clothing	-2.5	-4.1	8
Timber and furniture	-6.3	-5.2	5.7
Leather and footwear	-20.9	-6.9	-0.7
Non-metal mineral processing	0.6	3.4	1
Metallurgy	-4.6	3	4.7
Chemicals	12.2	0.3	7.1
Various	9.4	1.1	2.6

Table 4: Industrial production by sector – Abruzzo (quarterly variation simple average, source: Banca d’Italia, based on CRESA data)

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1.4. Evolution of the industrial activities in the Peloponnesus

As it is difficult to obtain certain statistics on the evolution of industrial estates in Peloponnesus due to the fact that industrial development is relatively new, this paragraph will describe the situation and the problems of the 3 main industrial areas in Peloponnesus:

- ✓ The industrial area of Sperhogia, Kalamata
- ✓ The industrial area of Meligala, Kalamata
- ✓ The industrial area of Tripoli

Figure 5 : Map of the Peloponnesus region

✓ *Industrial area of Sperhogia, Kalamata*

It is a region that is formally characterised as industrial, since the suitable infrastructures for the operation of enterprises do not exist and the few (enterprises) that do function face enormous problems. Globally there are 10-12 enterprises functioning with 30 employees, while occasionally up to 150 individuals are occupied. The cover of the total extent from the existing enterprises is less than 10-15%. It is 6 kilometres from the city of Kalamata and it 1 kilometre from the main Kalamata-Tripoli road.

In this region, the principal industrial sectors are standardisation and packing of rural products, treatment of timber, machine shops and warehouses.

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The following problems are generally observed in this area:

- The character of the region has been degraded due to the installation of the Romanies (Gypsies). In the area large settlements of Romanies have grown up, giving rise to the under-functioning of the existing infrastructures. For this reason, new units are no longer installed there, and the existing ones function with enormous problems. Lately, a lot of units are installed opposite by the enacted region because there, fewer problems are observed. The pollution of the environment due to the litter from the Romanies is enormous. Moreover, there is no refuse collection system.
- The sewerage, water supply and electricity networks do not function regularly.
- Access to the region is difficult, since a node with signposts and lighting has not yet been created. The railway line does not serve either, as there is no station for this area. Neither is there an airport service, since there are no flights to Kalamata.
- The area is unsafe for both employees and visitors due to the Romanies.
- There is a great deal of noise pollution from the military airport that is located 500 m from the region.

✓ ***Industrial area of Meligala, Kalamata***

This is also a degraded region, without the suitable infrastructures for the function of enterprises and without the minimal benefits from the forecasted. Globally there are 10-12 enterprises functioning with 20 employees while occasionally up to 50 individuals are employed. The cover of the total extent from the existing enterprises is less than 10-15%. It is 22 kilometres from the city of Kalamata, 2.5 kilometres from the city of Meligala and 1 kilometre from the main Tripoli-Kalamata road.
In this region the principal industries are the standardisation and packing of rural products, plastic, aluminium, treatment of timber and oil industries.

The following problems are generally observed in this area:

- The sewerage and water supply networks do not function regularly. There is no lighting in the streets, and there is no biological cleaning.
- The pollution of the environment due to litter, the various depositions, waters that stagnate and in some degree from [athigganoys] are serious. Moreover there is no refuse collection system.
- Access in the region it is not satisfactory, since a node with signposts and lighting has not yet been created. Moreover there are no suitable plates in the national Tripoli-Kalamata road and after dark the region is not safe due to the Romanies.

✓ ***Industrial area of Tripoli***

This region is better organised than the previous two; where more infrastructures function and the general level of availability of forecasted benefits is judged as mediocre. Globally 55 enterprises function with 600

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employees. The cover of the total extent from the existing enterprises is less than 60%. This region is the nearest to industrial area of Athens. It is scarcely 3 kilometres from the city of Tripoli on the national Athens-Tripoli road
The principal industries in this region are the treatment of timber, machine shops, aluminium, plastic, standardisation and packing rural products, treatment of glass, marble, production of building materials, printing-houses, production [asfaltomeigmatos], motor vehicle garages, etc.

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2 Global analysis of problems of durability linked to industrial ecology and common to the industrial estates of southern Europe

This second part seeks to analyze the 4 most important environmental problems, common to industrial estates of the South of Europe, and constituent constraints on the cooperative and sustainable development of the industrial activities.
The 4 problems identified concern:

- Greenhouse gas emissions.
- The management of natural resources and residue from industrial production.
- The use of land.
- Information and cooperation.

2.1. PROBLEM 1: Greenhouse gas emissions (GGE)

2.1.1. Definition of the problem

The industrial estates contribute excessively to the share of greenhouse gas emissions. This is largely due to low efficiency in the modes of production and transport. More precisely:

- The **dependence on oil is much too strong**. It is a non-renewable primary energy which is becoming more and more expensive, which requires haulage over excessive distances, with an inordinate environmental impact, and which does not ensure suitable levels of energy safety for industry.
- The **potential use of renewable energies** is **not, or only barely, exploited.**
- The **energy efficiency of production systems** is **low**.
- The **materials used and the productive systems** consume **too much energy**.
- The **share of the use of the collective means of transport** for the daily displacement of the people is **too low**, and the distances between the residence and the place of work are too great.
- The **distances covered per kilogram of final material produced** are **too great**.

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2.1.2. Methodology

In this document, an analysis of the problem will be carried out the European statistics available on Eurostat, and comparing the data from Spain, Greece and Italy with the average for the Europe of the 15 or 25.
It should be emphasised, above all, that the majority of the data have been provided by the Member States to Eurostat but that some may result from estimates.

Moreover the data concern industry in general, as data concerning the industrial estates more specifically are not available.

Initially, statistics of a general nature will be presented and subsequently, in accordance with the data available, more specific statistics will be analysed.

2.1.3. General description and statistical analysis

Initially, 2 general indicators will be introduced in order to show the importance of greenhouse gas emissions from the industrial sector. Then the industrial sectors which consume the most and are among the largest emitters of greenhouse gases will be highlighted.

2.1.3.a) Total greenhouse gas emissions and the targets of the Kyoto Protocol

The graph below presents the total greenhouse gas emissions of Spain, Italy, Greece and Europe of the 15, as well as the respective targets which were agreed within the Kyoto Protocol. The total emissions take into account carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4), hydrofluorocarbones (HFC), perfluorated hydrocarbons (PFC) and sulphur hexafluoride (SF6).

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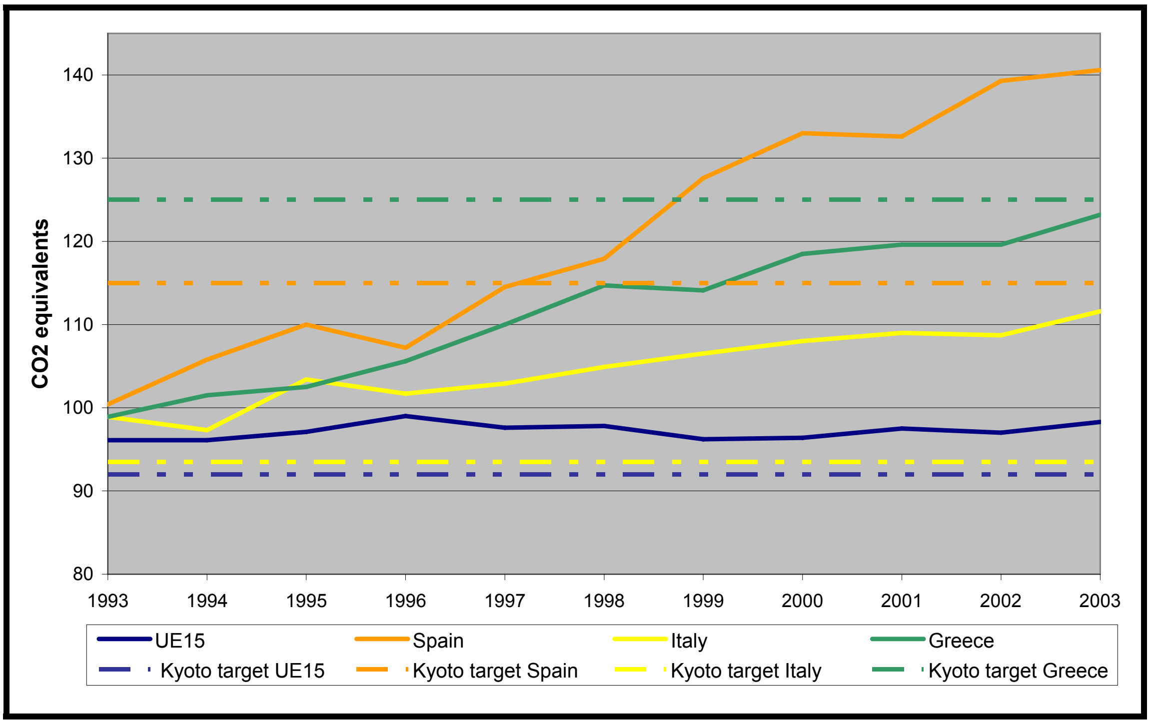

Graph 7: Indices of the total greenhouse gas emissions and the targets according to the Kyoto Protocol (Source: Eurostat [11])

Graph 7 shows that Spain and Italy were above the target of Kyoto and the average of the Europe of the 15 in 2003. Moreover, their emissions are on the increase. In 2003, Greece was somewat below its target but approaching it very strongly.

These data relate to all greenhouse gas-emitting sectors, but other indicators show that the industrial sector is one of the principal sectors contributing to the greenhouse gas effect.

[11] EUROSTAT, *Total des émissions de gaz à effet de serre,* [on line], http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=fr&product=Yearlies_new_environment_energy&root=Yearlies_new_environment_energy/H/H1/H13/en010, Consulted 12/03/2006.

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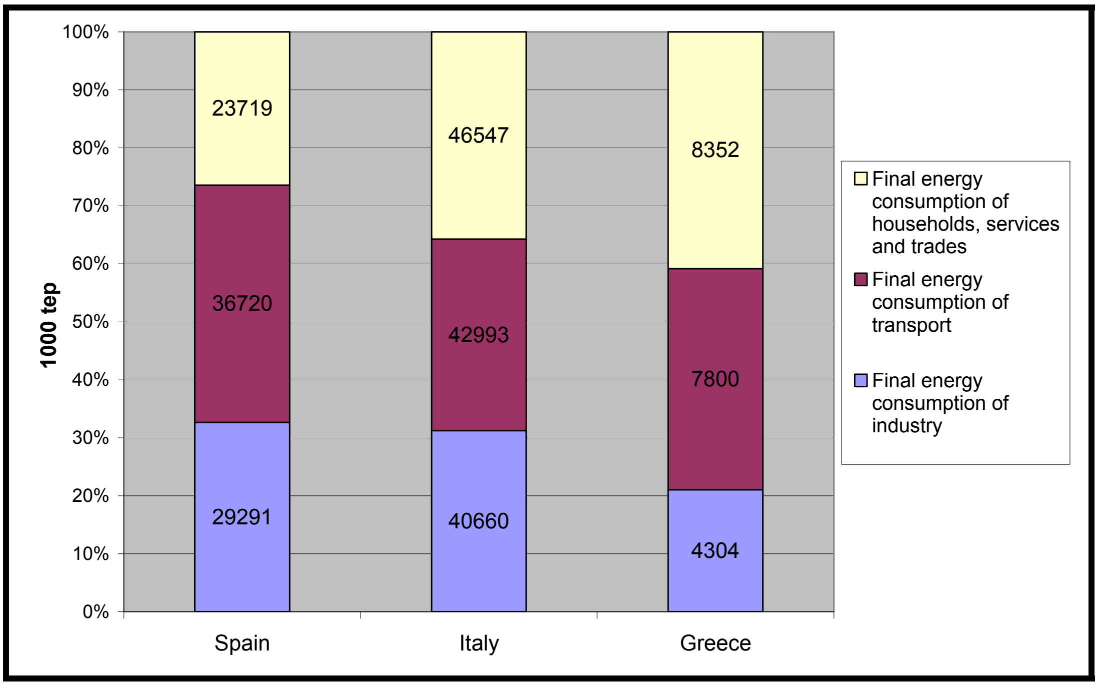
2.1.3.b) Contribution of the industrial sector to greenhouse gas emissions

The following Graph presents the final distribution of energy consumed for Spain, Italy and Greece by differentiating the sectors of industry, transport and finally households, services and trade.
In detail, the final consumption of energy represents all energy delivered to end consumers (in industry, transport, households and other sectors), all uses combined. It excludes deliveries for transformation and/or self-consumption by industries producing energy as well as network losses. With regard to industry, the final consumption covers consumption in all industrial sectors except for the "Energy" sector.



Graph 8: Distribution of final energy consumption for Spain Greece and Italy in 2003 (Source: Eurostat [12, 13, 14])

This demonstrates that industry is responsible for a third of the consumption for Spain and Italy and approximately a quarter for Greece. But this does not take into account the transport related to the activity of these industries, which is also a very large consumer of energy (more than a third of the total energy) and which is integrated into the transport branch.

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[12] EUROSTAT, *Consommation finale d'énergie de l'industrie*, [on line], http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=fr&product=Yearlies_new_environment_energy&root=Yearlies_new_environment_energy/H/H2/H24/ebc23312, Consulted 13/03/2006.
[13] EUROSTAT, *Consommation finale d'énergie des transports*, [on line], http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=fr&product=Yearlies_new_environment_energy&root=Yearlies_new_environment_energy/H/H2/H24/ebc23824, Consulted 13/03/2006.
[14] EUROSTAT, *Consommation finale d'énergie des ménages, du commerce et des services*, [on line], http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=fr&product=Yearlies_new_environment_energy&root=Yearlies_new_environment_energy/H/H2/H24/ebc24336, Consulted 13/03/2006.

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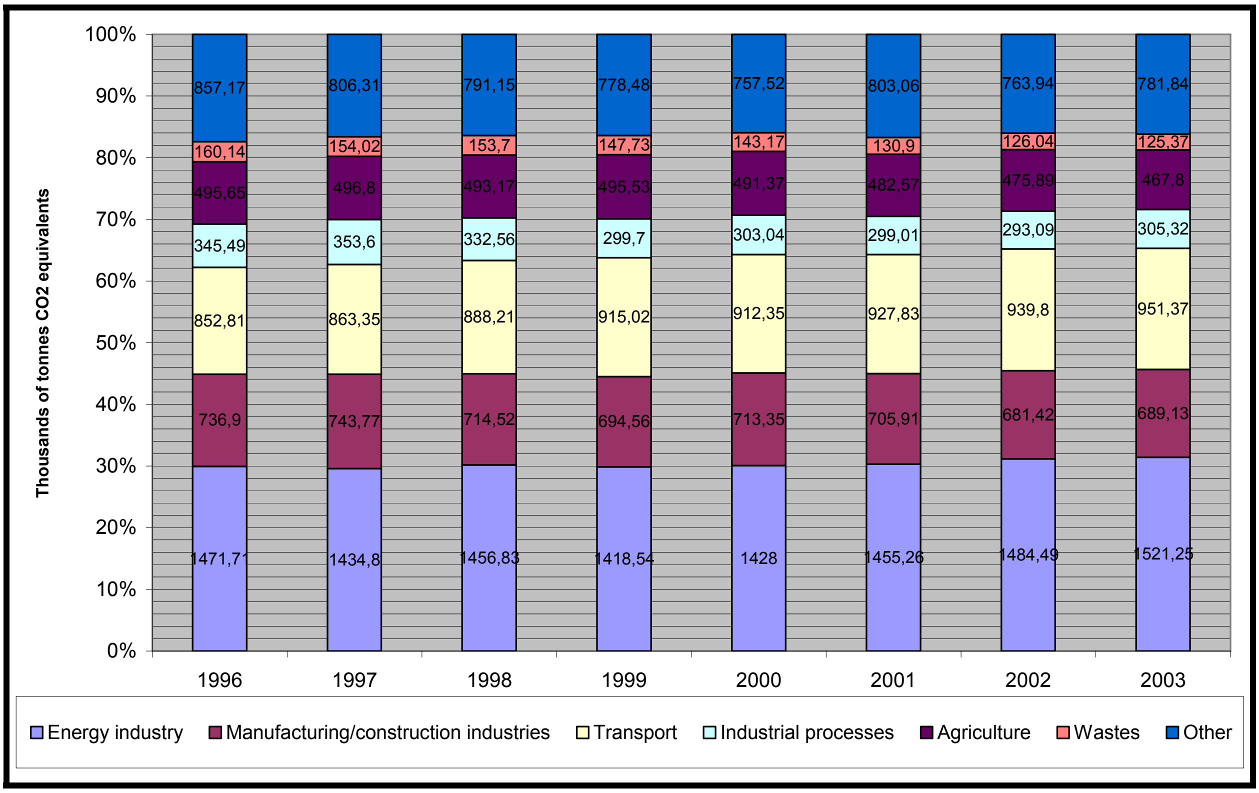
2.1.3.c) Distribution of greenhouse gas emissions within the industrial sector

The graph below shows the industrial sectors emitting gas contributing to the greenhouse effect:



Graph 9: Greenhouse gas emissions by sector EU25 (Source: Eurostat [15])

Graph 9 shows that the evolution of the distribution of greenhouse gas emissions is fairly stable over time.

The energy industry is responsible for approximately 30% of emissions, then transport is responsible for approximately 20% and then come manufacturing and the construction industries with approximately 15%.

2.1.3.d) Energy intensity of industry

This indicator, defined by Eurostat, makes it possible "to measure the quantity of energy necessary to generate a given level of industrial production in monetary or physical terms. A reduction in industrial energy intensity means that less energy is necessary to obtain the same production and thus reflects the energy efficiency of the industry".

[15] EUROSTAT, *Emissions de gaz à effet de serre par secteur*, [on line], http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=fr&product=sdi_cc&root=sdi_cc/sdi_cc/sdi_cc_cli/sdi_cc1100, Consulted 14/03/2006.

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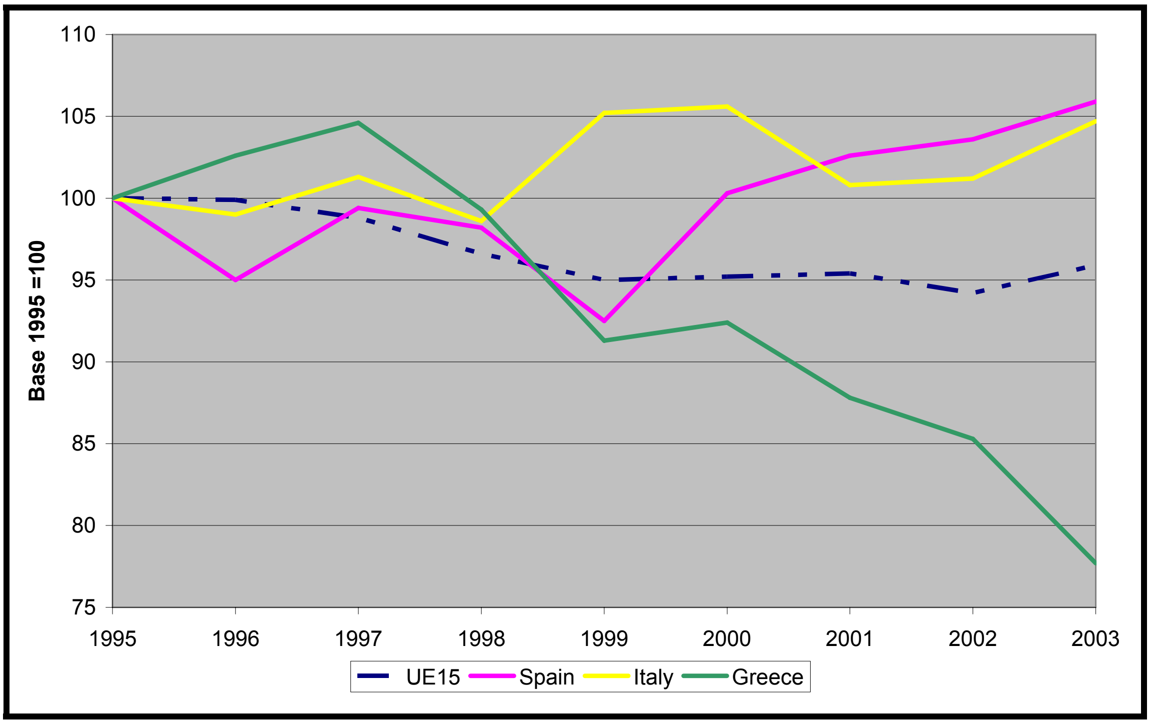
The energy intensity of industry is calculated by determining the ratio of consumption of final energy of industry (in equivalent tonnes of oil) with the gross added value of industry (based on the value of the euro in 1995).



Graph 10: The energy intensity of industry from 1995 to 2003 (Source: Eurostat[16])

Graph 10 shows a reduction in energy efficiency for Spain and Italy and an increase for Greece. Spain and Italy have worse results than the European average. By way of information, the least energy efficient European countries are: Portugal (114.2) and Turkey (128.9). The most energy efficient countries are Poland (55.6) and Estonia (42.7). However, this indicator has to be taken with care, as it does not reflect the energy efficiency of various industries, and is calculated on the basis of final energy and not primary energy.

This general description makes it easier to understand what the situation of the three Mediterranean countries was in comparison to the European situation with respect to the Kyoto Protocol. The industry sector is the one consuming most energy (If we also consider the energy used by the transports links with the industry) and it thus has a very important responsibility in contributing to greenhouse gas emissions. In addition in this industrial sector, it is the energy and transport industries which are the greatest emitters of greenhouse gases.

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[16] EUROSTAT, *Intensité énergétique de l'industrie*, [on line], http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=fr&product=sdi_cc&root=sdi_cc/sdi_cc/sdi_cc_ene/sdi_cc2330, Consulté le 14/03/2006.

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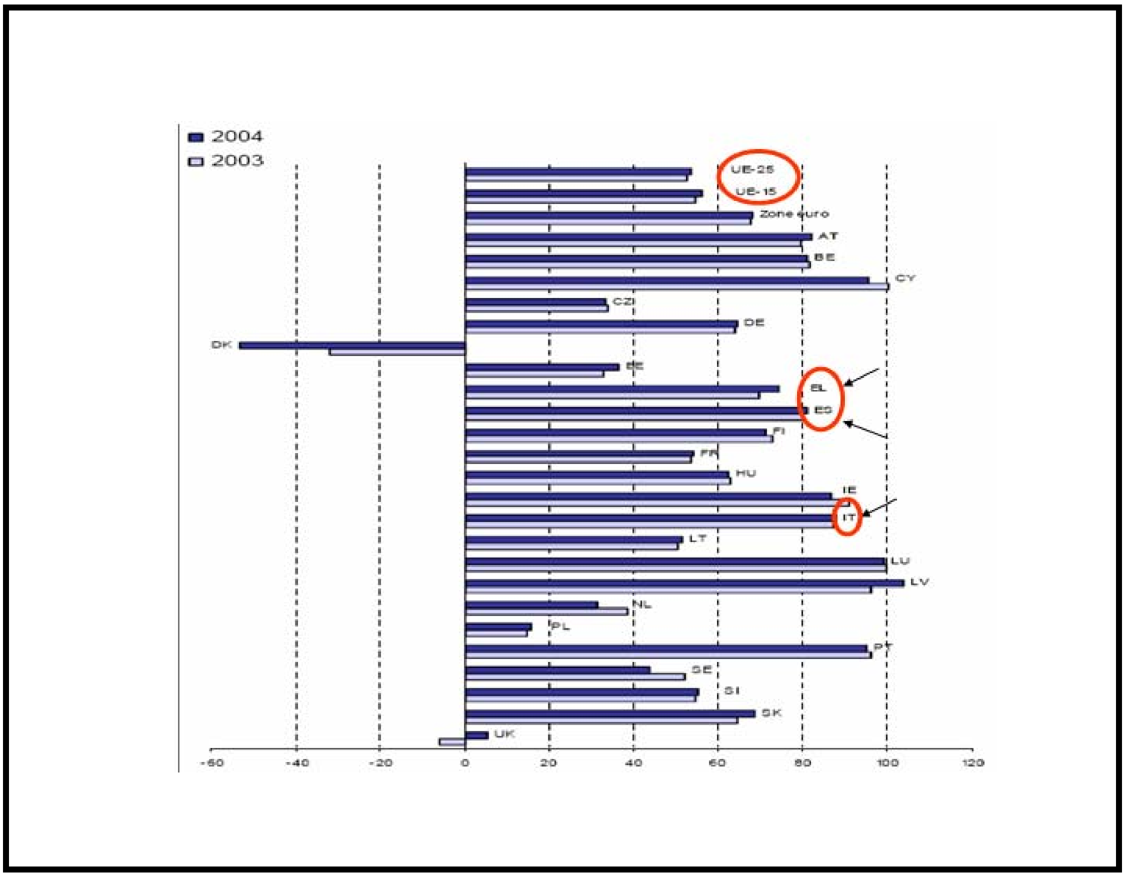
2.1.4. Analysis of the problem and specific effects produced

The more specific analysis of the problem will be divided into 2 main parts: on the one hand the problems involved in the production sector; and on the other, the problems involved in the sector of the transport of people, materials and waste.

2.1.4.a) Production sector

- ***Excessive dependence on energy***



Graph 11: Rate of energy dependence in % (Source: Eurostat[17])

The graph above shows the rate of energy dependence of various European countries. It is established by calculating the net imports of energy (imports - exports) and by measuring the latter as a percentage of gross national consumption.

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[17] EUROSTAT, *Aspects statistiques du secteur de l'énergie en 2004, la dépendance énergétique de l'UE-25 s'accroît,* [on line], downloadable at http://europa.eu.int/comm/eurostat/, consulted 17/03/2006.

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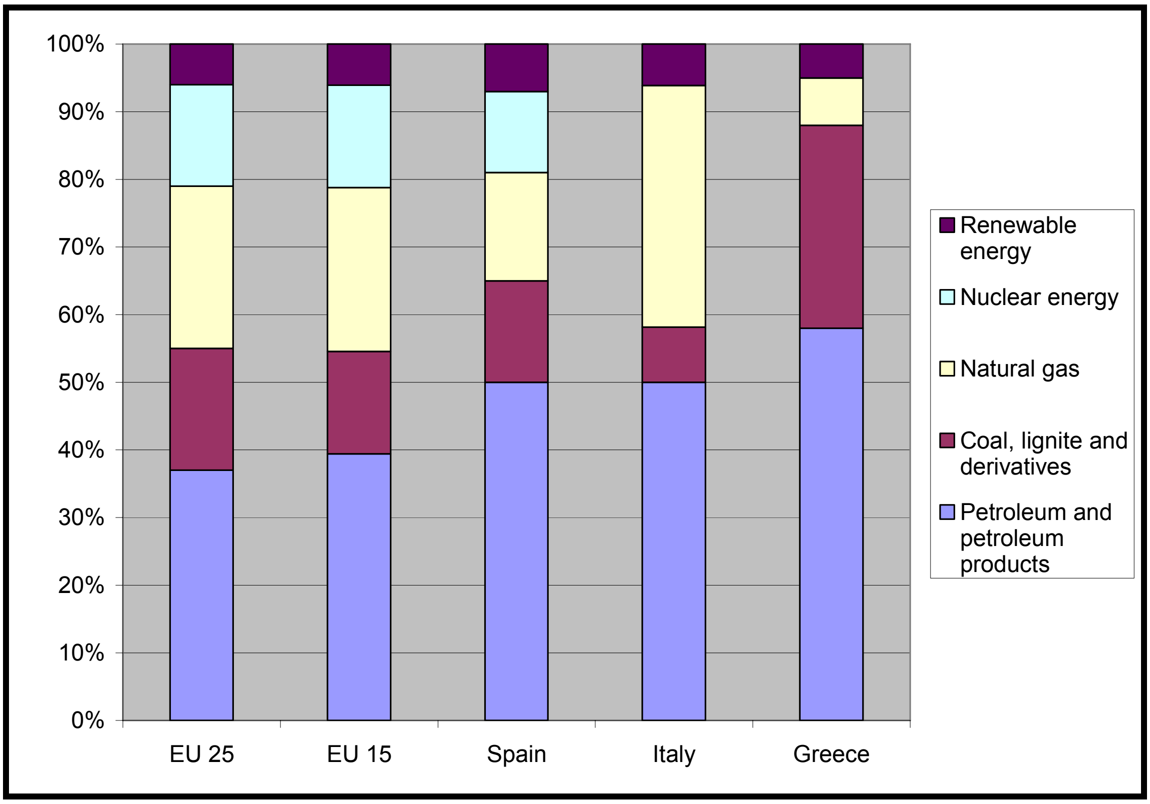
The energy dependence of Spain in 2004 was 81%, that of Italy 87.7% and that of Greece 76%. These data are much higher than the average of energy dependence in the Europe of 25, which was 53.8% in 2004.

It is easy to imagine that this considerable dependence is due in great part, to oil imports.

The graph below shows the distribution of final energy consumption by source:



Graph 12: Distribution of internal gross energy consumption by main types of fuels in 2003 (Source: Eurostat [18])

Spain uses 50% of petroleum products, Italy 49% and Greece 58%. These results cannot be questioned and clearly show that this dependence is much too strong and risky considering current tendencies. It is absolutely necessary to change sources of energy provision gradually but quickly.

The following section presents the trends concerning the use of renewable energies.

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[18] EUROSTAT, *Consommation brute d'énergie intérieure, par type de combustible*, [on line], http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=fr&product=sdi_cc&root=sdi_cc/sdi_cc/sdi_cc2000, consulted 17/032006.

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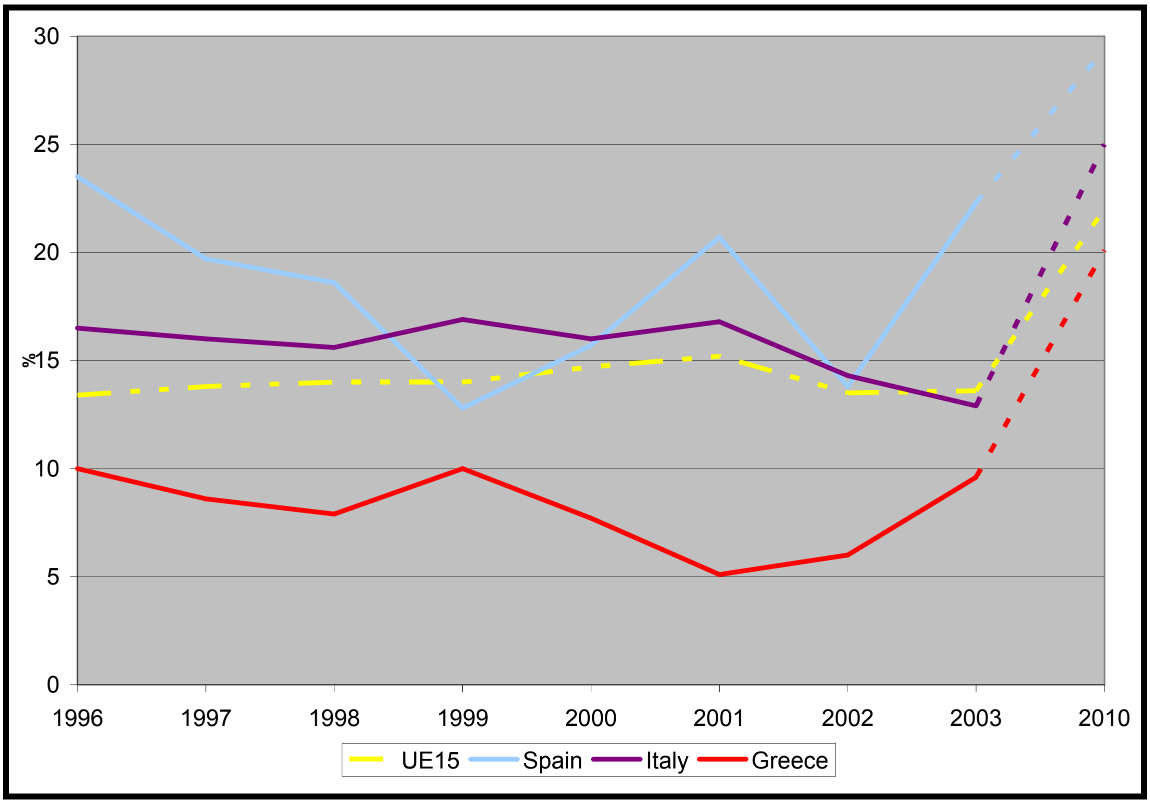
➢ *Use of renewable energies*

The use of renewable energies is very little, or not at all, widespread in industrial estates.

Graph 13 shows the proportion of electricity coming from renewable energies as part of the total generation of electricity as well as the objective to be reached for 2010. Nevertheless, these data are general and only concern industry where the results are most probably much weaker.



Graph 13: Proportion of electricity coming from renewable energies as part of the total generation of electricity in % (Source: Eurostat [19]).

It is easy to see that reaching the objectives of 2010 will require a large effort on the part of Member States. Greece is experiencing a certain delay while Spain has been moving in the right direction since 2002.

In 2003, Spain was at 22.3%, Italy at 12.9% and Greece at 9.6%.

Graph 14 indicates the distribution of the various types of renewable energies used in the Europe of the 25.

[19] EUROSTAT, *Part de l'électricité dans les énergies renouvelables pour agréger la consommation brute d'électricité,* [on line], http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=fr&product=Yearlies_new_environment_energy&root=Yearlies_new_environment_energy/H/H2/H23/en061, Consulted 17/03/2006.

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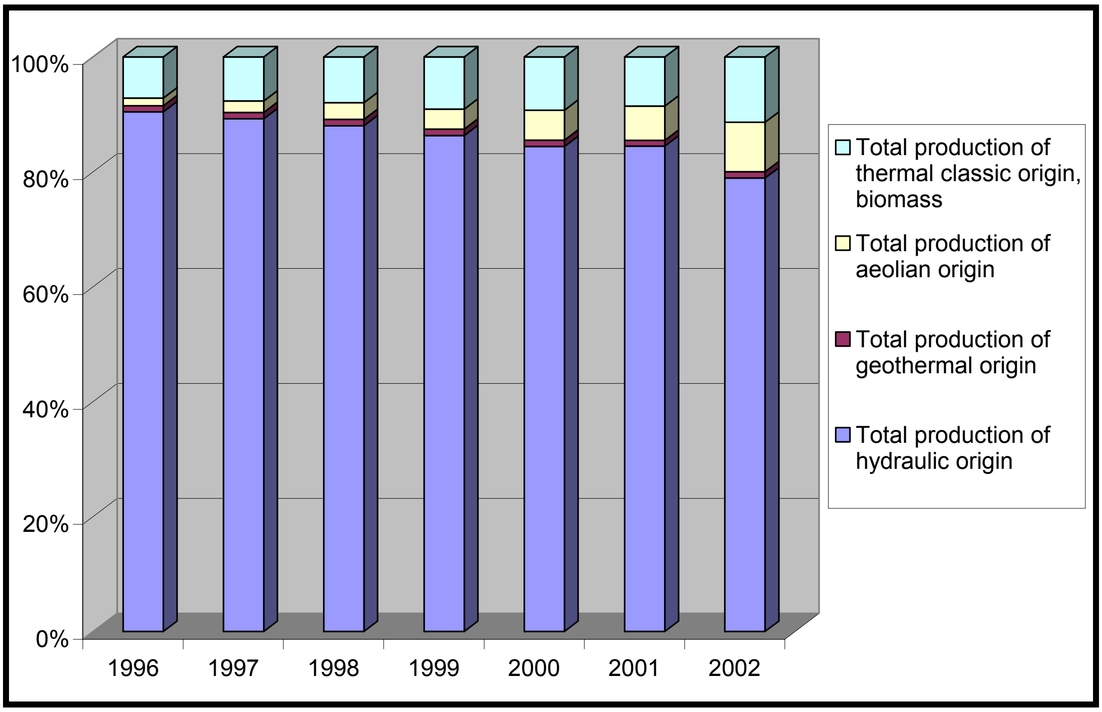

Graph 14: Proportion of electricity coming from renewable energies in the total generation of electricity by source for the EU25 in % (Source: Eurostat[20]).

Hydraulic power is the most used (at more than 80%). But in 2002, it was possible to distinguish an increase in favour of wind and the use of the biomass. In general, Geo-thermics is still somewhat under-developed.

- ***Energy efficiency of the systems and production equipment***

In the light of the experiments of the ECOSIND sub-projects, co-generation, would seem to be a good solution for achieving suitable energy efficiency in an industrial estate or for a group of companies. The graph below gives percentages of its use as a function of total gross electricity production.

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[20] EUROSTAT, *Part de l'électricité dans les énergies renouvelables pour agréger la consommation brute d'électricité,* [on line], http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=fr&product=Yearlies_new_environment_energy&root=Yearlies_new_environment_energy/H/H2/H23/en061, Consulted 17/03/2006.

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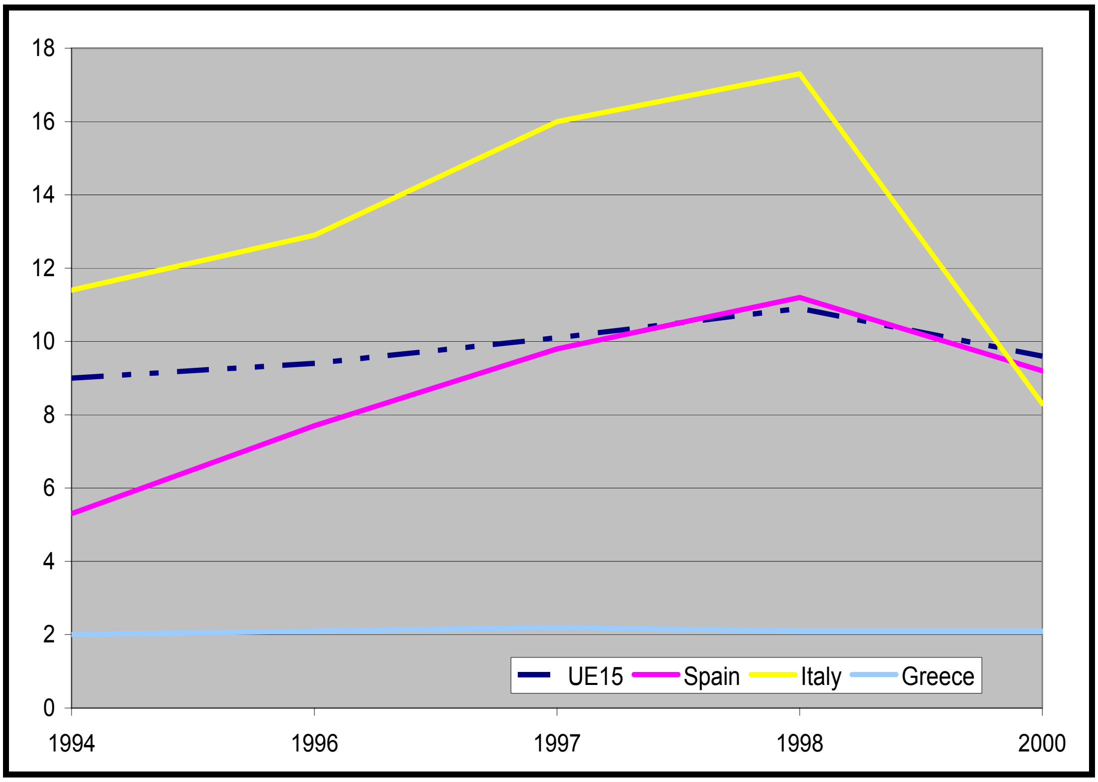

Graph 15: Combined production of heat and of electricity: co-generation (in % of the total gross electricity production source: Eurostat[21]).

Greece has developed almost no cogeneration. After making good progress until 1998, Spain and Italy have notably decreased their efforts and fallen beneath the 10% threshold. These heavy decreases are most probably due to the political will and the desire to develop cogeneration or not. Economic incentives would allow the reversal of these tendencies.

Furthermore, it is important to add that industrial energy efficiency can be improved by the use the Best Available Techniquess (BAT) which were established by the IPPC Directive. The BATs are described by sector on an Internet site of the European Community: http://eippcb.jrc.es/.

- ***Environmental quality of buildings***

Few statistics are available on this point, but it is important to remember that the way in which buildings are built strongly influences the power consumption in them, in particular concerning heating or air-conditioning. Ideally, there should be good heat insulation, preventing the passage of the cold in winter and the heat in summer.

[21] EUROSTAT, Production combinée de chaleur et d'électricité, [on line], http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=fr&product=sdi_cc&root=sdi_cc/sdi_cc/sdi_cc_ene/sdi_cc2320, consulted 17/03/2006.

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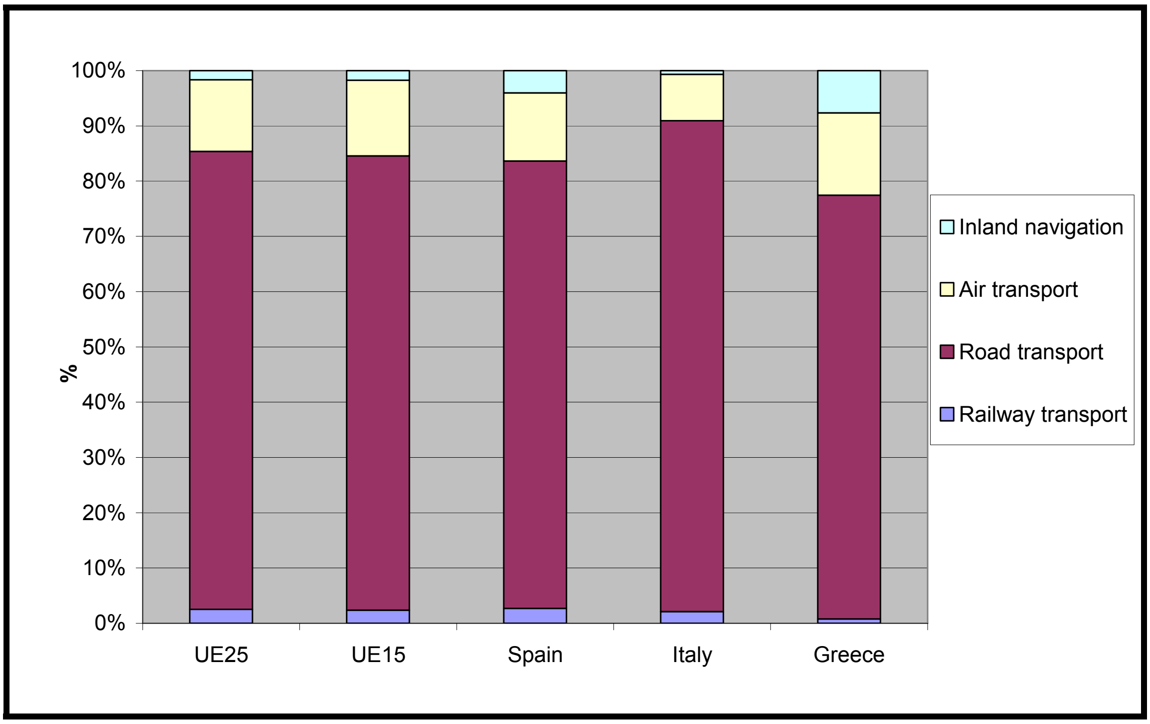
Moreover, the lifespan of buildings is increasingly short, and the methods of demolition do not always facilitate the sorting of materials to facilitate their re-use or recycling.

The types of materials used, the energy required to manufacture them and their geographical origin are also criteria to be taken into account in the construction of new eco-industrial estates.

2.1.4.b) Transport sector

Graph 9 showed that the greenhouse gas emissions due to transport represent approximately a third of the total emissions. It is thus a sector in which a great deal of progress needs to be made in order to reduce energy consumption.

The graph below shows the energy consumption of domestic transport by mode of transport (including all types of transport for people, waste or goods).



Graph 16: Energy consumption of domestic transport by mode of transport in 2003 in % (Source: Eurostat[22])

The conclusions to be drawn from this graph are very significant: road transport is used too much and consumes far too much energy, especially which with respect to oil.

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[22] EUROSTAT, *Consommation énergétique des transports par mode de transport*, [on line], http://epp.eurostat.cec.eu.int/portal/page?_pageid=0,1136228,0_45572945&_dad=portal&_schema=PORTAL, consulted 20/03/2006.

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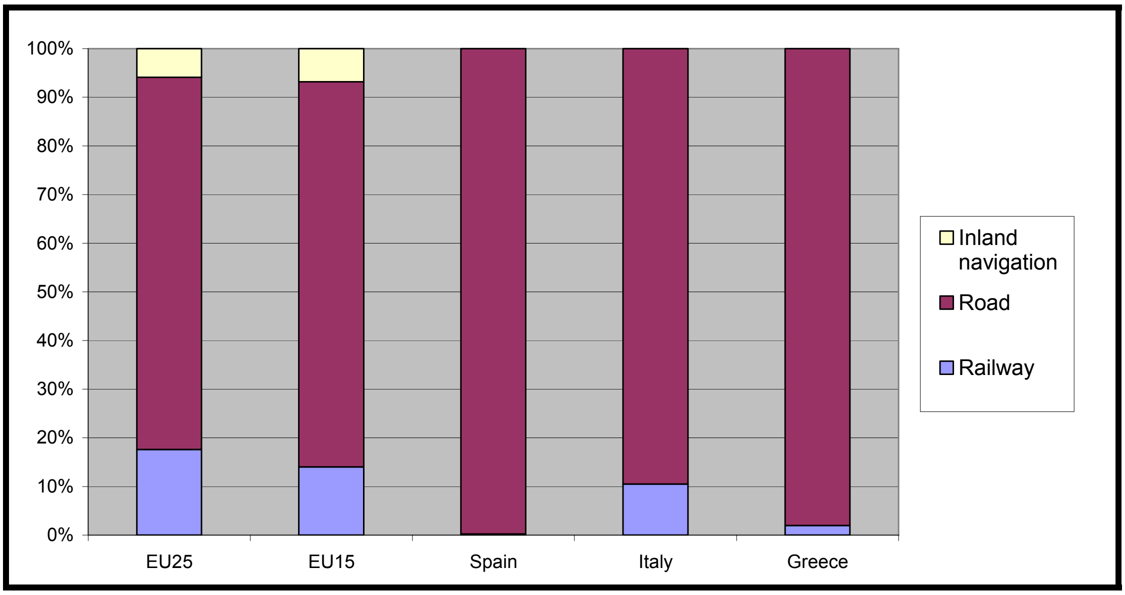
➢ *Transport of materials*

It is difficult to find statistics concerning the number of kilometres that various materials or resources have to be transported before resulting in an end product which may also have to be transported a distance before being delivered to the final consumer. Nevertheless are Life Cycle Analysis (LCA) of products show that current transport logistics are not at all in harmony with a reduction in transport distances and a consumption of local products.

The graph below simply shows that road transport is over-used and that its reduction is imperative.



Graph 17: Modal split of freight transport in 2004 in % (Source: Eurostat[23])

➢ *Transport of people*

There is a clear deficit of collective transport allowing people to get to industrial estates. The time necessary to reach them by public transport is sometimes so long that the workers prefer to use their private cars to reduce the time spent in transport.

A study undertaken by the "industrial pact of the Barcelona metropolitan region" on the metropolitan area of Barcelona shows this deficit to a certain extent. The principal results are as follows:

- 19% of the industrial estates in the area of Barcelona have a shortfall in accessibility to public transport (when the distance to the nearest underground or railway station is greater than 1.5 kilometres).
- 54% of the municipalities have an industrial estate with a shortfall in accessibility to collective transport.

[23] EUROSTAT, *Répartition modale du transport de fret*, [on line], http://epp.eurostat.cec.eu.int/portal/page?_pageid=0,1136228,0_45572945&_dad=portal&_schema=PORTAL, consulted 20/03/2006.

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But this study does not define the percentage of people who use a car to go to work, and what percentage use car-sharing.

Real efforts need to be made concerning the movement of people in the light of the current situation and the impact of road transport on greenhouse gas emissions.

2.1.5. Overview of the problem

Point of view	Production sector	Transport sector
Environmental	► Poor energy efficiency ► Low proportion of renewable energy and co-generation ► Poor environmental quality of buildings ► Strong environmental impact of GGE	► Excessive transport distances ► Excessive dependence on transport sector ► Low use of collective transport ► No mutualisation of transport ► Strong environmental impact of GGE
Economic	► Excessive dependence on oil ► Low substitution for petroleum products	► Excessive dependence on oil
Social	► Low awareness of urgency of problem ► Effects of the very harmful emissions on health	► Few efforts to reduce road transport ► Effects of the very harmful emissions on health

Table 5: Summary of the problems concerning the emissions of GGE in industrial estates

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2.2. PROBLEM 2: Management of natural resources and industrial production residues

2.2.1. Definition of the problem

The use of the natural resources and the management of waste by the majority of companies in industrial estates are not optimal (or efficient). The rates of recovery, re-use and recycling are still too low, and those actions taken are not sufficiently effective to reverse the current trend quickly.

This is the consequence of the excessive a consumption of raw materials and of few efforts concerning product end-of-life scenarios. Thus, this does not make it possible to meet the objective of closing the loop defined by industrial ecology, or to implement a circular economy.

The image of the funnel created by “the natural step”[24] makes it possible to truly understand this problem: the fact that there are fewer and fewer resources, greater and greater consumption and thus more and more waste. Thus, there is increasingly less room for manœuvre, and it is thus necessary to act very quickly in order to attempt to “re-widen the funnel “.

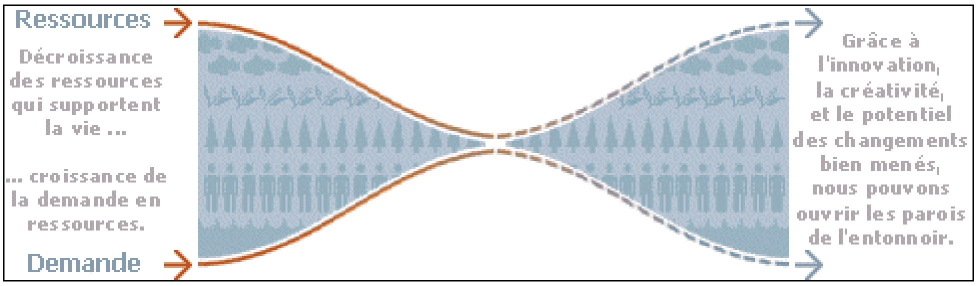

Figure 6: The funnel of “the natural step” (Source: www.tns-france.org)

2.2.2. Methodology

First of all some statistics on the use of water will be presented.
Then, general and quantitative data on the production of industrial waste in Europe will be presented, with the objective of analysing what is the situation of the countries of Southern Europe concerning economic sectors which produce the most waste. Then, the case of Catalonia will be studied, to show the evolution over the last 10 years of the types of waste produced and their various modes of treatment.
Thus, the problems will be analysed with respect to the modes of management and of waste production by industrial companies and industrial estates.
The statistical data analysed come from Eurostat (certain figures are estimates), the Spanish Ministryof the Environment and the Department of the Environment of the Government of Catalonia.

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[24] The NATURAL STEP, *La démarche TNS*, [on line], http://www.tns-france.org/page/visu_article.php?categorie=37, consulted 10/04/2006.

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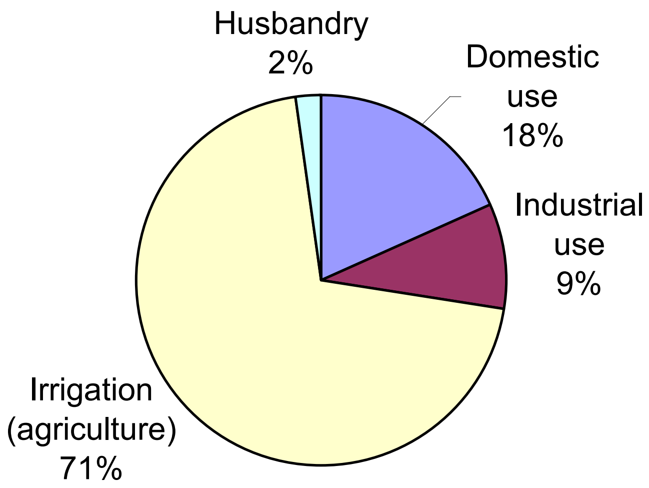
2.2.3. Use of natural resources - use of water

The use of natural resources is a field for which it is difficult to find statistics on the utilisation ratios that come within the framework of this report, but many experts agree in saying that there is an excessive use of raw materials, and that the stock of available resources is decreasing.

Thus, within the framework of this report, statistics will be only presented on the use and treatment of water in Catalonia in view of the limited European data available on the subject.

Concerning water, Graph 18 indicates the distribution of its use in Catalonia:



Graph 18: Distribution of the demand for water by type of use in Catalonia (year 1999, source DMAH [25])

It is not surprising to see that agriculture alone is responsible for more than 70% of water consumed. This represents 2,202 hm^3 per annum.

It would also be interesting to compare the toxicity of the water returned by each of these sectors and to see the position of the industrial sector. But no statistics are available on the subject.

[25] DEPARTAMENT DE MEDI AMBIENT I HABITATGE, *Estadístiques del Departament de Medi Ambient i Habitatge, Demandes d'aigua per usos consumptius,* [on line], http://mediambient.gencat.net/cat/el_departament/estadistiques/aigua/aigua01_demandes_aigua.jsp?ComponentID=86932&SourcePageID=87706#1, consulted 17/08/2006.

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Concerning water treatment, here are some general data on the output of the purification stations in service in Catalonia. No differentiation has been made between the purification stations used for water coming from the industrial sector and the domestic sector.

	1999	2000	2001	2002	2003	2004
Number of purification stations in service	225	246	270	290	297	314
Output treated (m^3/day)	1,536,135	1556,860	1,534,239	1,606,844	1,958,800	1,972,069
Average global output of SPM (%)	91	92.2	93.6	89.3	93.2	87.1
Average global output of elimination of the DBO5 (%)	94.0	93.7	94.4	91.9	94.5	90.8

Table 6: Total output of purification stations in service in Catalonia (source: DMAH [26])

It is interesting to note that, like the quantity of treated water, the number of purification stations continued to increase between 1999 and 2004. This may mean that the quantity of dirty water returned into the natural environment without treatment decreased, or that the quantity of dirty water to be treated increased.

[26] DEPARTAMENT DE MEDI AMBIENT I HABITATGE, *Estadístiques del Departament de Medi Ambient i Habitatge, Rendiments globals de les depuradores en servei,* [on line], http://mediambient.gencat.net/cat/el_departament/estadistiques/aigua/aigua03_rend_globals.jsp?ComponentID=86937&SourcePageID=87706#1, consulted 17/08/2006.

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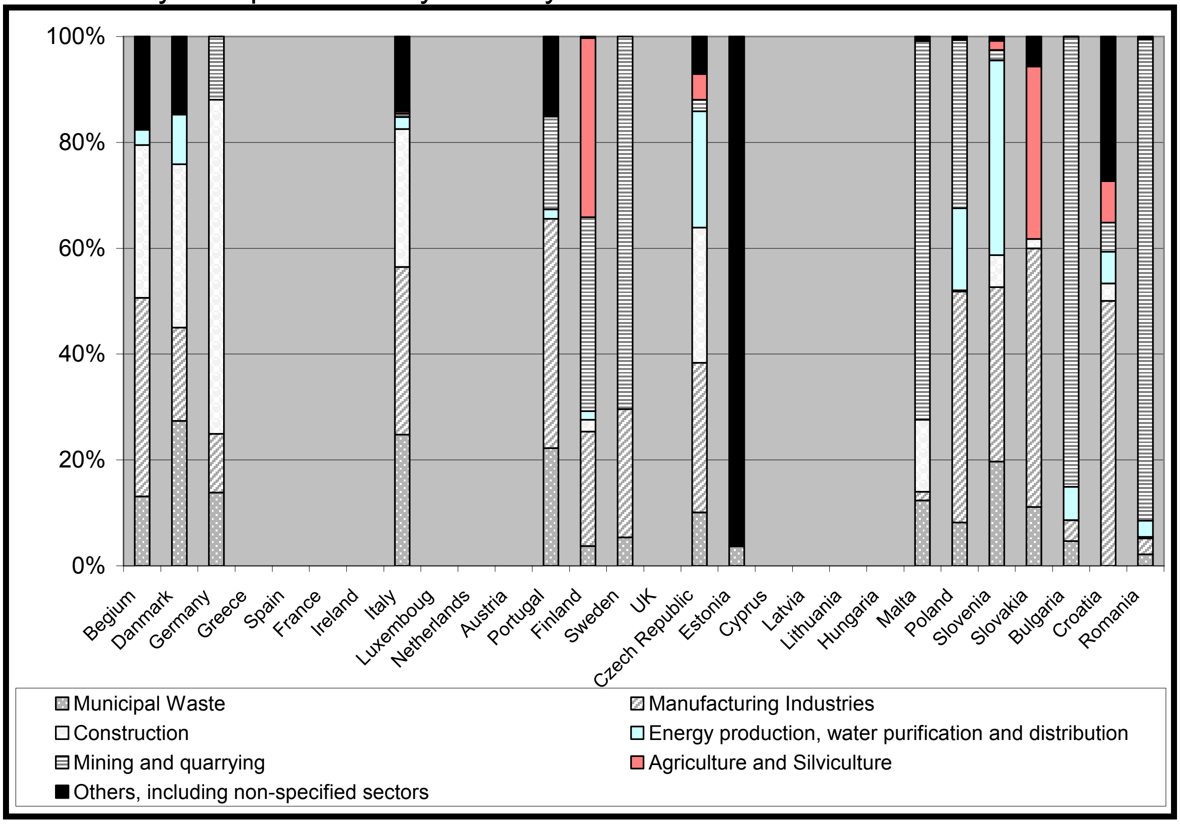
2.2.4. General data on waste generation

2.2.4.a) Source of the waste generated by sector

The graph below shows the source of the waste generated by economic sector and by European country for the year 2002:



Graph 19: Origin of waste generated by economic sector and by European country in 2002 (%) (Source: Eurostat [27])

In view of the lack of statistics, especially for Greece and Italy, it is difficult to make a very precise analysis. However, it can be observed that in general waste from the manufacturing industry constitutes a major proportion of waste produced.

Concerning Spain, the data are not available on Eurostat; nevertheless, data from the Department of the Environment [28] for the year 2000 provide this information:

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[27] EUROSTAT, *Waste generated and treated in Europe – Data 1995-2003*, [on line], downloadable from http://europa.eu.int/comm/eurostat/, consulted 10/04/2006.

[28]Ministerio de Medio Ambiente, *Información Estadística y Ambiental,* [on line], http://www.mma.es/portal/secciones/info_estadistica_ambiental/estadisticas_info/, consulted 10/04/2006

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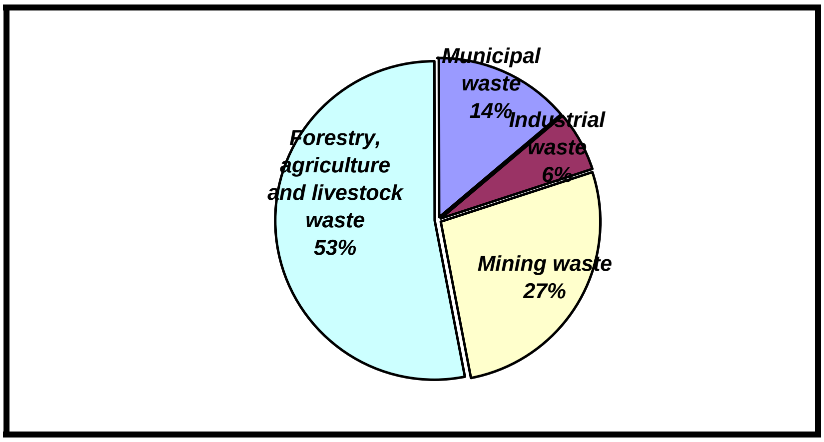
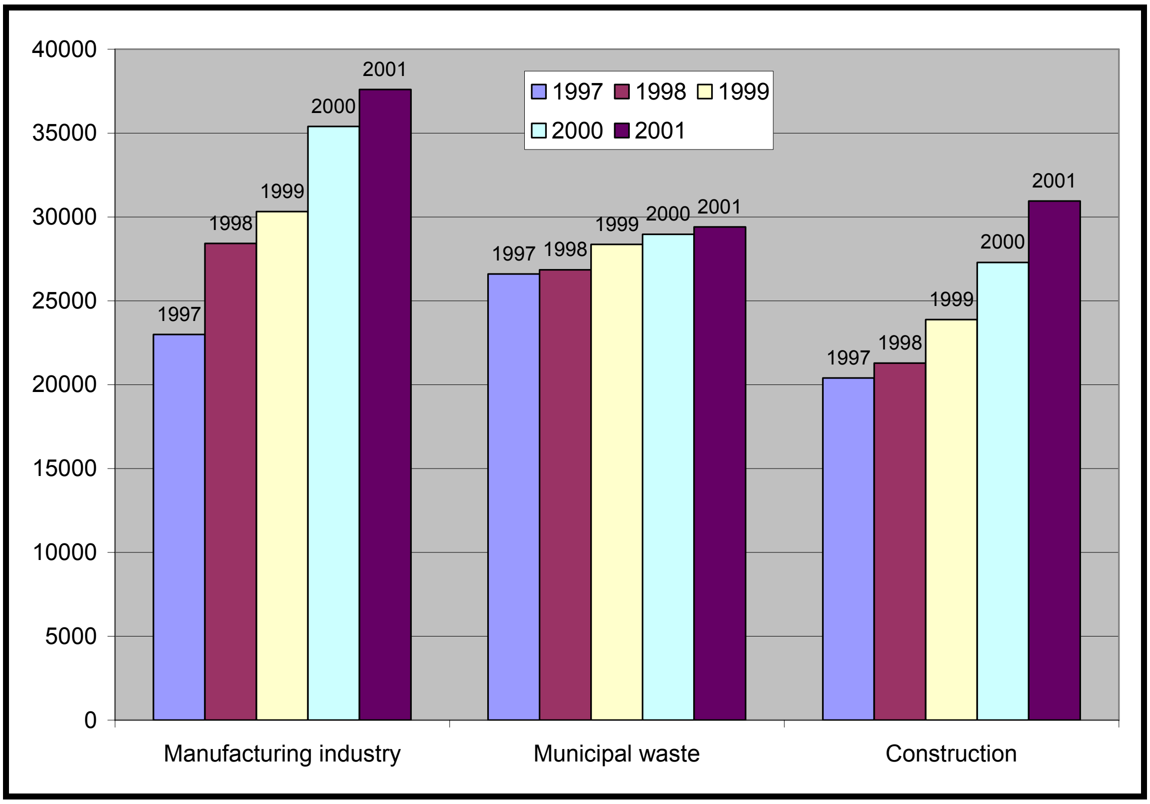


Graph 20: Annual distribution of waste production in Spain for the year 2000

2.2.4.b) Evolution of the quantity of waste generated

Graph 21 shows the evolution of the quantity of waste produced by the economic sectors producing the largest amount of waste for Italy (data for Spain and Greece not being available):



Graph 21 : Evolution of the total quantity of waste produced in Italy from 1997 to 2001 for the sectors of the manufacturing industry, municipal waste and construction (1000 tonnes) (Source: Eurostat [21])

It is not surprising, but always worrying, to see that the quantity of waste produced by the main economic sectors is constantly increasing. The statistics above are only available up until 2001, but few radical changes have occurred since then.

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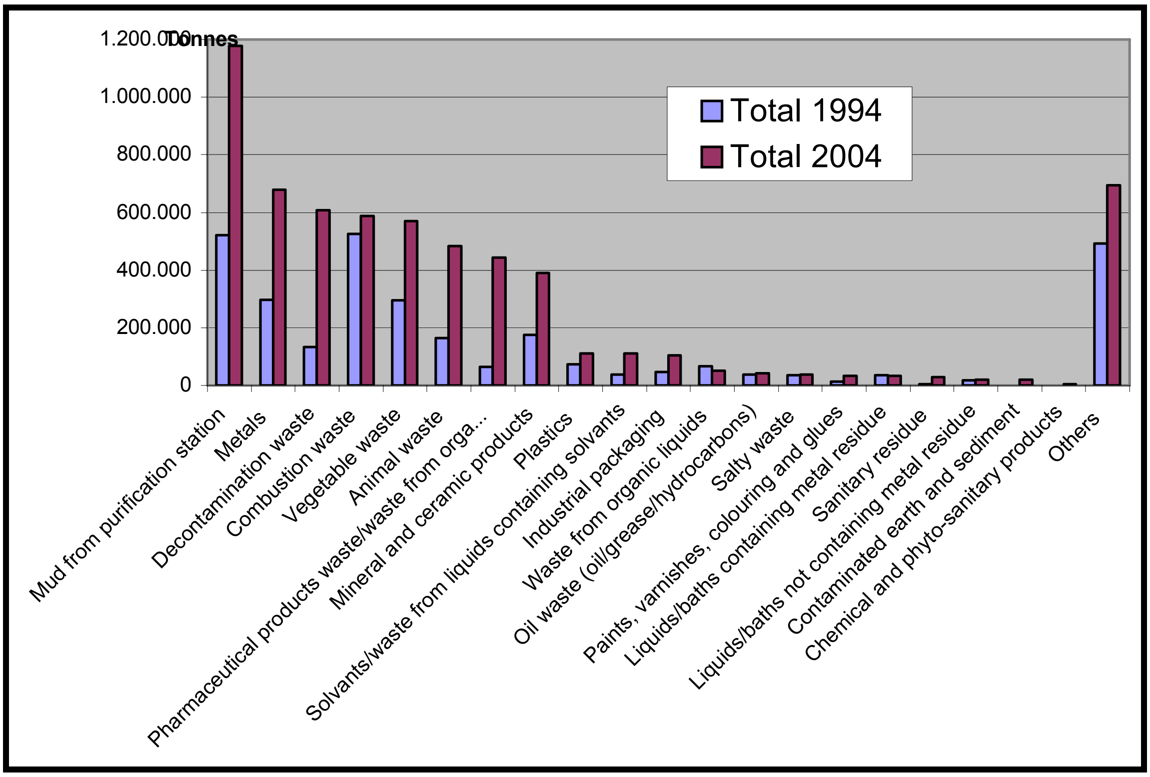
2.2.4.c) Example of Catalonia: evolution of the types of waste generated and their mode of treatment

Based on existing precise statistics on industrial waste in Catalonia, the following 2 graphs show how the types of waste produced as well as the types of treatment or recovery evolved over a 10-year period:



Graph 22: Distribution and evolution between 1994 and 2004 of the various types of existing industrial waste in Catalonia (Source: ARC [29])

It is easy to see that all the main categories of waste have considerably increased. The most important increases concern pharmaceutical products (x7) and residues from organic manufacture as well as residues from decontamination (x4.6). Nevertheless, the consequent increases in the quantity of waste for livestock (x3) and metals (x2,3) should also be noted.

These sharp increases are largely due to an increase in the production of waste, but the evolution of the environmental regulations concerning waste may also be responsible.

In fact, for example, reinforcement of the regulations concerning recovery of pharmaceutical products and the decontamination of products before recovery have without doubt strongly increased their influence on the statistics.

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[29] Agència de Residus de Catalunya, *Estadístiques corresponents a les dades de la declaració anual de residus industrials,* [on line], http://www.arc-cat.net/ca/estaddin/Industrials/estadRI1.asp, consulted11/04/2006.

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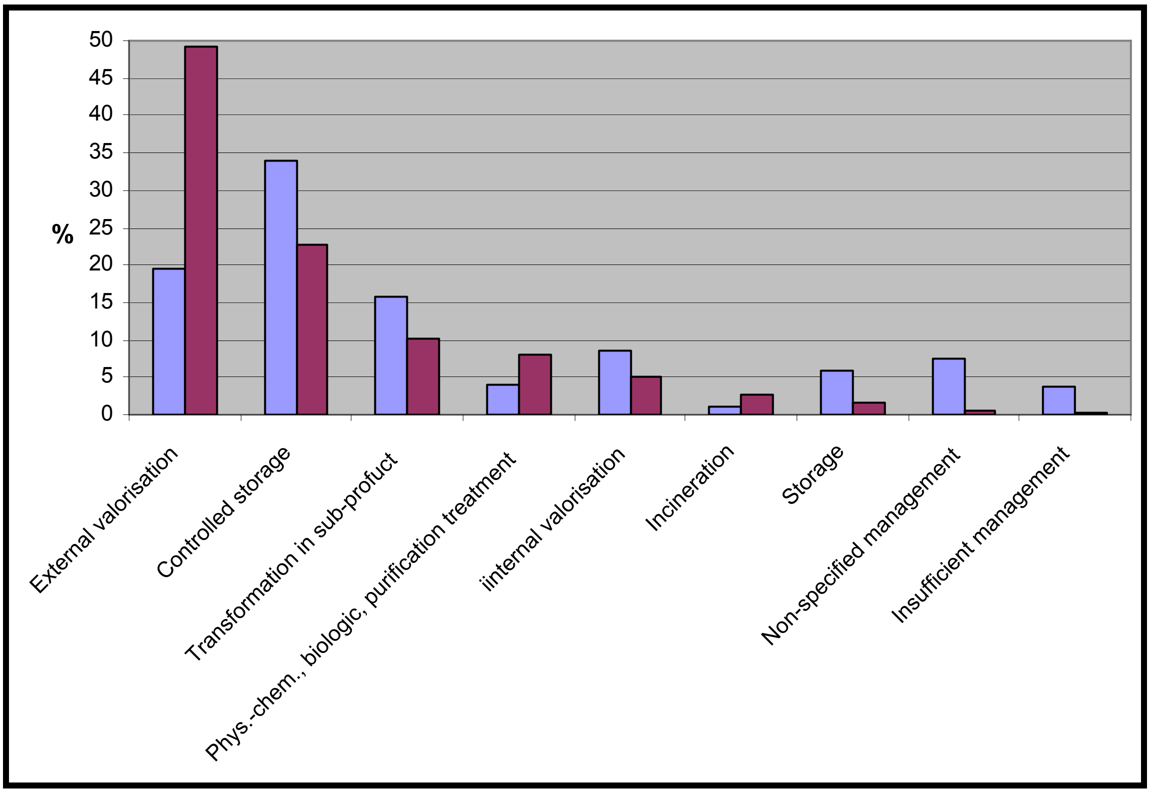

Graph 23: Distribution and evolution of the various types of treatment of industrial waste for 1994 and 2004 for Catalonia (Source: ARC23)

The preceding statistics are rather positive as the rates of internal and external recovery have increased. In addition, waste storage and unspecified or insufficient management are decreasing. However, in the light of the current situation, the evolution could be even more significant.

Moreover, the category of transformation into by-products is very important from the point of view of industrial ecology, and the decrease in the percentage of them not positive.

Nonetheless, the decrease of the quantity of waste transformed into by-product may be merely the result of a statutory mechanism connected to the definition of the waste (directive of 1975): the application of the regulations gradually leads to output flow which is not a product of manufacturing to be administratively considered as a waste, and thus it can thus concern by-products. This change of status calls for an important transformation of the considered flow (injection into a process, etc.).

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2.2.5. Analysis of industrial practices concerning the management of waste

We have just seen that an excess of waste (much of which is toxic) is produced and that the trend is not towards a decrease. Thus it is now important to seek to analyse the facts which can explain the preceding figures.

2.2.5.a) Analyse the source of waste

Waste comes from products which internally are no longer usable in the company. In order to deal with the source of the problem, it appears important to reflect on the composition of consumed materials, their environmental impacts and their end of life scenario.

- ***Think in terms of life cycle***

First of all, is necessary to consider the toxicity of waste products as well as the lifespan of a product before it is transformed into waste. Certain products (in particular packaging) have very short lifespans and this is not acceptable. Before choosing a product, it is also necessary to take into account its environmental impacts throughout its life cycle.

Certain materials used require too much energy and material to be produced, used, transported and disposed of or recovered and that is unacceptable. The choice of a material should not only be made in accordance with economic criteria, it is also important to integrate environmental criteria, in particular for the end of life of waste.

This initial reflexion would doubtless make it possible to deal with the quantity and the toxicity of waste produced. For certain sectors this has been made compulsory by European directives (automobile, WEE, packaging) which fix objectives of recycling or elimination of certain toxic products in the processes, etc.

- ***Think internalisation of the external effects***

In addition, extra efforts should be made to take into account the internalisation of the external effects: i.e. to know who must pay for the damage caused to the environment by the discharge of a certain hazardous product into the environment - the producer or the user?

2.2.5.b) Use of production processes generating too much waste

Many current production processes generate too much waste. In some cases, too much waste is generated per unit produced. For example, if one cuts out parts from plate metal, it is necessary to optimise the punching of this plate to obtain a maximum number of parts from the least possible metal purchased. Thus, there is less production waste.

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This example appears commonplace, but actually many companies do not yet check whether their production process could be more effective in terms of the use of raw materials and the quantity of waste generated.
Hence, BATs (Best Available Techniques) give access to more effective processes and thus decrease waste generation.

2.2.5.c) Few efforts to close the loop

Once the quantity of waste has been reduced by the improvement of a process; a further, more advanced, stage consists of introducing the notion of " the closing of the loop" among entrepreneurs; i.e. it is necessary to try to close the material cycle as far as possible, "to avoid leakages".
This consists initially of:

- Re-using used materials to the maximum.
- Only discharging organic and biodegradable materials into the environment.
- Reducing the use of packaging and using recycled paper and cardboard for packaging.
- Trying to learn whether waste from companies could serve as the raw material for a neighbouring company.

Waste is a central element to setting up an industrial symbiosis; hence it must be the subject of more in-depth reflection in order to determine the potential for re-use and not as a material to be disposed of.

Perhaps an evolution in environmental regulation would be one of the tools to help to change this current vision.

2.2.6. Overview of the problem

Point of view:	Quantitative	Qualitative
Environmental	►Too much waste ►Fewer and fewer resources	► Highly toxic and hazardous waste ► Production processes generate too much waste ► Few efforts to close the loop
Economic	► Cost of treatment of certain waste rather high	► Lack of efficiency of the process used
Social		► Extremely hazardous impact on health by toxic waste discharged into the environment

Table 7: Overview of the problems concerning the production of waste in industrial estates

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2.3. PROBLEM 3: Land use

2.3.1. Definition of the problem

The efficiency of land use within an industrial estate is too low. The organization of space is not optimal and does not allow the putting in place of conditions to ensure adequate competitiveness of the industrial estates, from economic, environmental and social points of view.

2.3.2. Methodology

Initially, we will see a number of historical elements which will shed light on the current situation. Then we will see which are the current prevalent criteria for the selection of industrial land and finally we will analyse some specific examples of industrial estates which have experienced problems due to the criteria for implementation not being well selected.

2.3.3. General description of the problem

2.3.3.a) Setting-up of the industrial estates: the problem of land

In Catalonia, industries were initially located in the centre of large cities, but with urban development over the last few decades, residential areas have been established in the centre, and industrial estates have been moved to the outskirts, in the outer urban areas and close to major roads. This has led to a fragmented industrial layout, at times located on sites of public interest.

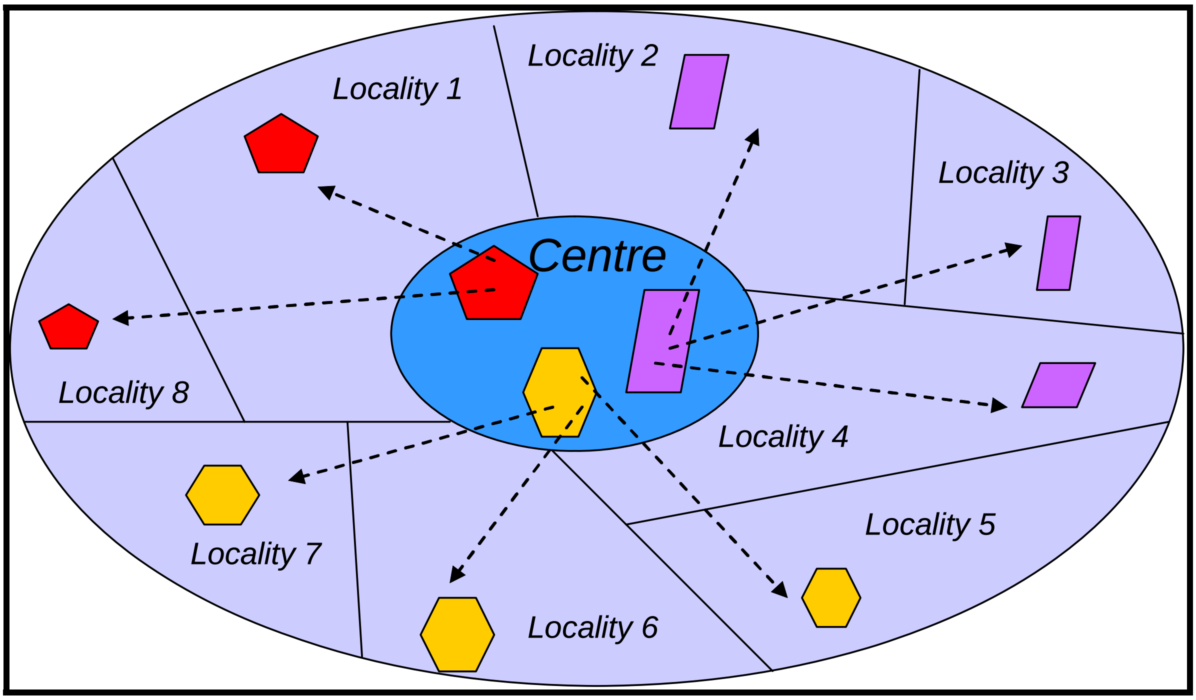

Figure 7: Delocalisation and expansion of the industrial estates from the centre towards the outer urban areas

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2.3.3.b) Dominant criteria for the establishment of industrial estates

Currently, the principal criteria for the establishment of industrial estates are:

- Individual interest of the people, the land and buildings
- Proximity of the sources of water and energy
- Proximity of the road axes
- Individual interest of the communities (each one wishes to have its industrial estate on its administrative territory to show its economic power)
- Economic motivations: tax collection, the development of the city.

Nevertheless, these criteria are not enough if one wants to move towards a durable environmentally friendly society. In fact, the weak rationality of these criteria leads to areas of conflict where serious problems can appear. Examples are given below of conflicts which exist in industrial estates in Southern Europe.

2.3.4. Description of the estates of conflicts by type of conflict

Besides the problems of setting-up and land, a number of the other interactions of the industrial estate with the rest of the territory can create conflicts.

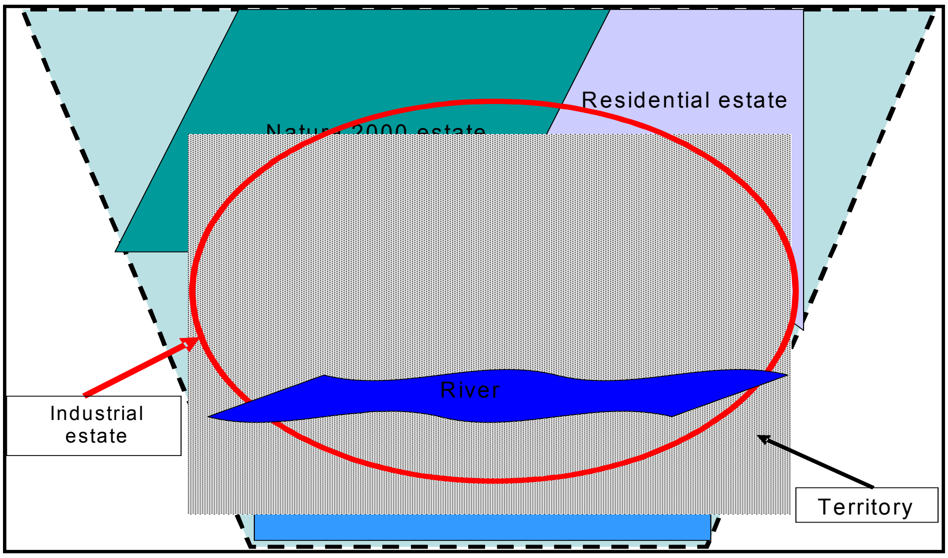

Figure 8: Representation of the possible conflicts between a territory and its specificities and an industrial estate

- ***Floodable areas (coast and river)***

It is not infrequent for industries to decide to set up close to rivers to have a source of water in the vicinity or close to the sea if maritime transport is used for goods.

However, a number of these estates are prone to flooding, which constitutes an important risk for industrial estates located in floodable areas. Moreover, the damage of this type of conflict may prove considerable.

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➢ *Areas of natural interest and biodiversity*

There are still a certain number of industrial estates which are located on protected areas of public interest.
It may be the case, among other, of the areas referred to below:

- Picturesque Areas (ZCP)
- Areas of protected environment (ZEP)
- Areas exposed to risks related to the movements of the ground and substrata (ZERMOS)
- Important bird conservation Areas (ZICO)
- Natural areas (ZN)
- Natural balance areas (ZNE)
- Natural areas of ecological, plant and wildlife interest (ZNIEFF)
- Areas to be protected (ZP)
- Landscape protection Areas (ZPP)
- Areas registered in the Natura 2000 network
- Protection perimeter for the collection of water

The establishment of industrial estates on this type of territory contributes to the erosion of the biodiversity and can give rise to irreversible after-effects.

➢ *Permeability of the ground (contamination and vulnerability of subsoil waters)*

Certain industrial estates are located on permeable ground, and no special measures for protection of the soil have been taken. This can induce strong contamination of the soil, in particular of subsoil and surface waters. This contamination may be irreversible or may require a good deal of time to attenuate. However there are still a certain number of activities which are not in accordance with the standards.

➢ *Estates in conflict with residential areas (noise, odour, atmosphere, particulate emissions, view, real estate property)*

The distance between residential areas and industrial estates must be sufficient to avoid the production of harmful sound, olfactory and visual effects. This is also necessary as certain industrial atmospheric emissions can be very harmful to the health. However there are still industries located near residential areas that can create major conflicts between residents and industrialists if the harmful effects are perceived as awkward by the former.
They can also damage the value of their real estate property (detached houses, apartments) if they are very serious.

➢ *Landscaping*

Landscaping industrial estates is important for the proper integration of the site in its natural context.

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However, a certain number of industrial estates require more effort to be made in this field, especially when these estates are located close to dwellings or to natural sites of a special interest.
In addition to this deficiency, often no architectural specifications were defined when industrial estates were established. That would have made it possible to define common general rules for the construction of the buildings. Industrial estates are not harmonised at the level of the style of buildings. Landscaping of an industrial estate and its good integration are major elements in its attractiveness.

- ***Transport system***

Good accessibility to an industrial estate using collective transport and by road is essential for its proper operation. However, many industrial estates suffer from a lack of accessibility, with public transport stops too far away, and dense traffic at peak hours. This is an essential element of territorial planning for good links between the estate and the outside.

- ***Energy network and productive capacity (sun/wind/hot water)***

The proximity of sources of energy is also an important point in avoiding excessive transport distances and high-energy losses. But that is not always the case with old industrial estates. Moreover, few sources of renewable energies and collective supply networks are used.

- ***Capacity of environmental management (waste/white, grey, soiled and black waters)***

The management of waste and soiled water in an industrial estate is still problematic. For waste, selective and collective sorting is often not set up, with each company managing its waste in its own way. For water, the differentiation between grey, white, and black water is not always made; however, they do not require the same treatment, and white water (rainwater) can be re-used without requiring chemical treatment.

- ***Utility services***

Industrial estates do not have many utility services such as restaurants, cafeterias, conference rooms and a nursery service being shared between firms. A restaurant shared between firms, for example, would mean workers not having to go home for lunch.
The conference room could prove to be useful, and would increase the attractiveness of the estate for companies.

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2.3.5. Overview of the problem

All the aforementioned territorial conflicts, which are summarised below, must be taken into account during the planning of new industrial estates. It is essential to consider these elements before starting to launch industrial ecology.

Domain	Name of territorial conflict
Land	IE expanded in each locality
Land/water	IE located on land prone to flooding
Land/ environmental management	IE located on areas of public interest
Land/water/environmental management	IE located on permeable soils
Land/water	IE located close to residential areas
Environmental management/facilities	IE without landscape integration or architectural layout
Displacements	IE badly served by collective transport systems
Energy	IE without energy efficient network
Environmental management/waste	IE without capacity of environmental management
Facilities	IE without collective facilities

Figure 9: Summary of the territorial problems of industrial estates

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2.4. PROBLEM 4: Information and co-operation

2.4.1. Definition of the problem

Cooperation is a key condition for the success of an initiative of industrial ecology in an industrial estate. Indeed, before exchanging flows of water, materials and energy, companies initially have to exchange information about their flows, study the conditions of realisation of synergies, and then define the terms which are going to govern the exchange.
Regrettably, the statistical analyses, described in the preceding paragraphs on energy, waste and natural resources, show that there is a major lack of information on the activity and the management of industrial estates.
This is both the consequence of and one of the reasons for low co-operation among various companies in an industrial estate, and between the various industrial estates of a given territory, and does not encourage experiments in:

- **Mutualisation** of services, information, energy and material supply, etc.
- **Substitution** (implementation of synergies).

Another factor influences the capacity of the manufacturers to exchange information and to cooperate: **the culture of competition**. Indeed, this is the natural and dominant mode of functioning in the world of the company. This situation obviously results in individualist behaviour. Moreover, managers are trained for this situation of competition, with competitors distributed sometimes all over the world. Hence, cooperation with nearby companies which goes beyond the simple client/supplier relationship is a completely new notion.

2.4.2. Methodology

Problems concerning the access to information will be analysed first. Then those relative to co-operation and communication will be studied at three different levels: on a territory level which includes several industrial estates, at the level of the industrial estate itself, and at the level of the companies which constitute the heart of the problem.

2.4.3. Difficulties of access to information

In order to develop effective management plans and to thoroughly understand the activity in the industrial estates and its evolution, it is important to have a good database and reliable indicators.
However, there is currently very little information for each industrial estate on:

- The types of materials entering and exiting.
- The management of water and the different treatments.
- The quantity, composition and treatment of waste.
- Atmospheric emissions.
- Risk factors.
- Environmental management.

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There are few bodies responsible for the collection and dissemination of this information. Moreover, bodies which could have this type information are not easy to access. It is not obvious to know where to go to look for information.
Thus a software tool (e.g. a database accessible by internet) is required, making it possible to centralise and update of this information, and to diffuse it so that it is harmonised for all of the industrial estates in a given territory.

2.4.4. Analysis at the level of a territory including several industrial estates

2.4.4.a) Territorial planning

It is important for each community or territorial district to have at least one industrial estate to show their economic power and their territorial influence.
But not every estate has a body or an administrator in charge of its operation and development. This role is often played by the municipality in which it is set up, and which has to assume it along with all other missions for which it is responsible.
The upshot of this is that several industrial estates may be found in very close proximity if they are each located close to the borders of the localities; nevertheless, as they do not belong to the same administrative divisions, and there is no management structure attempting to create a link, they do not share any communication. This can be seen in Figure 10.

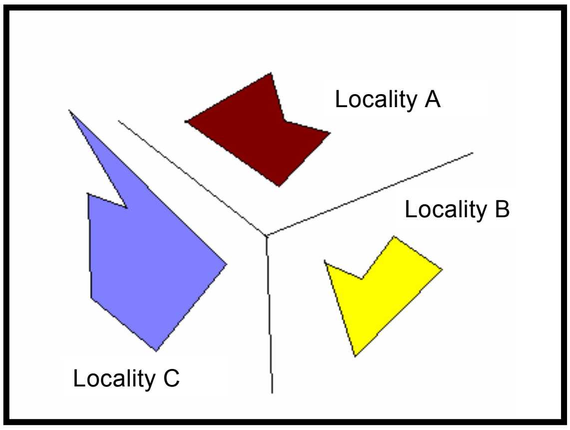

Figure 10: Representation of 3 industrial estates in close proximity but located in different localities

However, in order to establish co-operation, the territory where the industrial estates are located must be seen as a “common territory” with something to share.
The borders of this “common territory” should not be limited to the administrative borders of the various localities, as they are not appropriate.
Three industrial estates geographically close to one another could be more efficient (in particular concerning occupation of the land and the implementation of synergies) if all three units were joined together in the same industrial estate managed by a body entrusted with this task.

2.4.4.b) Mutualisation of services

This location of the industrial estates in the territory described above does not encourage the setting up of structures for cooperation between the industrial estates, even though geographically they may be very close.
In fact, simple services could be “mutualised” among several small industrial estates, such as, for example, security, restaurants for employees or the

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collection of special waste, the use of wooden pallets, the procurement of products or materials.
For example, optimisation of certain of transport needs or security will certainly result in both environmental and economic benefits, by reducing the costs and thus by reinforcing the attractiveness of the estates in question.

2.4.4.c) Waste exchange

The cost of waste disposal for a company often represents major expenditure.
It would be interesting to study the viability of the installation of a marketplace dedicated to the treatment of this waste in optimal costs: a waste stock exchange serving several industrial estates.
Its success would depend greatly on the quality and quantity of waste available, and on the kind of enterprises concerned. It would also depend on another very important factor: the level of information on the various possibilities of treatment, notably the valuation of their own waste flows or their capacity to use others flows in their processes. In the absence of this type of information, manufacturers indeed have no reason for using a waste stock exchange.

2.4.5. Analysis at the level of the industrial estate

2.4.5.a) Communication among companies

Within an estate or an industrial network, most of the time, communication between companies is generally very weak. The absence of culture of collaboration, and thus of knowledge of their economic and strategic interests, partially explains why communication with the other companies does not necessarily seem to be indispensable for them.

Thus, there are few industrial estates which have a common structure that represents all of the companies.
For example, in Catalonia, according to the UPIC (Unió de Polígons Industrials de Catalunya), there are 500 industrial estates and 50 associations of companies of industrial estates, but only half of these associations are active, and only 12 are members of the UPIC.
Thus only 5% of the industrial estates have an association, and only 2.4% have joined the UPIC.

But in the rare cases where one does exist, the association is set up rather with an economic objective (for example for the promotion of the industrial estate), and not with an objective for environmental management.

However, currently, a certain number of small and medium enterprises (SME) have problems meeting the evolution in environmental directive is it too costly.

Thus, if several SMEs decide to set up a joint system of environmental management (of the EMAS type), it then becomes possible for them to bear the costs, and thus significantly reduce certain environmental impacts through collective action.

PART 1: SITUATION AND PROBLEMS OF INDUSTRIAL ESTATES IN SOUTHERN EUROPE

A European project named RECONS is currently working on this point. It acts, inter alia, by setting up a system of co-operation between SMEs in the construction sector in Catalonia in the form of a union. This union would be responsible for implementing a common EMAS with all of the small companies in the sector.

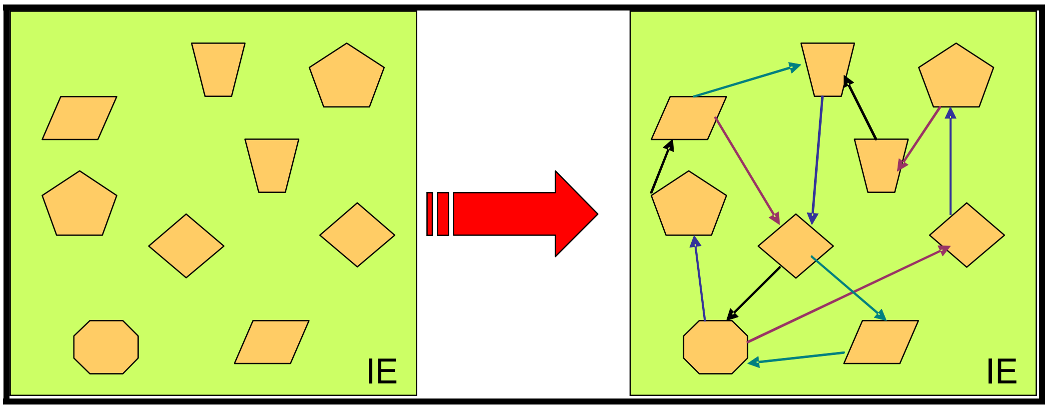

Figure 11: Representation of the desired evolution concerning the co-operation among companies of an industrial estate

On the scale of an industrial estate, certain experiences, for example in France, show us the importance for the estate of having a management structure that is dedicated exclusively to this task.
Projects for the ISO14001 certification of estates were indeed introduced and taken up by these structures of management; stimulating the operation of the estate and attempting to make companies communicate between themselves by means of these projects (see the www.oree.org site).

PART 1: SITUATION AND PROBLEMS OF INDUSTRIAL ESTATES IN SOUTHERN EUROPE

2.4.6. Analysis at the level of the companies

We have just seen the general problems of co-operation which slow down the development of a culture of cooperation, which is indispensable to industrial ecology.

Now, it is important to try to understand why the behaviour of companies and entrepreneurs is often negative in the implementation of co-operation, and why co-operation is such a difficult step in development of industrial ecology.

The classic company is a rather closed entity which communicates with its customers and suppliers, but which does not seek to know its neighbours if there is no commercial interest.
Not being informed about the economic profits linked with co-operation with other companies on the estate, it may feel that this type of initiative is pointless.
This induces many difficulties in the creation of bonds in an industrial estate, and even more so if the industrial estate is old and its operation is well established.

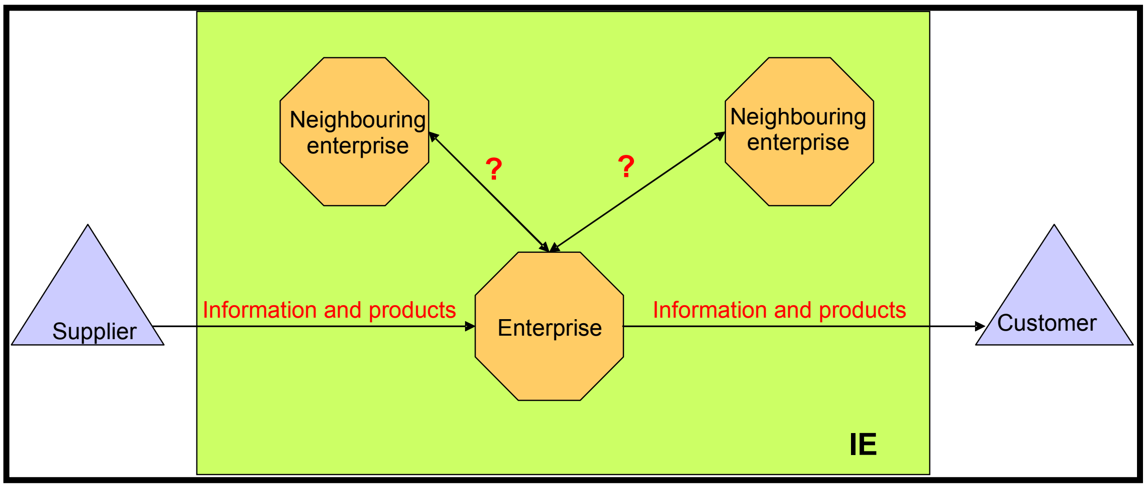

Figure 12: Representation of the exchanges carried out by a company

However co-operation between companies is the basis for the implementation of an industrial symbiosis. Indeed, the implementation of a synergy can require long-term commitment among several companies. This thus requires confidence in the durability of relations and synergy. This confidence is based on sound knowledge of the other company.

To try to get companies which do not know one another to work together is probably one of the main difficulties of industrial ecology.

The stakes are very high, as this requires entrepreneurs to change their vision of the company and to think differently and in a more globalised manner.
The status of the company will have to change from that of a completely individual, solitary entity to that of being an active member in a network of

PART 1: SITUATION AND PROBLEMS OF INDUSTRIAL ESTATES IN SOUTHERN EUROPE

several entities. And similarly, the industrial estate must belong to a territory where there are several industrial estates.
As the figure below shows, this perspective breaks with the classic plans of the entrepreneur and communities' cultures.

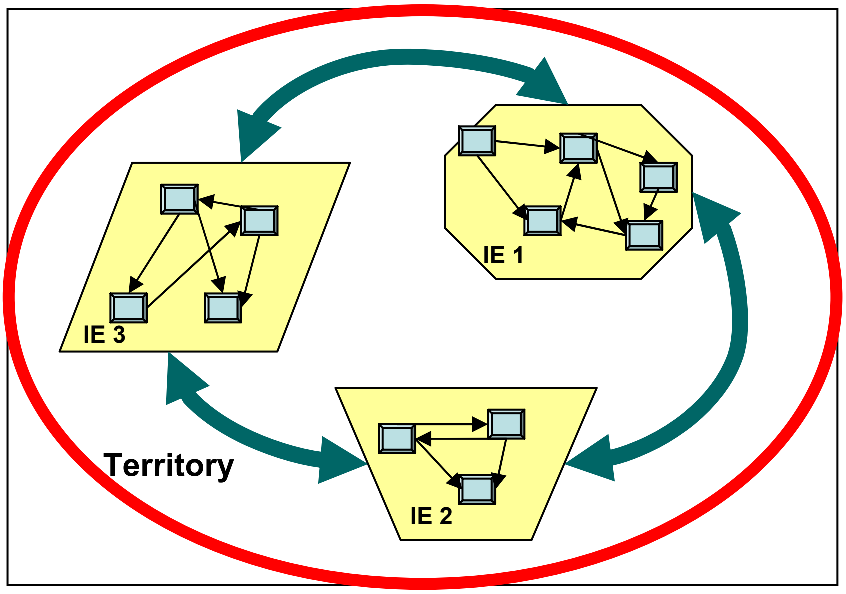

Figure 13: Representation of desired co-operation

2.4.7. Overview of the problem

Point of view	At the level of the territory	At the level of the industrial estates	At the level of the companies
Environmental	► Poor territorial distribution of the industrial estates	► No common environmental management system ► No synergies	► Difficulties regarding environmental regulation
Economic	► Poor efficiency ► No mutualisations	► Poor efficiency ► No mutualisations ► Transport costs too high	► Excessive expenditure to meet regulation
Social	► No communication with neighbours ► No common structure	► No communication with neighbours ► No common structure	► No communication with neighbours ► Limited vision of the system

Table 8: Summary of the problems concerning co-operation

PART 1: SITUATION AND PROBLEMS OF INDUSTRIAL ESTATES IN SOUTHERN EUROPE

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PART 2: ECOSIND RECOMMENDATIONS

1 Recommendations for planning of new or partially developed industrial estates

One of the main difficulties for the application of projects of industrial ecology within industrial estates is connected with the conception of these estates.

Indeed, on an existing estate, there was no planning to facilitate the setting up of synergies between companies (possibility of building pipelines later, etc.).

Moreover, when the already implanted companies conceived and created their processes, they did not integrate the possibility of using a flow resulting from a nearby company or of proposing their own outgoing flows to these same neighbours.

Thus, they implemented production tools which they have to pay off before to possibly modernising them and to establishing any possible synergies. Then, for example, they will be able to eliminate the use of a chemical which prevents the re-use of a waste.

The planning of new or partially occupied industrial estates is thus a marvellous opportunity to create land that is favourable to the development of loops of materials, water and energy.

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1.1. Organisation of the recommendations for the planning of industrial estates

To establish recommendations concerning the planning of new or partially developed industrial estates, 4 different phases have been defined.
The methodology used to develop these various phases was based on the Wheel of Deming[30] or PDCA (Plan Do Check Act), which makes it possible to emphasise the importance of a programme of continuous improvement: it is always necessary to evaluate the impact of the actions carried out and to set up corrective measures if that is necessary.

The 4 phases defined and represented in the figure below are:
PHASE 1: ANALYSE THE TERRITORY
PHASE 2: CREATE THE INDUSTRIAL ESTATE (IE)
PHASE 3: MANAGE THE ACTIVITY OF THE IE
PHASE 4: FOLLOW UP AND EVALUATE THE ACTIVITY OF THE IE

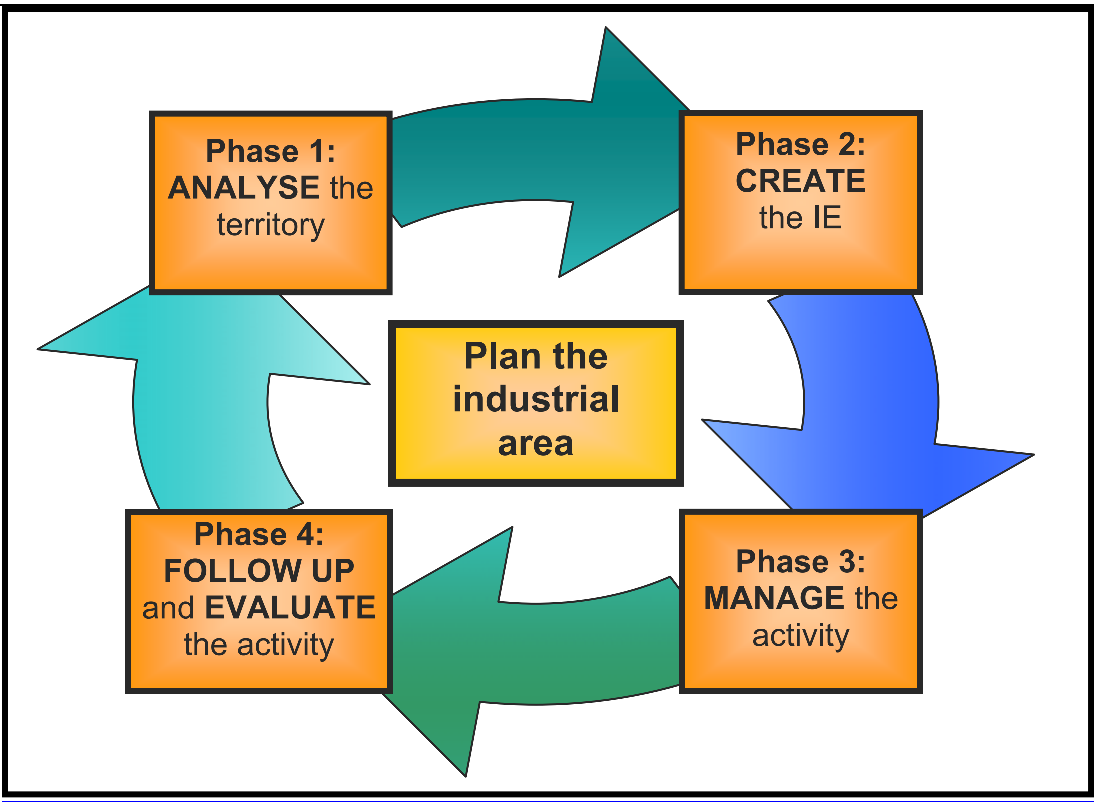

Figure 14: Organisation for the planning of industrial estate

[30] Actu-environnement, *La norme ISO 14001*, [on line], http://www.actu-environnement.com/ae/dossiers/iso14000/iso_principe.php4

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From these 4 phases, 8 recommendations have been defined:

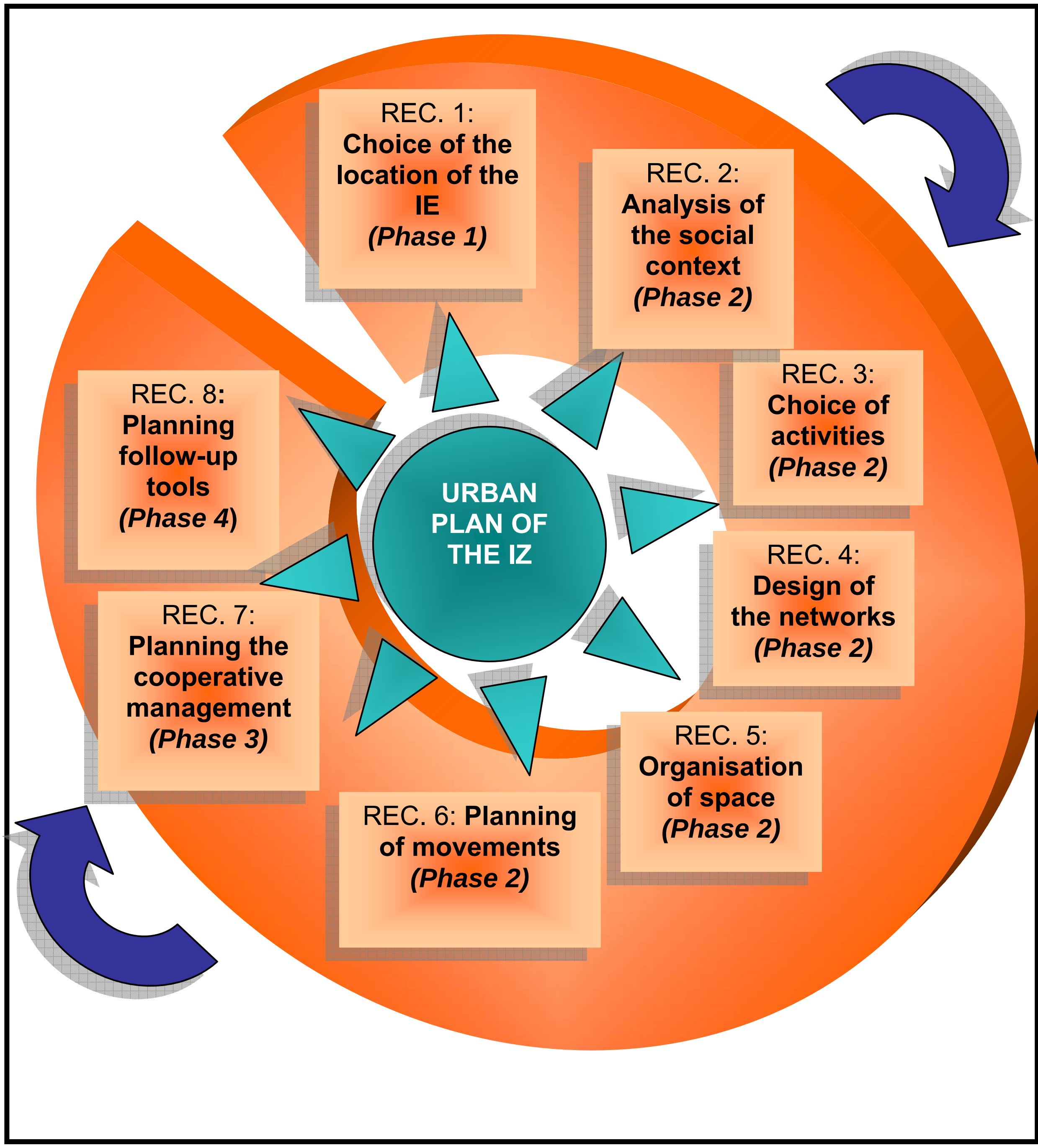

Figure 15: Organisation of the recommendations for the planning of new industrial estates

The 7 recommendations will be all outlined and presented in the same format:

- **KEY MESSAGE**
- **METHODOLOGY**
- **RECOMMENDATION**
- **LINKS WITH ECOSIND OR OUTSIDE EXPERIMENTS**

PART 2: ECOSIND RECOMMENDATIONS

1.2. RECOMMENDATION 1: Analyse the territory using Geographical Information Systems (SIG) and choice of the location of the industrial estate.

- **KEY MESSAGE**

The choice of new industrial estates with sustainable development criteria requires a precise approach based on indicators which allow to avoid future conflicts.

- **METHODOLOGY**

The methodology proposed to realize an exhaustive evaluation of the territory and to end up in a suitable choice for the situation of the industrial estate:

- **Step 1** : Identification of suitable areas for industrial use on the basis of law,
- **Step 2** : Definition of indicators and search for necessary information,
- **Step 3** : Site zoning with respect to the defined indicators,
- **Step 4** : Assigning weights for each indicator involved and assembling them to evaluate suitability of different possible industrial estates,
- **Step 5**: Classification of the most suitable estates and final choice.

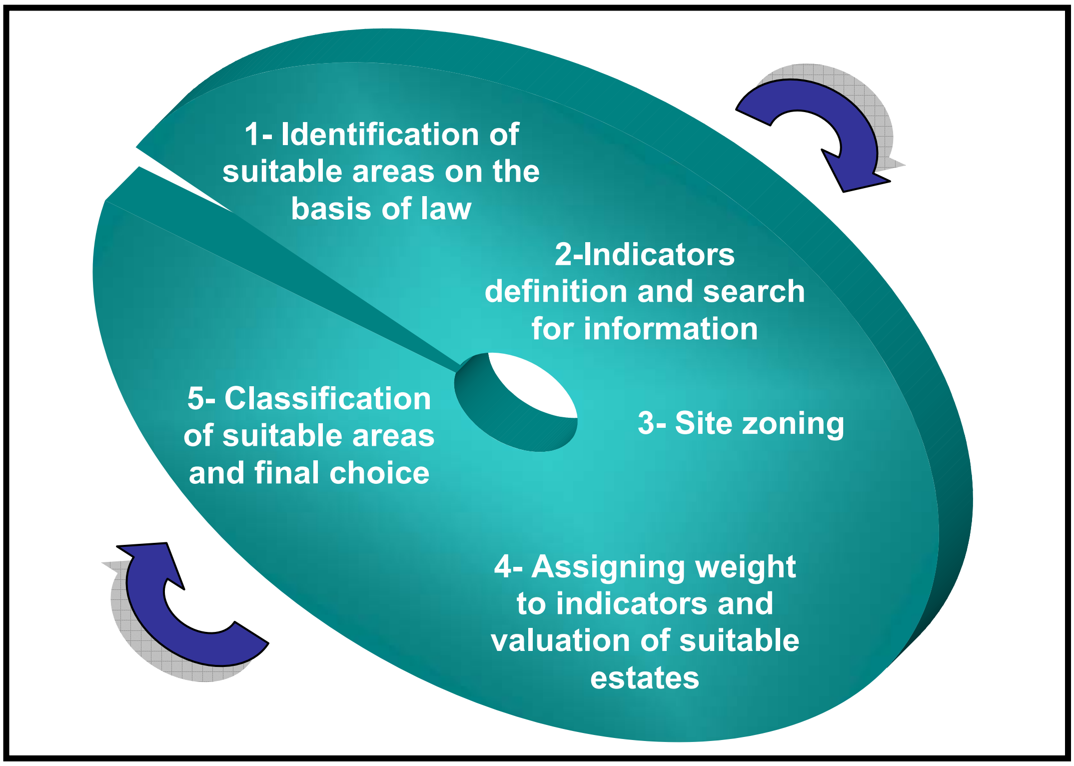

Figure 16: Methodology for Planning Recommendation 1

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• RECOMMENDATION

Before clarifying the various stages of the recommendation, it is important to define the necessary perimeter to study the territory.
If planning responsible already has an idea of several possible estates to implant the industrial activities, it is necessary to have a study which shows, on the same plan, what is in a radius of 5 to 10 kilometres with regard to the centre of each identified zone. The radius of study depends on the available means and time.

✓ *Step 1 : Identification of suitable areas for industrial use on the basis of law*

At first, it is necessary to look for the criteria defined by the rules that authorize the installation of industrial activities on a territory.
It is important to target well the statutory requirements from the beginning of the project and to have them in mind throughout the realization of the urban plan of the new estate; it is a key element for the success.

✓ *Step 2 : Definition of indicators and search for necessary information*

This second step consists in determining exactly which are the criteria that one wants to use to choose the situation of the area, besides those of statutory order.

These criteria have to consider the territorial conflicts that have to face the existing industrial estates. These conflicts were described during the presentation of the problem of the use of the soils of the part 1 of this guide. They are briefly reminded below; it is necessary to avoid:

- Location on land prone to flooding,
- Location on areas of public interest,
- Location on permeable soils,
- Location lose to residential areas,
- Weak landscape integration,
- Bad serving by collective transport systems,
- Distance to the energy network,
- Weak availability of collective facilities,
- Expansion in each locality…..

With regard to these criteria, it is necessary to define indicators that it will be possible to "geo-reference" thanks to the Geographic Information Systems (GIS); each data collected must be associated to a geographic location.
In the case they would not be geo-referenciated, it is necessary to treat them to assign them a spatial location in the concerned territory.

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To facilitate the step and when it is possible, it is strongly recommended to choose already available indicators resulting for example from the Environment European Agency, National and Regional Environmental Agencies, literature on Impact assessment projects.

The necessary data for the construction of indicators must be collected by using enough sources of varied information. Their collection will thus ask for a good cooperation between several governmental organizations, it can ask certain time.

The main types of information to be collected are presented below, it is important to note that this list is not exhaustive, every territory having its own specificities which it is important to take into account:

- ***Socio-economic***
- Buildings usage (e.g.: Schools, Hospitals)
- Existing Economic Activities
- Mobility
- Population

- ***Environmental***
- Land use
- Hydrology (flood risk areas)
- Geomorphology (landforms)
- Soil moisture
- Geology
- Soil Pollution
- Protected Areas
- Geophysics (seismic areas)

- ***Historical***
- Natural hazards

- ***Urban planning***
- Urban zoning
- Transportations

The use of the above information will typically involve integration of data arising from:

- “Ready-to-use” archives (e.g. generally available data already used in planning policies, both governmental or regional)
- Remote sensing data
- Predictive models
- GPS Surveys

The collected information and the defined indicators will be, at first, intended for the planning project of the new industrial estate, but afterward, they can be reused for all other planning projects requiring these data.

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✓ *Step 3 : Site zoning with respect to the defined indicators*

The following step consists in zoning the territory with the defined indicators. The geographic representation of indicators will allow to highlight them and to show the specificities of the territory.

Data sources must be spatially modelled the same way, using a raster model or a vector model.
Raster data models are suitable for continuous spatially varying variables characterisation, while vector ones should be preferred while dealing with discrete spatially-varying variables (tabular data can be associated to a vector entity). Conversion between the two models (raster to vector or vice-versa) could be mandatory to achieve spatial homogeneity.

Data collected in tables can be represented by different kind of geometry (points/lines/polygons). Geometry conversions (polygon to point) or geometry matching procedures could be mandatory to achieve geometric homogeneity

✓ *Step 4: Assigning weights for each indicator involved and assembling them to evaluate suitability of different possible industrial estates.*

The front last step consists in defining a threshold value for each indicator and in representing geographically this threshold value to be able to visualize on cards which are the available areas that will be able to support the installation of industrial activities.

✓ *Step 5 : Classification of the most suitable estates and final choice*

Finally, the last step consists in identifying what is the most available estate.
It is possible to lean on the choice on other criteria than the ones defined by the previous stages.
For example, it can be chosen according to the social context which seems the most favourable.

• LINKS WITH EXPERIENCES AND TECHNIQUES

File EXP 1 C3 – CICLE PELL: Planning for moving an industrial area containing tanneries in Igualada, location: Catalonia.

File EXP 3 C3 – GAT SPOT: Replacement of chemical oils with vegetable-based oils in the textile sector through sustainable regional planning, location: Tuscany.

File EXP 10 C4 – PLASOS: Planning new ecologically equipped and sustainable production areas on the Versilia plain (Seravezza), location: Tuscany.

PART 2: ECOSIND RECOMMENDATIONS

File EXP 13 EXT – GENEVA: Industrial ecology in Geneva – creation of eco-industrial synergies between the companies of the cantonal territory, location: Switzerland

List of Open Source Software

The FreeGIS Project
http://www.freegis.org

Geographic Resources Analysis Support System (GRASS)
http://grass.itc.it/

The R Project for Statistical Computing
http://sal.uiuc.edu/csiss/Rgeo//

R Spatial Project
http://sal.uiuc.edu/csiss/Rgeo//

GNU Octave (Numerical Computation)
http://www.gnu.org/software/octave/

PART 2: ECOSIND RECOMMENDATIONS

1.3. RECOMMENDATION 2: Analysis of the social context

- **KEY MESSAGE**

The new industrial estates and of economic activity have to be fully accepted by the whole economic and social stakeholders who operate in the territory where they are going to be implanted.

- **METHODOLOGY**

There are several stages in the methodology for analysing the social context:

- **Stage 1**: Identification of the concerned groups of actors.
- **Stage 2:** Research for previous conflicts around industrial activities or around industrial accidents.
- **Stage 3**: Analysis of relations between communities concerned with the estate.
- **Stage 4:** Elaboration of a strategy of communication or dialogue towards various groups of actors.

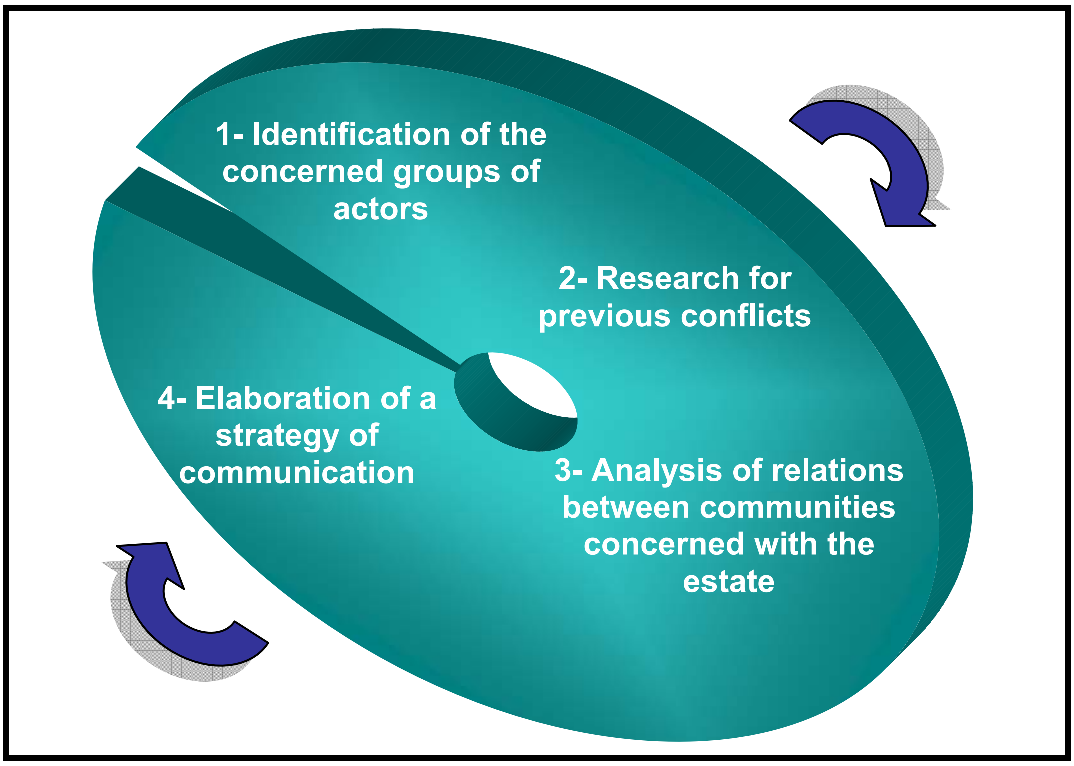

Figure 17 : Methodology for Planning Recommendation 2

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• RECOMMENDATIONS

✓ *Stage 1: Identification of the concerned groups of actors*

The main groups of actors that can be concerned by the creation of an industrial estate are (cf figure below):

- Local residents.
- The other inhabitants of the municipality where it is going to be implemented.
- The elected members and the inhabitants of the neighbouring municipalities.
- Environmental protection associations.
- The authorities in charge of enforcing the law.

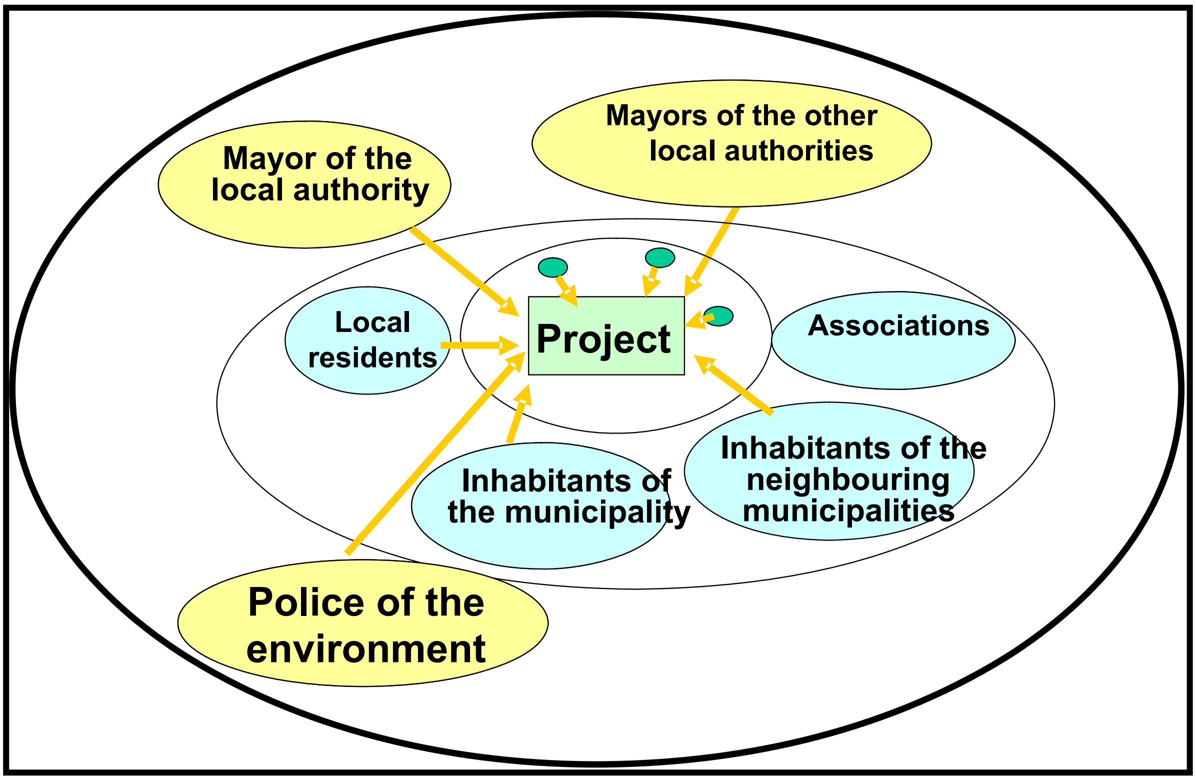

Figure 18 : Main actors involved in the project for the estate

✓ *Stage2 : Research for previous conflicts around industrial activities or around industrial accidents*

In the past, conflicts between the identified actors and industrial concerns were possible. This type of situation leaves tracks, and can create a distrust towards the industrial activity to be established and which is going to handle waste.
Moreover, a previous industrial accident (explosion, spillage of product in a river, etc.) in the municipality, or in the neighbouring municipalities, can create this distrust. The met elected members can supply this type of information.

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✓ ***Stage3 : Analyze relations between communities concerned by the estate***

Tense political relations between the municipality housing the estate and the peripheral municipalities can perturb the progress of the project and the success of the estate. The project can indeed become grounds for confrontation between the various protagonists. Furthermore, the networking of the future estate with those already implanted close by these municipalities becomes then complicated. The elected members or the met citizens can supply this type of information.

✓ ***Stage 4: Preparation of a strategy of communication or dialogue towards various groups of actors.***

In accordance with the results of the previous analyses, several strategies are possible. In case of risks of conflicts or weak tensions, a **strategy of communication** is sufficient. This consists of informing as far upstream as possible the various previously identified shareholders by explaining the interest of the estate and the measures taken to mitigate any problems that may worry these actors.
In case of risks of conflicts or serious tension, a **strategy of dialogue** needs to be implemented. This consists of establishing, through the transparency of the exchanges, a real dialogue between the various participants, in order to precisely define the various interests in play, as well as the nature of the stumbling block, and subsequently the solutions acceptable by all to remedy it.

• LINKS WITH EXPERIENCES AND TECHNIQUES

File EXP 1 C3 – CICLE PELL: Planning for moving an industrial area containing tanneries in Igualada, location: Catalonia.

PART 2: ECOSIND RECOMMENDATIONS

1.4. RECOMMENDATION 3: Choice of activities of the industrial estate

- **KEY MESSAGE**

The choice of economic activities to be established in the new industrial estates must be subjected to a deep analysis of the possible synergies with the existing activities.

- **METHODOLOGY**

This stage consists of considering the type of activity which one wants to see established on the selected estate in order to create synergies and interrelations between these activities and the territory on which they are situated.
This stage is very important and has to integrate a deep reflection on the characteristics of the estate before acting in order to maximise the creation of synergies and facilitate the setting up of a cooperative management.
The figure below shows the various stages defined to lead up to this choice:

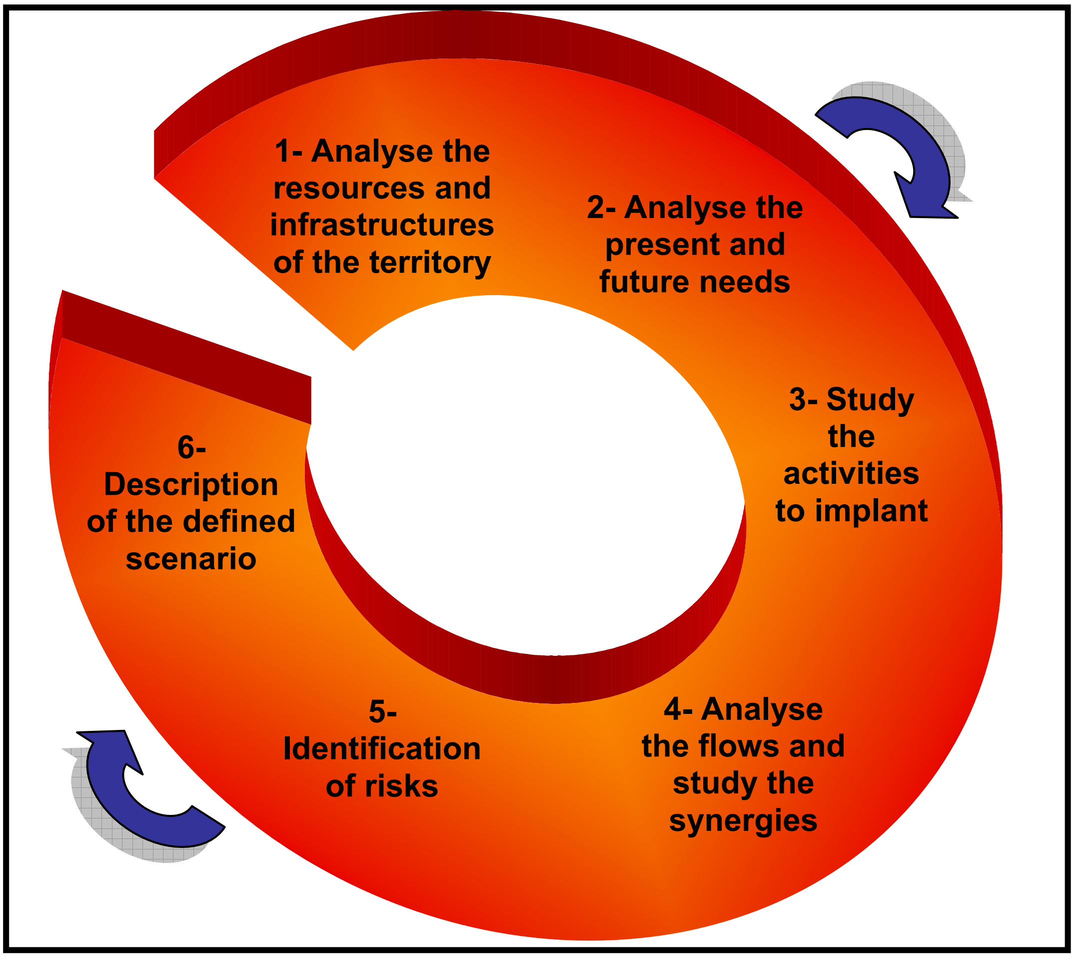

Figure 19 : Methodology for Planning Recommendation 2

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• RECOMMENDATION

To seek to reach a high degree of synergies between the activities of the industrial estate to be developed, from the town-planning phase, it is advisable to develop the carry out studies and analyses:

✓ *Analyse the resources and infrastructures of the territory*

This stage consists of collecting all information required to have a good knowledge of the territory. Much of this information will come from the study carried out previously with the Geographical Information Systems (GIS). It is especially important to study the various economic activities of the territory: Industry, agriculture, services, etc., as well as the transport systems available.

✓ *Analysis of present and future needs*

Thanks to knowledge of the territory and on the basis of discussions with the economic actors, it is then necessary to determine the shortcomings in the territory, with respect to services and products (transport, recovery, recycling, etc.). This study is important to detect possibilities for optimisation of the networks for wastewater treatment, energy supplies and transport services. Moreover, it may be possible to reduce transport distances by introducing new activities into the territory for the provisioning of companies already present.

✓ *Survey of the various activities that may be installed in the IE*

This stage consists of indexing which companies are likely to set up in the territory: heavy industries, SMEs, service firms.
Then, it is advisable to look for the activities with great potential of development in the selected territory. Determining the nature of these activities is complex.
They are identified on the basis of:

- The convergence of assets of the territory (climate, qualification of the inhabitants, the nearness of communications, industrial traditions),
- The development of a local, national or international market.

If, according to the results of the preceding stage, the lack of a certain type of activity is detected, it is then necessary to think of a suitable way of encouraging the establishment of all these different types of activity in the territory.

✓ *Analysis of flows and survey of possible synergies*

This phase of study is undoubtedly one of the most important and also one of the most difficult.
It is indeed a question of seeking to study present and future flows of material, water and energy by means of a metabolic survey, and to determine the various

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possible synergies. This survey must include companies already established in the territory where the estate is located[31].

The graph below shows the objective to be reached when the survey is based on 2 important existing companies. The companies in violet are future companies.

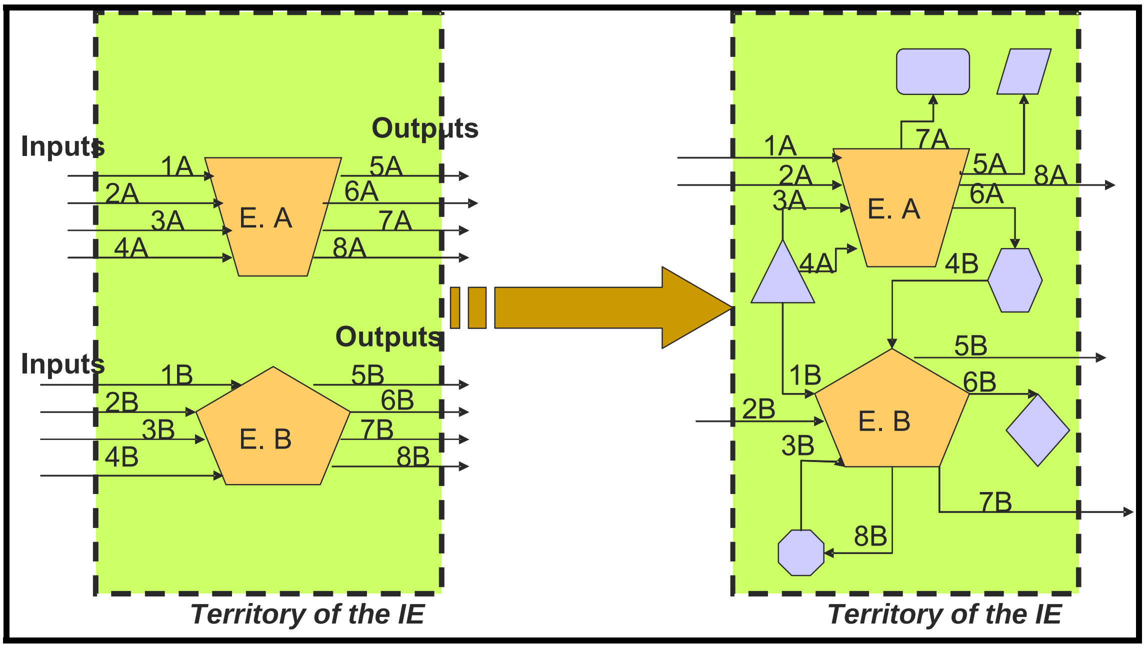

Figure 20: Search for synergy starting with 2 large companies

When the estate is completely virgin or when very few companies have been set up there, this stage is difficult: determining exactly the flows of companies which do not exist is impossible.

However, it is possible to direct the research into future synergies by using the data on the flows which already go through the whole territory (study of metabolism) or by working on the sectors targeted in the previous stage.

The appeal to an expertise on the different industrial processes makes it possible to identify their main consumptions and discharges. The identification of these major flows and their order of magnitude permits the identification of potential synergies established with the future activities of the estate.

The types of activities which could use certain streams circulating through the territory or produce useful flows by the already implanted companies can indeed be discovered. Moreover, by determining the principal flows connected with a target activity that the estate wishes to see established, types of potentially additional activities can be imagined.

This stage is not obvious, as it is very difficult to determine the flows of companies which are still not in operation, with any degree of accuracy.

[31] *It would be interesting to be able to choose the companies according to synergies which they could supply. However current knowledge does not allow the setting up of synergies in a virgin territory. Thus this research can be carried out either with a half occupied industrial estate or with other nearby industrial estates.*

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Different experiences of industrial ecology show that numerous synergies were formed with secondary flows which are not thus detectable from the expertise. Other synergies will be identified once the industrial area is functioning.
Indeed, a network of exchange of flows evolves continuously, new synergies can appear and others can disappear (regulation, closing of a company, synergy which is not profitable any more).

✓ *Identification of the risks and probable failures*

As industrial ecology is still a relatively new domain, during the conception of a project it is important to assimilate well those elements which condition the creation of the synergies.
Indeed, several factors must be taken into account for the success of a synergy[32]. These include the following very important elements:

- **Geographical feasibility:** The transport distances for the flows of water and energy are elements which can be determinant for the viability of a synergy. The greater the transport distances, the greater the losses will be.

- **Qualitative and technical feasibility:** The quality of the flow to be exchanged can be a very restrictive element. This flow of waste, energy or effluent is rarely useful as it for by the process which is going to recover it. It often requires a light transformation: cleanup, repair, grading, etc. The adaptation of the quality of the flow, offered to the demand, thus requires the intervention of the technique, with costs which that must remain reasonable.

- **Quantitative feasibility:** The volume of the flow offered by a company must be adapted, in quantity, to the needs of the recovery process. The orders of height must be close. If the company has to look for other suppliers or other recovery processes, the synergy can lose its interest by becoming too complex to manage.

- **Legal feasibility:** Regulations probably constitute one of the most important obstacles and they are more difficult to surmount. Indeed, at the European level, the statute of waste is subject to very strict regulation. Thus the exchange of waste may entail a long and expensive authorisation procedure. However, in certain member States, such as for example Belgium (the region of Wallonie), it has been possible to find solutions. The established regulation relieves the constraints on the recovery of certain types of waste.

- **Economic interest:** The implementation of a synergy can thus require high investment at the beginning. These high levels of confidence between the two companies in the exchange are required to achieve

[32] These factors were identified by Cyril Adoue in his thesis entitled: “Methodology of identification of achievable eco-industrial synergies among companies on French territory“ and were presented in December 2004.

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benefits. If the return on investment is too long or if the profit too low, or even negative, then the synergy will probably be more difficult to set up.

- **Acceptability by the companies:** The cultural factor is a major element. The concept of industrial ecology is indeed a recent one. It is thus not very well known yet, and even less unanimously accepted by industrialists. Hence, the application of a step of this type is based on collaboration between companies, which is a completely original attitude for a company culture based on the notion of competition. Finally, the fact of using material, having the statute of waste, as raw material requires some cultural change. Nevertheless, the possible economic benefits are certainly good leverage.

All these factors must be analysed during the reflection on future synergies within the estate.

✓ ***Description of the definite scenario***

This stage consists of carrying out a synthesis of all the elements previously studied to gather them in a final document.

• LINKS WITH EXPERIENCES AND TECHNIQUES

File EXP 1 C3 – CICLE PELL: Planning for moving an industrial area containing tanneries in Igualada, location: Catalonia.

File EXP 3 C3 – GAT SPOT: Replacement of chemical oils with vegetable-based oils in the textile sector through sustainable regional planning, location: Tuscany.

File EXP 10 C4 – PLASOS: Planning new ecologically equipped and sustainable production areas on the Versilia plain (Seravezza), location: Tuscany.

File TEC 2 C3 – MESVAL: Methodology to find the most sustainable synergies on a territory and examples of application, location: Catalonia.

File TEC 4 EXT – PRESTEO: Program of Research of Synergies on a TErritOry, location: France

Life environment project: Closed Loop System with Eco-Industrial District - CLOSED **:** www.arpat.toscana.it/progetti/pr_closed.html

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1.5. RECOMMENDATION 4: Design of IE - Organisation of space

- **KEY MESSAGE**

The situation of companies, community facilities and open spaces within the industrial estate has to facilitate the cooperative environmental management and optimize the conditions of work.

- **METHODOLOGY**

The organisation of space is a very important element for the good functioning and cooperative management of the industrial estate.
The different points to be considered for developing the recommendation are shown in the figure below:

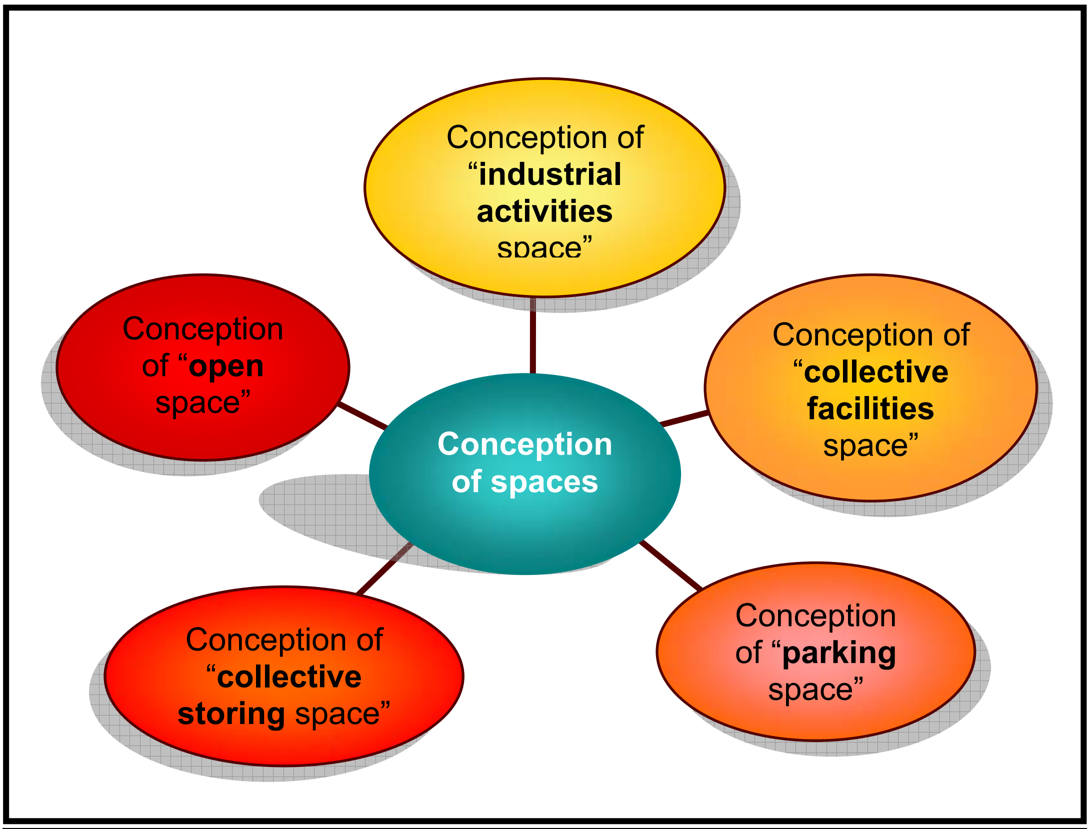

Figure 21: Methodology of Planning Recommendation 5

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• RECOMMENDATION

Often, space on an industrial area is not well maintained. However, if it is used to favour communication between companies, provide mutual services, reduce individual costs and improve the environment, it could turn out to be very useful. Here are some recommendations to take into account to improve the organisation of spaces in urban plans:

➢ *Open space:*

Including open space is important for two reasons:

- To integrate the industrial estate into the landscape and with natural areas: in fact, it is important to create a pleasant working environment for the good of workers and to minimise the impact of the industrial area on the surround ecosystem.
- To provide shade in summer: if the trees are well arranged near the offices and car parks this can reduce the use of air conditioning by preventing the sun from overheating buildings and vehicles.

➢ *Selective sorting:*

Putting terminals in place for the selective collection of waste can reduce the individual management costs of eliminating waste.
From the environmental point of view, this can also make it possible to increase the rate of waste recycling and recovery.
In addition, if several enterprises in the area have a common category of hazardous waste, it is possible to organise a joint collection if the rule allows it.

➢ *Parking:*

Among the communal areas it is important to establish a car park with a impermeable surface to prevent oil and fuel running off into the soil.
In addition, rainwater running off the car park can be recovered and reused after filtering and/or specific treatment.

➢ *Collective facilities:*

Putting in collective facilities is a very important point in planning an industrial estate.
It involves putting into place structures available to all the enterprises on the industrial estate. These structures can include:

- A café
- An inter-company restaurant
- A conference hall
- A meeting place for the industrial estate or a grouping on the industrial estate
- A crèche…

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The purpose of these amenities is to encourage communication between the enterprises, to help to reduce the management costs of individual support buildings, to improve the work environment and limit movement by car.
In fact, if a café or business restaurant offers good service at competitive prices, workers will have less of a need to travel by car to go and eat. This could contribute to the reduction in traffic and atmospheric emissions linked to the industrial estate.

- ***Industrial activities:***

Finally, concerning the construction of buildings intended to receive the activities, it is necessary to define a list of architectural criteria to minimise their environmental impacts.
Here is a non restrictive list of recommendations to establish these criteria:

- Favour if possible the town-planning and architectural choices which promote natural light and integrate bioclimatic principles.
- Plan buildings which guarantee good heat insulation throughout the building.
- Use, wherever possible, materials which consume little energy in their manufacture, their transport and their application, which are easily recyclable, and which respect the criteria of health and healthiness.
- Plan the use of sun panels built into constructions, and favour choices of low-consumption, suitably sized electric equipment or electrical household appliances.
- Allowing for the easy separation of materials in deconstruction.

Numerous normative repositories exist in various countries of Europe, and these can be used to set these criteria, according to the environmental priorities established initially: energy (Ref. Minergie-Suisse), environmental management of building project (Ref. HQE - France) …

• LINKS WITH EXPERIENCES AND TECHNIQUES

File EXP 10 C4 – PLASOS: Planning new ecologically equipped and sustainable production areas on the Versilia plain (Seravezza), location: Tuscany – Italy

File EXP 14 EXT – ECOPAL: ECOPAL, an alliance of companies engaged in the take up of Industrial Ecology, location: Dunkirk - France

PART 2: ECOSIND RECOMMENDATIONS

1.6. RECOMMENDATION 5: Design of IE - Design of the networks

• KEY MESSAGE

The conception of the water, energy, transport and telecommunication networks has to facilitate the development of synergies between the activities and the implementation of measures for the recycling, re-use, valorisation and resources clean production.

• METHODOLOGY

Once we know the main companies and their importance (heavy industry, SME, etc.) which will come to settle in the estate as well as the synergies envisaged, it is then possible to consider the design of the networks, with possible relations and mutualisations among the companies.

For greater effectiveness of the industrial estate and to reduce the individual costs of management, it is important to try systematically to group or centralise the flows.
The diagram below shows more precisely which are the various networks that need to be considered in the installation plans for designing an efficient industrial estate

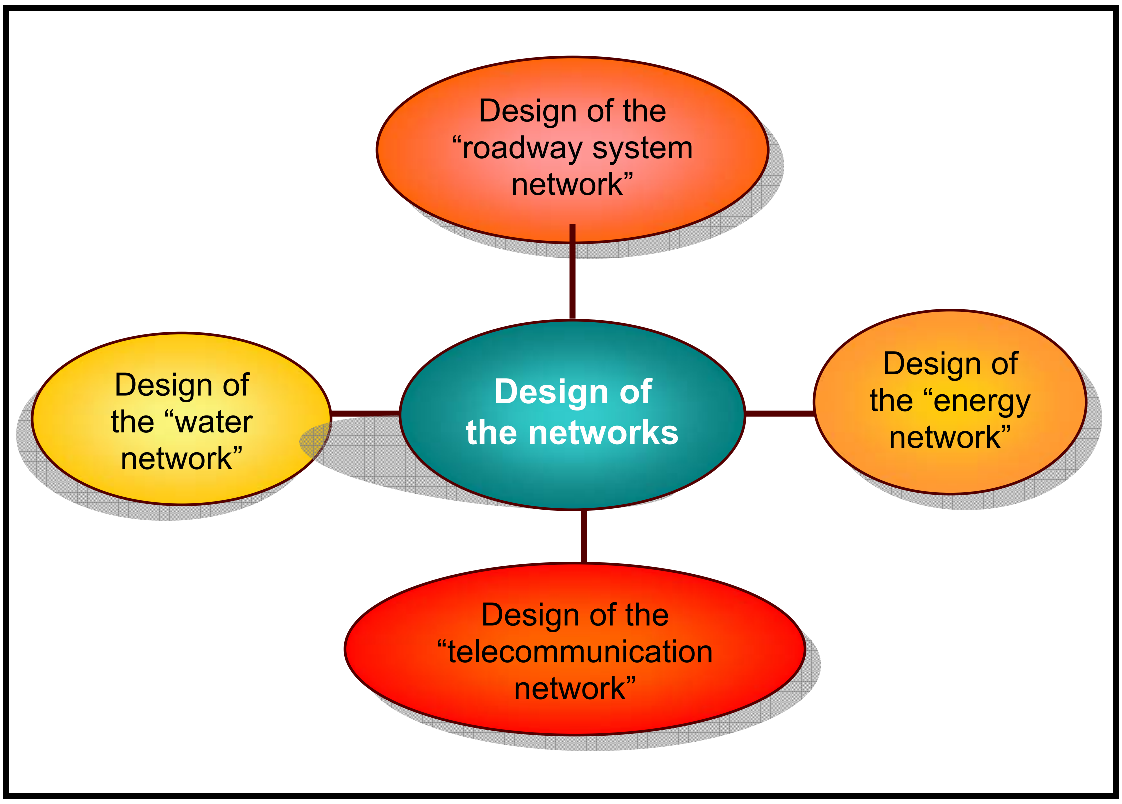

Figure 22: Methodology for Planning Recommendation 4

The recommendation consists of considering in the urban plans of the industrial estate, each type of network and seeing how it is possible to optimise the

PART 2: ECOSIND RECOMMENDATIONS

circulation of flows and put in place common facilities for the whole industrial estate or a group of enterprises. This entails no longer thinking individually for each enterprise, but rather thinking more globally for a group of enterprises in the same area which have economic, environmental and social interests in doing things communally.
Here are some recommendations for each type of network (although this list is not exhaustive):

➢ *Design of the "WATER" network*

- Plan for an efficient collecting system of different types of waters
- Plan to re-use collected water (watering of the parks, etc.)
- Limit the use of drinking water to those uses which require it,
- Plan integrated management of heavily polluted, lightly polluted and rain water
- During the organisation of the space, facilitate the future construction of pipeline or water mains necessary for the synergies,
- According to the size of the estate, plan for a joint purification station

➢ *Design of the "ENERGY" network*

- Study the possibility of installation of a cogeneration station
- Attempt to install an energy distribution network
- Foresee the production of renewable energies in situ
- Insulate buildings well to avoid heat loss
- Group together those activities using compressed air in order to optimise production
- Plan for good shade in summer to limit the use of air-conditioning
- Foresee a common lighting system for the industrial area, etc.

➢ *Design of the "ROADWAY SYSTEMS " network*

- Dimension the streets adequately, and plan for parking spaces
- Plan for appropriate street lighting
- During the organisation of the space, consider mobility, the evolution of the estate and the physical connection of synergic companies, etc.

➢ *Design of the "TELECOMMUNICATIONS" network*

- Plan good access to the telephone network
- Plan the installation of M-BUS cables for a centralised monitoring of water and energy consumption

For the telecommunications network it is particularly important to put a monitoring network into place to follow the development of consumption of water, electricity and gas in different parts of the industrial estate.
This is necessary for Phase 4 concerning the management and monitoring of the industrial estate.
This makes it possible to assess the effectiveness of certain actions undertaken, and also to detect possible problems.

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• LINKS WITH EXPERIENCES AND TECHNIQUES

File EXP 4 C3 – MITCO2: Integrated supply of energy services to an important petrochemical industry. Location: Catalonia.

File EXP 5 C3 – MITCO2: Application of cogeneration in Tuscan production districts, location: Tuscany.

File EXP 9 C4 – PLASOS: Energy planning of a new industrial and residential area in the municipality of Cerdanyola del Vallès, location: Catalonia.

File TEC 1 C3 – MEDUSE: Methods and techniques advanced for the environmental analysis in zones with high industrial density by means of optoelectronic probes, location: Tuscany.

File TEC 3 C4 – PLASOS: Installation of a centralised trigeneration system (cold, heat and electricity supply) in a District Heating and Cooling (DHC) network, including renewable energy (biomass and solar energy), location: Catalonia.

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1.7. RECOMMENDATION 6: Design of IE - To envisage and organise mobility

- **KEY MESSAGE**

The urban plans of the industrial estates have to incorporate measures which reduce significantly the environmental, economic and social costs deriving from the transport of persons, goods and waste and which increase the flows of information inside and outside of the estate.

- **METHODOLOGY**

The organisation of transport is a basic requirement for making installation plans. Movement needs to be organised both inside and outside the industrial estate to avoid unnecessary movement.
The diagram below shows the different elements that need to be taken into account to develop the recommendation:

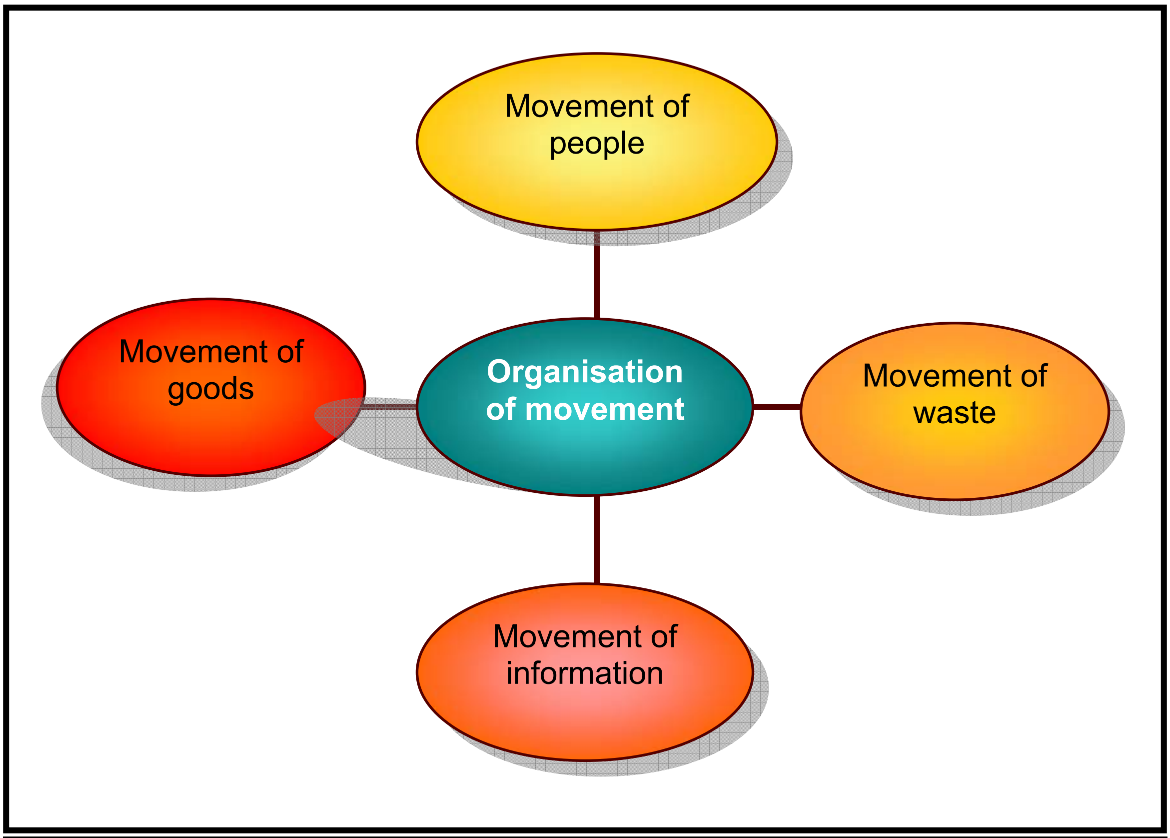

Figure 23: Methodology for Planning Recommendation 6

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• RECOMMENDATION

During the carrying out of the urban plans, it is necessary to design and organise the movements in order to avoid unnecessary costs. In certain cases, it will also allow greenhouse gas emissions to be reduced.
The various recommendations defined are as follows:

➢ *Transport of persons*

It is essential to have a public transport network (train or bus) connected to the industrial area at a maximum distance of 500 metres
If no public transport is available within this distance, this must be proposed in the urban plan of the industrial estate.
Industrial estates that have poor connections with public transport networks lead to heavy road traffic and atmospheric emissions.
In addition, car sharing must be encouraged in order to reduce the number of people travelling alone by car. This can be done by using a shared Internet site for the industrial estate showing car sharing offers and requests.

➢ *Transport of goods*

It is necessary to have properly dimensioned road access to allow unrestricted access for lorries carrying merchandise.
These vehicles must not have to pass through highly urbanised areas, and must have good parking facilities.
Moreover, if it is possible to have a railway access for the transit of goods, this must be exploited to reduce greenhouse gas emissions and to protect the future competitiveness of the estate with regard to the rising costs of road transport.
At least, it is a good idea to consider sharing transport in order to make deliveries more efficient. In fact, if several enterprises require products or materials from the same supplier, it may be a good idea to make group orders to reduce delivery costs. This can begin with the joint ordering of office materials.
Moreover, certain lorries or cars intended for the delivery of goods are not always used to full capacity, and the available space could be bought by a company delivering on the same estate. As for persons, an Internet site for co-transport by wagon or by lorry can be set up.

➢ *Transport of waste*

With regard to the transport of goods, it is in the financial interests of enterprises to seek shared transport of waste.

➢ *Information and human relations*

As with people, materials or waste, information is an element that must circulate properly inside and outside the industrial area.
The industrial area must have a good network of relationships with the region and a high-quality information exchange system.

• LINKS WITH EXPERIENCES AND TECHNIQUES

File EXP 14 EXT – ECOPAL: an alliance of companies engaged in the adoption of Industrial Ecology, location: Dunkerque – France

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1.8. RECOMMENDATION 7: Planning of the cooperative management of the industrial area

- **KEY MESSAGE**

The standards of the plans which regulate new industrial estates have to include specific measures for the creation of an association between the activities of the estate to coordinate the cooperative environmental management.

- **METHODOLOGY**

One of the best manners of organising the cooperative management of an industrial area is to create an association that is responsible for actions of cooperation between the companies.
According to the activities foreseen and the means, it is necessary to define, during the installation plan, the optimal form of possible association, its functions and its conditions of development.
The figure below shows the organisation of this recommendation:

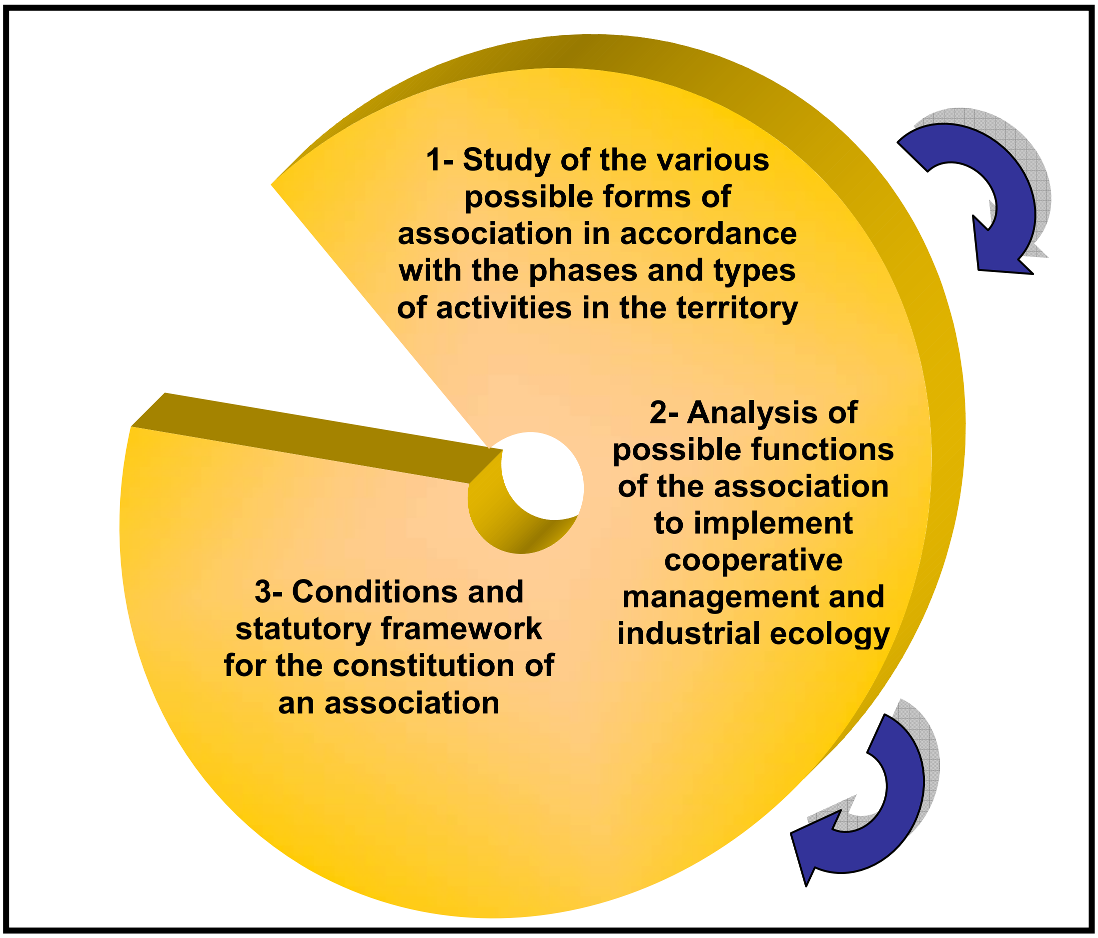

Figure 24: Methodology for Planning Recommendation 6

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- **RECOMMENDATION**

In order to establish an optimum cooperative management for the industrial estate, it is necessary to prepare its creation in the plans of installation.

> ***Study of the various possible associative forms according to the phases and the types of activities in the territory***

The implementation of a type of association between companies requires time, and the cooperative management of an industrial area has to begin during the planning and improve constantly.
To facilitate the initiatives, it is possible to forecast, more or less, the types of cooperation in accordance with the types of activities planned for the industrial estate.
The type of association can be:

- Uni-functional if a single type of cooperation to is planned initially (e.g. selective sorting of waste)
- Pluri-functional if several different fields of cooperation are planned (e.g. selective sorting of waste, the updating of the environmental regulations).

Moreover, the type of association will depend on:

- The dominant type of activity (services, heavy industry, transport, crafts).
- The size of the industrial area.
- The type of territory, if it is fairly old with well established traditions, or if it is new and quickly adapts to changes.

If the area of planned activities is small, it is possible to imagine cooperation between companies of several small, geographically close, industrial areas.

> ***Analyse possible functions of the association for implementing cooperative management and industrial ecology.***

If the plan is to set up an industrial area including service companies or to install production factories, the cooperation will be different. Indeed, a zone of service industry activity will consume less energy and use lower quantities of material.

And if it is a "district" (industrial area including the same types of activities), there will be still different possibilities of cooperation.
The various roles that the association can set, according to the type of industrial area, are given below:

Type of estate	Possibilities of cooperation
Services and small and medium-sized firms	• Information on the evolution of environmental regulations • Purchase of office automation material • Integrated management of office waste (Paper, printers cartridges, electronic waste, etc.

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	• Collective Management of dangerous waste in small scattered quantities (fluorescent lamps, batteries, sprayers, medical waste)
Industries (production)	• Research into synergies • Integrated waste management • Set-up of a common energy network • Integrated wastewater treatment management • External Communications Management
Mixed (services and production)	• Research into synergies • Integrated waste management • Information on the evolution of environmental regulations • External Communications Management
« Districts » (Similar activities)	• Collective purchase of materials • Integrated waste treatment • Purchase of community equipment • External Communications Management
Technology park	• Collective electronic waste treatment • External Communications Management
Logistics park	• Mutualisation of transport • Mutualisation of car-park maintenance

It is important to clarify that the proposed associative functions are not restrictive; it is highly important to consider the specific character of each industrial estate.

- ***Terms and statutory framework for the creation of an association.***

In its statutory framework, the urban plan stipulates the need to create an association to oblige the various activities to coordinate them together for the environmental management. The size and the configuration of the association can be extremely variable. It is necessary to appoint at least an administrator of the industrial estate.

In order to establish this association, it is indispensable, upstream, to draft and to sign a charter for cooperation.
This declaration can be based on the recommendations for the implementation of EMAS, and it must establish the objectives of the cooperation, along with the results expected and the participants.
To encourage manufacturers to get involved effectively beyond their obligations, the field of competence of the association may go beyond the strict environmental setting, and may deal with the economic development of the estate, or promote the image of the estate and its good practices (external communication).

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• LINKS WITH EXPERIENCES AND TECHNIQUES

File EXP 14 EXT – ECOPAL: an alliance of companies engaged in the take up of Industrial Ecology, location: Dunkirk – France

File TEC1 C3 – MEDUSE: Methods and techniques advanced for the environmental analysis in zones with high industrial density by means of optoelectronic probes, location: Tuscany - Italy

File TEC 2 C3 – MESVAL: Methodology to find the most sustainable synergies on a territory and examples of application in Catalonia.

EMAS (Eco-Management and Audit Scheme):
http://ec.europa.eu/environment/emas/index_en.htm

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1.9. RECOMMENDATION 8: Implementation of tools to evaluate the degree of application of industrial ecology.

- **KEY MESSAGE**

The follow-up through indicators of profits deriving from the application of the industrial ecology must be foreseen in the urban plans of installations of the new industrial estate.

- **METHODOLOGY**

For this recommendation, the urban plan must:

- Define a list of environmental indicators, which must be updated regularly.
- Define clauses of confidentiality with companies whenever required.
- Define the characteristics of a secure database.

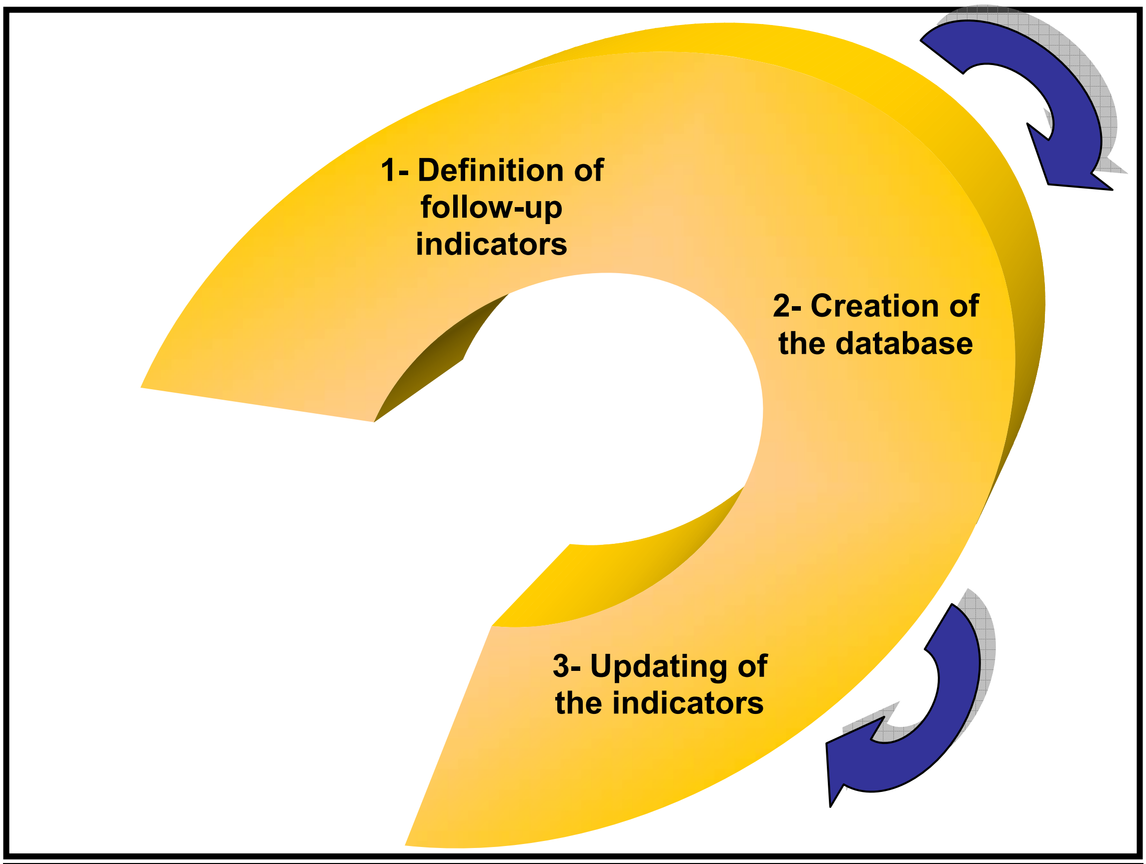

Figure 25 : Organisation of management recommendation 8

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• RECOMMENDATION

➢ *Definition of indicators*

Below is a list of the defined environmental, economic and social indicators, which will make it possible to characterise:

- activities,
- functioning,
- impacts
- degree of environmental cooperation of an industrial estate:

Indicators	Unity	Comments
Identification		
Municipality	Text	
Year of creation	Year	
Promoter	Text	Name of the promoter or indication IE public/private
Type of industrial estate	Text	Scientific/logistics park, SME or services area, etc.
Geographical environment		
Population living within 100 meters	Number of inhabitants	Population living within a 100-metres from the perimeter of the ZI
Population living within 15 min.	Number of inhabitants	Population living within maximum of 15 min from the IE (estimated time with a private vehicle)
Distance to the closest natural space	Metres	
Geographical localisation		
Localisation of the IE	Dxf	Drawing or geo-referenced plan of the IE
Address	Text	
Enterprises	Dxf	Geo-referenced plan of - enterprises and plots
Collectives equipment	Dxf	Drawing or geo-referenced plan of - equipment
Infrastructures	Dxf	Drawing or geo-referenced plan of - infrastructures
Communication network	Text	Enumeration of the available networks
Land use / Development		
Area of the IE	M2	
Average area of plots	M2	
Occupation of the IE	%	Total percentage of unoccupied parcels
Distance to the entrance of the highway	m	Distance to the nearest highway
Distance to the train station	m	Distance to the nearest train station
Price	€/m2	Estimation of the cost price of 1 m2 of the IE
Economic activity		
Number of enterprises	Number	
Factories	%	Percentage of factories
Construction firms	%	Percentage of construction firms
Extraction enterprises	%	Percentage of extraction enterprises
Service concerns	%	Percentage of service concerns
Business enterprises	%	Percentage of business enterprises
Enterprises from other sectors	%	Percentage of enterprises of other sectors
Cooperation between enterprises	Number	Existence of a cooperation between one or

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		several enterprises of the IE
Number of workers	Number	Sum of the workers of all the enterprises in the IE
Annual turn-over	Euros	Sum of the annual turn-over of all the enterprises in the IE
Energy		
Consumption of primary energy	TEP/an	
Consumption of renewable energy	%	
Individual cogeneration	Yes/no	Existence of cogeneration installations in one of the companies
Shared cogeneration	Yes/no	Existence of cogeneration installations for 2 companies or more
Cost of energy consumption	€	
Mobility		
Transit of light cars	Number	Total number of entrances and exits of light cars
Transit of industrial vehicles	Number	Total number of entrances and exits of industrial vehicles
Bus Service available	Yes/No	
Train Service available	Yes/No	
Cost of transport	€	
Water supply		
Consumption of drinking water	m3/year	Drinking water discharge consumed
Consumption of reused water	m3/year	Reused water discharge
Discharge of water caught in the aquifer	m3/year	Discharge of water caught by proper methods
Purification network		
Existence of a water separation network	Yes/No	
Existence of a wastewater treatment plant	Yes/No	
Enterprises with their own purification system	%	Percentage of enterprises carrying out treatment or pre-treatment inside the IE
Discharge of sewage without treatment	m3/year	Discharge of water without treatment or pre-treatment
Discharge of waters spilled in the aquifer	Yes/No	
Discharge to a wastewater treatment plant	m3/year	Discharge of water treated by a wastewater treatment plant
Cost of the water	€	This cost includes the consumption and the treatment of this water
Waste		
Waste generated	Tonnes/year	Total amount of waste generated in the IE
Hazardous wastes	text	List of waste which need a specific treatment
Quantity of recovered waste	%	Percentage of waste reused inside the IE
Quantity of stored waste	%	Percentage of waste storage centres
Quantity of treated waste	%	Percentage waste undergoing physical or chemical treatment
Cost of the waste treatment	€	
Environmental impacts		
Enterprises and emission rights	Number	Total amount of enterprises in the IE which have emission rights
CO2 emissions	Tonnes/year	Total Volume of CO2 emissions of the enterprises in the IE

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Acoustic contamination	Yes/No	
Odours	Yes/No	
Risks of flood	Yes/No	IE situated in an area flooded less than 50 years ago
Other	Text	Description of other environmental impacts generated by the IE
Risks		
Degree of risk	%	Percentage of enterprises that need and use an exterior emergency plan (chemical risk or others)
Geological risks / risks to the subsoil	Text	Description of risks for the activity of companies in relation with soil erosion, subsoil contamination, etc.
Hydrological risks	Text	Description of environmental risks for the activity of companies in relation with water bodies (seas, rivers, aquifers)
Environmental management		
Individual involvement concerning environmental management	%	Percentage of companies qualified with EMAS or ISO in the IE
Existence of environmental coordinators	Yes/No	Existence, in the IE, of an enterprise, entity or association responsible for the subjects in relation with the environmental management of the whole IE
Types of environmental cooperation	Text	Description of the types of environmental management and cooperation between companies
Indicators of environmental evaluation of the IE		
Efficiency of the land occupation	Index number	Capacity of minimisation of the consumption of the industrial land
Energetic efficiency	Index number	Capacity of minimisation of the consumption of primary energy and maximisation of the consumption of renewable energy
Water management efficiency	Index number	Capacity of minimisation of the consumption of water and maximisation of its reuse
Waste management efficiency	Index number	Capacity of minimisation of the generation of waste and maximisation of its reusing
Mobility management efficiency	Index number	Capacity of minimisation of the transit in relation with the volume of merchandise and the quantity of transported persons
Environmental management efficiency	Index number	Capacity of cooperation between enterprises (reduction of costs and impacts)

To establish these indicators, it is supposed that companies must supply certain data, which must be harmonised to facilitate their treatment and reduce any risks of error. To this end, it is possible to prepare a questionnaire for each company, containing the necessary data.
The follow-up of the costs at the level of the industrial estate is important and could help to:

- Demonstrate the economic relevance of the initiative of industrial ecology, both inside and outside the estate .
- Attract new companies.
- Prepare connections with the nearby industrial estates.

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➤ ***Confidentiality clauses***

The fact of establishing indicators at the level of the industrial estate makes it possible to limit the problems of data broadcasting outside the industrial estate, which are connected to the clauses of confidentiality of companies.
In order to receive the data from every company, it will be necessary to establish clauses of confidentiality with those requiring them.

Nevertheless, it would be interesting to be able to keep the individual data of inputs and outputs of every company, at the level of the association of the industrial area.
It would indeed make it possible to study the feasibility of certain synergies more effectively.

• LINKS WITH ECOSIND OR OUTSIDE EXPERIMENTS

File TEC 2 C3 – MESVAL: Methodology to find the most sustainable synergies on a territory and examples of application in Catalonia.

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1.10. European regulation link to the planning of industrial estates

➢ *Regulation link with all the recommendations*

Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment

Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment

➢ *Regulation link with recommendation 1*

Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment

Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment

➢ *Regulation link with recommendations 3 and 4*

Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control

Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment

Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment

➢ *Regulation link with recommendations 7 and 8*

Regulation (EC) No 761/2001 of the European parliament and of the council of 19 March 2001 allowing voluntary participation by organisations in a Community eco-management and audit scheme (EMAS)

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2 Recommendations for management of existing industrial estates

2.1. Organisation of the recommendations for the management of existing industrial estates

To establish recommendations concerning the management of already existing industrial estates, 3 different working axes were defined:

AXIS 1: Setting-up of a cooperative environmental management system (CEMS) **AXIS 2: Improvement of resources and waste management** **AXIS 3: Management, collection and updating of environmental information**

These 3 axes are represented in the plan below:

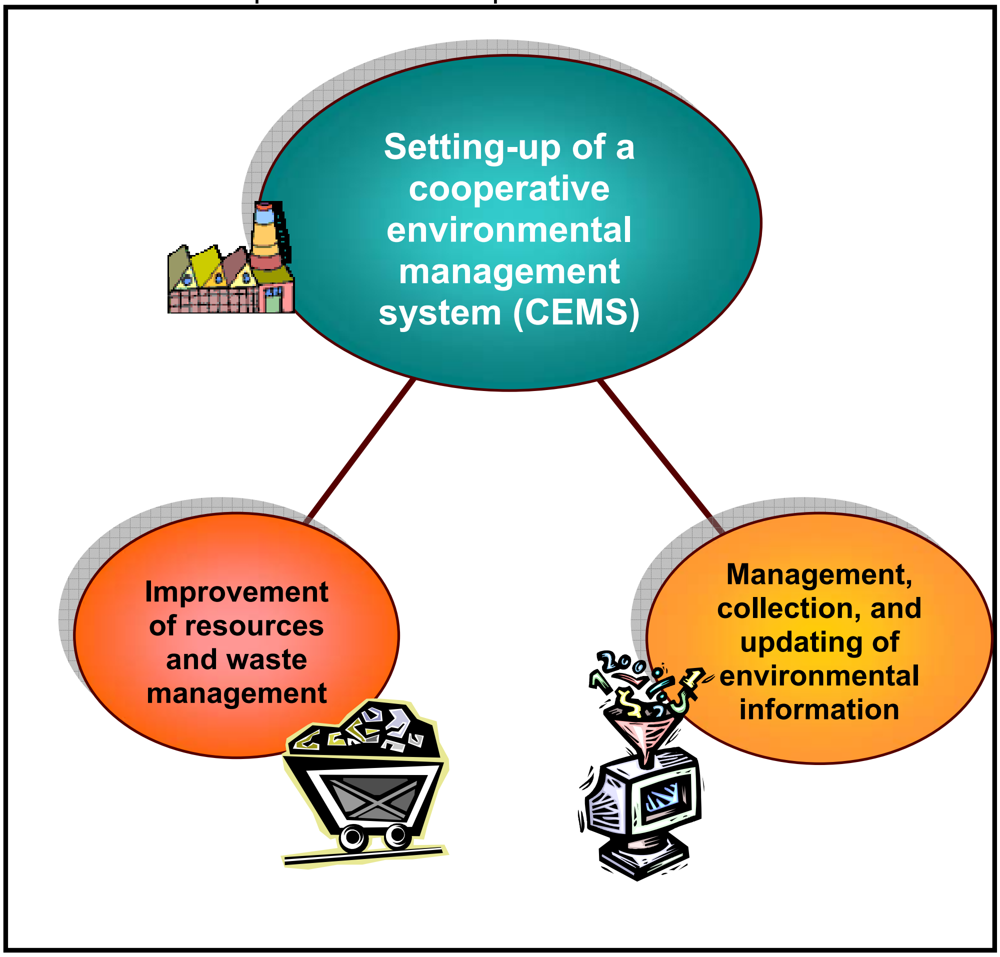

Figure 26: Organisation for the recommendations of management of industrial estates

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Of these 3 axes, 5 recommendations were defined:

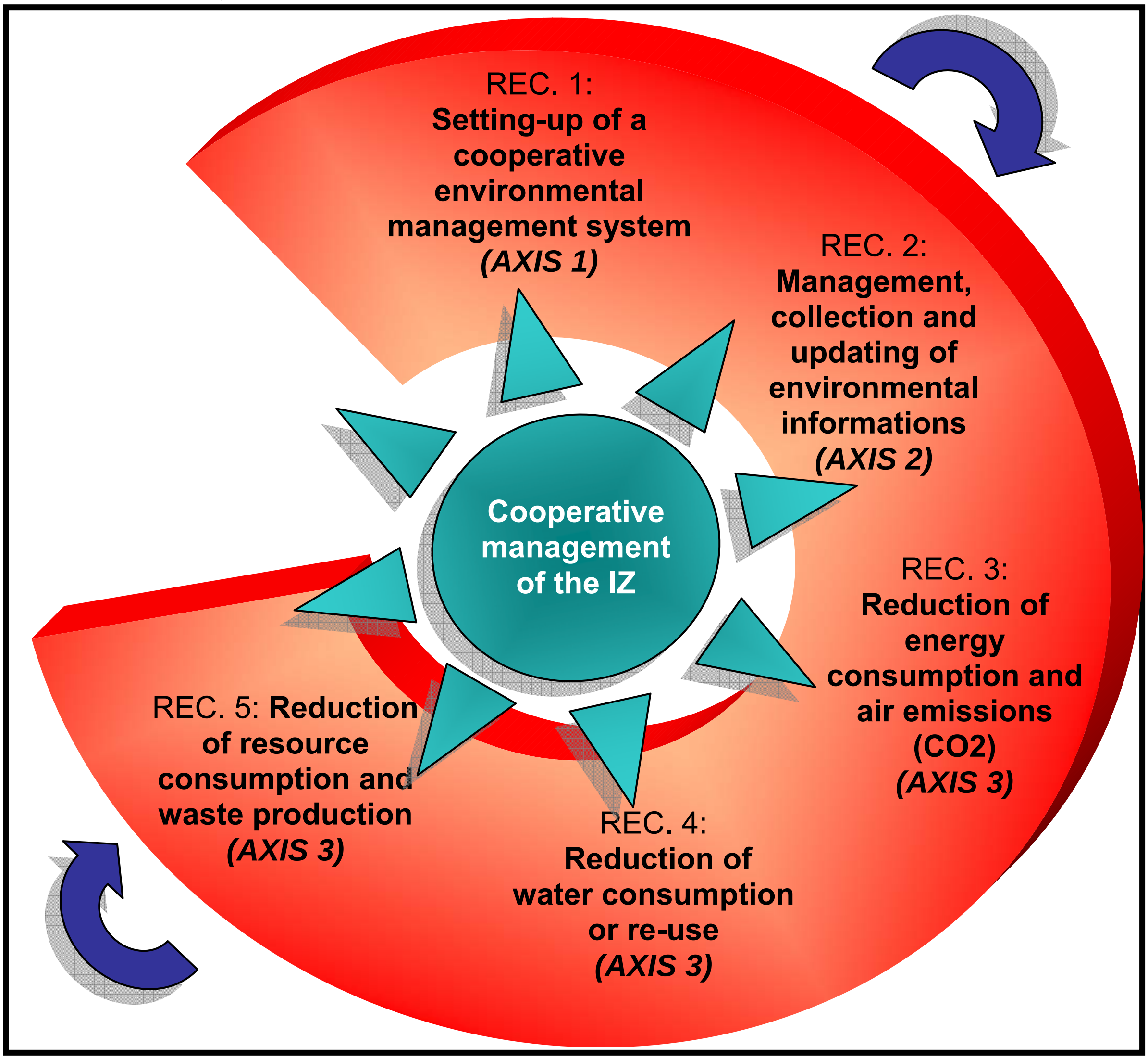

Figure 27: Organisation for the recommendations of planning

As the figure shows, the first stage consists of attempting to verify whether it is necessary to create an association, or whether it is necessary to modify the current management of the existing association to introduce concepts of industrial ecology or cooperative management into the industrial area in question. For this, at the level of the industrial area, there are two important fields to explore, which can improve the quality of the area, help companies to reduce management costs and improve environmental quality.
These fields are related to:

- The management, collection and updating of information.
- The management of resources (water, energy, materials and waste).

A good way to work on those fields is to build a cooperative environmental management system (CEMS), within the existing association of the industrial area.
It should be pointed out that both parts of the CEMS are linked: for efficient resource management, it is essential to have good, regularly updated information.
How the CEMS (REC1) is constructed, and how to manage information (REC 2) and resources (REC 3, 4 and 5) is explained below.

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2.2. RECOMMENDATION 1: Optimisation of the cooperation between companies

- **KEY MESSAGE**

Within the zones of economic activity, it is important to have a minimum of organization between companies which would allow to set up a system of cooperative environmental management.

- **METHODOLOGY**

The **first step** of this recommendation consists of making a study in order to prove to the companies the economical and environmental interest of cooperative management by means of implementing industrial ecology. This study has to prove the feasibility of synergies in the local context.

The **second step** must evaluate the feasibility of the setting-up or modification of an association of an industrial area to implement inside a step of cooperative management.

As each industrial estate is unique (the number of companies, the type of activity, the history of the area, etc.) it is important to evaluate the situation for each case, and to verify what it is possible to do.

For example, if the industrial area seems to be undersized, it may be more interesting to create an association of a grouping of small industrial areas.

The **third step** after this study is to legally constitute the association.

Then the **forth step** consists of the setting-up of a cooperative environmental management system. The contents of this CEMS will be the object of the following 4 recommendations.

The graph below shows the methodology established for the progress of this first recommendation for the management of existing industrial areas.

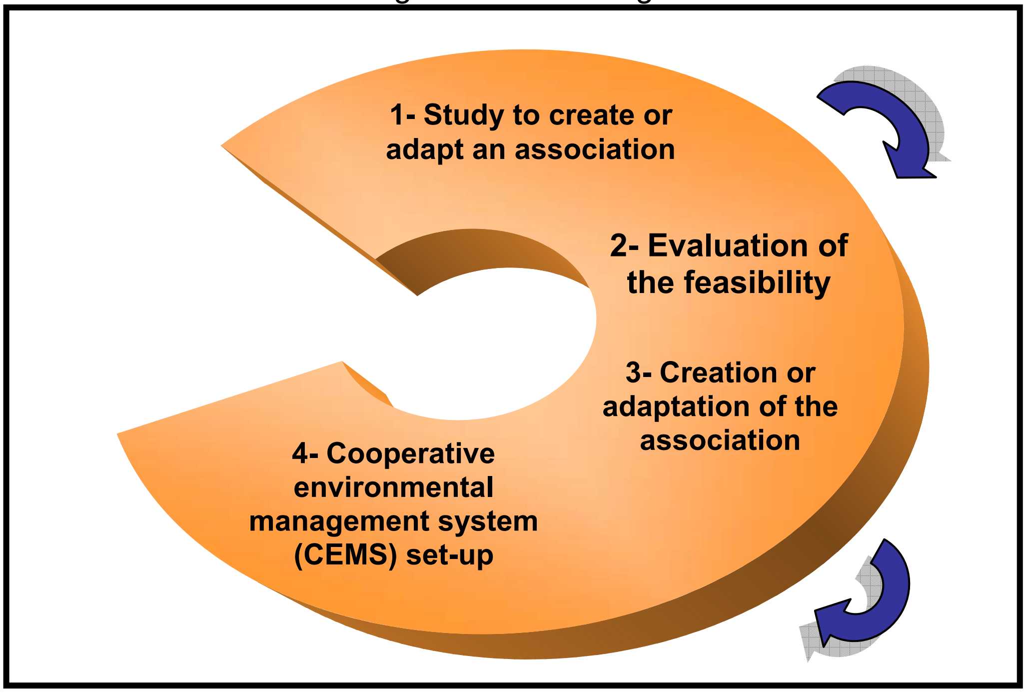

Figure 28: Organisation of Management Recommendation 3

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• RECOMMENDATION

The creation of an association for the environmental management of an industrial area is an important stage in implementing cooperative management. This association has to:

- centralise and manage all information concerning the industrial area.
- Implement methods for the **joint** management of water, energy, materials and waste.

This step introduces a modification in comparison with more traditional methods (such as cleaner production), which seek to improve resource management in one company.
This recommendation requires building a joint structure to implement a joint step of industrial ecology. This can lead to benefits from an environmental, economical and social point of view.

The 4 main steps which have to be led to create or modify the association are given below:

✓ *1- Demonstration of interests and feasibility of a cooperative industrial ecology project*

Industrial ecology in an industrial estate is a completely new concept for established companies. Furthermore, it is based on a practice that is totally original for managers who have only been trained with competition in mind: cooperation between companies.
Before working on the operation of the association which is going to structure the functioning of the project, it is thus advisable to demonstrate its efficiency and its chances of success. This preliminary "demonstration" stage aims to convince these companies of the interest of such a step on the economic and environmental planes, and its feasibility onthe estate where they are installed.
So, to make subscribe the companies in the step can avoid using coercive measures of type "rule", not always applicable according to States - members.
The method of demonstration developed by Dr. C. Adoue, consists of carrying out a study on a representative sample of companies on the estate.
Having drawn up balance sheet of input and output flows, the potential synergies are looked for, possibly with a specific computer tool. Any synergies already implemented on the estate will also be systematically searched for, and their environmental and economic profits estimated.
The results will then be communicated to the companies on the estate, in order to demonstrate the interest for them to participate actively in such a project with specific, local examples.

✓ *2 - Feasibility study for the creation or adaptation of an association to implement EI in industrial estates*

The aim of this step is to analyse the current situation of the industrial area in order to know how to act.

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The step is divided in 2 parts: how to act with an already existing association or without one.

If the association already exists and has no system of environmental management, it is necessary to carry out a study to verify how to modify its operation in order to implement an integrated environmental management system.

In this study, first, it is important to establish a diagnostic of the current situation, with information such as:

- The history of the industrial area
- Its characteristics (number of companies, type of activities, etc.)
- The goals, activities and actions of the association.

From this diagnostic, it will be possible to evaluate the best way to modify the functioning of the association in order to insert the CEMS without eliminating the association's initial objectives.

Then, in order to involve all the stakeholders and discuss the new project, a round table must be organised:

- To explain the goals and benefits of industrial ecology
- To be acquainted with the different points of view
- To discuss the feasibility of the project

This round table is a very important step, as if companies are not involved in the project from the outset, it will be more difficult to work effectively with them.

To facilitate the next step of recommendation, it is important to make a short report containing:

- Advice on modifying the organisation of the association.
- The priority actions to be carried out.

If the association does not exist, it will be necessary to carry out a study in to evaluate the feasibility of its constitution.
The methodology is similar to the previous one so that, first the industrial area and its characteristics must be studies, and then there will be round table with representatives of companies and other stakeholders to discuss the constitution.
In this case, the final report must contain advice on:

- How to create the structure.
- How to organise the structure.
- Who the members and the board of directors are.
- How it is to be financed.

✓ *3- Creation or adaptation of the association*

The second step is to create or adapt the association, depending on the final report made for the feasibility study.
It is important to establish a declaration of environmental cooperation that sets the objectives for cooperation, the participants and the means.

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Depending on the objectives for cooperation and financing, the association may set up joint facilities, such as:

- A conference room
- A cafeteria
- A staff canteen
- A day nursery, etc.

From an environmental point of view, those facilities can help to reduce the distances of transport and energy consumption.
Indeed, if there are good facilities inside the industrial area, the workers will not need to use their cars to go home eat or leave their infants in nurseries.
Moreover, a common conference room will help to reduce individual consumption of energy for heating and lighting.

✓ *4- Cooperative environmental management system (CEMS) setup*

Once the association has been constituted, the final step is to construct the cooperative environmental management system (CEMS).
The objective of this system is to define a framework and structure that will support and encourage the cooperative management of the area.
This system contains 2 parts as defined in the methodology:

- The first part especially concerns the management of information. Indeed, information is the most important thing to implement for cooperative management: in the absence of information, it is not possible to make communication between companies and to look for synergies between them. This information has to be collected, organised and updated regularly.
- The second part concerns the management of resources (water, energy, materials and waste). The cooperative management of certain streams can give rise to economic, environmental and social benefits to the companies.

The CEMS will implement different actions at the level of the industrial area.
Those actions will be explained below in Recommendations 3, 4 and 5, in accordance with actions linked with energy, water and resources.

• LINKS WITH EXPERIENCES OR TECHNIQUES

File EXP 2 C3 - ESEMPLA: Use of EMAS for local environmental monitoring and planning, location: Tuscany.

File EXP 7 C4 – BLU: Project about environmental improvement in industries and local public administrations associated with the naval sector, location: Tuscany.

File EXP 13 EXT – GENEVA: Industrial ecology in Geneva – creation of eco-industrial synergies between the companies of the cantonal territory, location: Switzerland

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File EXP 14 EXT – ECOPAL: an alliance of companies engaged in the take up of Industrial Ecology, location: Dunkirk – France

File EXP 16 EXT - CTTEI: Technology Transfer Centre on Industrial Ecology (CTTEI) – Creating a value chain for industrial by-products, location: Sorel-Tracy, Quebec - Canada

File TEC 4 EXT – PRESTEO: Program of Research of Synergies on a TErritOry, location: France

UPIC – Catalan Union of Industrial Estates – (www.upic.es)

Regulation databases, e.g.:

http://www.mma.es/portal/secciones/normativa/
http://mediambient.gencat.net/cat/el_departament/actuacions_i_serveis/legislacio/

PART 2: ECOSIND RECOMMENDATIONS

2.3. RECOMMENDATION 2: Organising the available information

- **KEY MESSAGE**

The first function of the cooperative environmental management system is to be to organize the environmental information of companies in order to facilitate the development of synergies and collaborations.

- **METHODOLOGY**

Efficient information management is essential for carryint out actions of cooperative management; information must be exchanged and disseminated both inside and outside the industrial area:
To carry out actions it is necessary to have indicators and good knowledge of the situation, and it is important that outsiders should have easy access to all information on the industrial area.
In order to attain those objectives, the first step inside the CEMS is to create an information management service.
This service will contain 3 parts corresponding to 3 different types of information:

- External information
- Internal information
- Legal information

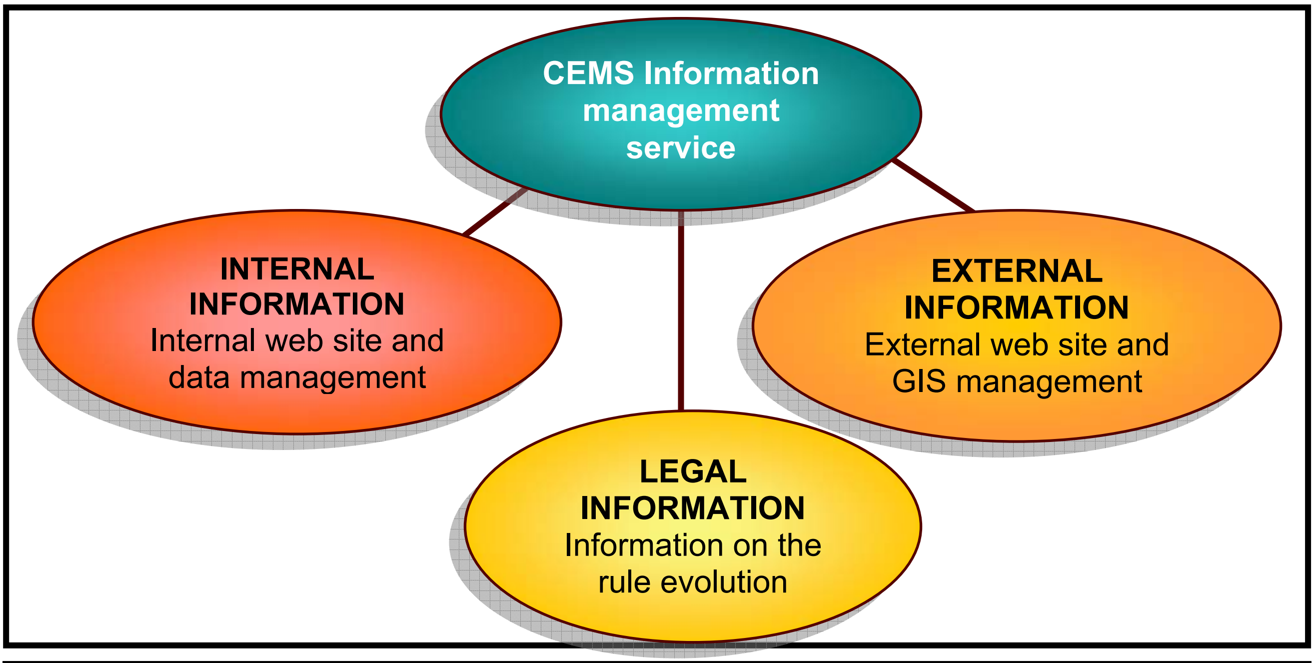

Figure 29: Organisation of Management Recommendation 2

PART 2: ECOSIND RECOMMENDATIONS

• RECOMMENDATION

The objective of this recommendation is to facilitate the creation of the database containing all the information relative to the activity of companies (inputs and outputs) and services available for the industrial area. There must be harmonised information on each company.
The data necessary for each of the three types of information (Internal, legal and external) are given below.

✓ *Internal information*

The internal information characterises all the information collected concerning the functioning and activity of each company. The quality of the internal information will have an influence on the external information

The different types of information that need to be collected are listed below. This information can be modulated according to need.

Company data:

- General data of the company / identification number / type of activity
- Raw materials
    - Category of consumed materials
    - Quantity of consumed materials
- Manufactured products (Type and quantity)
- Waste:
    - Category
    - Quantity and rhythm of generation
    - Manner of generation (liquid, solid, en container, etc ...)
    - Manner of elimination
- Energy:
    - Supply Sources
    - Cogeneration of energy
- Water:
    - Type of water consumed
    - Water treatment plant
    - Pond of water stocking (fire)
    - Water consumption points
- Management:
    - Quality management system (ISO 9001)
    - Environmental management system (ISO 14001 – EMAS)
    - Integrated management system
    - Other management systems (OSHAS)

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Common information:

- Water separation network
- Water treatment plant
- Industrial area lighting system
- Area prevention plan

The internal information concerns the collection of data and the creation of an internal web site.
This information can be collected using questionnaires.
These will contain questions corresponding to all the information needed and will be distributed to each company.
In the case of no response, contact will be made by phone, and then a member of the association can have an interview a responsible person in the company in order to complete the questionnaire.
This stage is sensitive due to possible problems of confidentiality. Depending of the reaction of companies, clauses of confidentiality may have to be established.

✓ *Legal information*

The legal information concerns the updating of the environmental regulations. It has been noted that it is difficult for small and medium companies to keep abreast of changes in environmental regulations.
Thus it may be of interest for a member of the association to monitor any changes in the environmental regulations and regularly inform the companies in meetings.
It may also be interesting for the association to inform companies on:

- Best Manufacturing Practices (BMPs)
- Best Available Techniques (BATs)
- Recommendations for the internalisation of external costs
- Updating emergency service contacts (Police, Fire Brigade, Ambulance Service, etc.)
- Updating contacts with public administrations, official bulletins, etc.

This will be all the more effective if a single person is in charge of those tasks for the whole industrial area.
The meetings can serve as occasions for companies to get to know each other better.

✓ *External information*

The external information is characterised by all the information that is disseminated outside the industrial area.
There is several means of communication for the diffusion of this information:

- A web site

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- A news letter
- E-mails

There are different types of information to be disseminated:

- information related to actions carried out in the area
- Information linked to indicators (economic, environmental and social) of the industrial area
- Information related to the quality of the reception and the services which the industrial area offers investors

Besides the management of information, this service can play a significant role on the workers movements and the means of transportation:

- It can set up a car sharing service via an internal internet page
- It can influence decisions to make the industrial area more accessible by public transport (e.g. extension of a bus line, setting up of a shuttle)

• LINKS WITH EXPERIENCES OR TECHNIQUES

File EXP 2 EXT – ESEMPLA: Use of EMAS for local environmental monitoring and planning, location: Toscana.

File EXP 14 EXT – ECOPAL: An alliance of companies engaged in the take up of Industrial Ecology, location: Dunkirk – France

File EXP 16 EXT – CTTEI, Québec: Technology Transfer Centre on Industrial Ecology (CTTEI) – Creating a value chain for industrial by-products, location: Sorel-Tracy, Quebec – Canada

File TEC 4 EXT – PRESTEO: Program of Research of Synergies on a TErritOry, location: France

File TEC 5 EXT – Ecopark Hartberg: Creating an infotainment park based on industrial ecology principles, location: Hartberg – Austria

Regulation data base, for example:
http://www.mma.es/portal/secciones/normativa/
http://mediambient.gencat.net/cat/el_departament/actuacions_i_serveis/legislacio/

PART 2: ECOSIND RECOMMENDATIONS

2.4. RECOMMENDATION 3: Implement measures for improvement - Reduction of the consumption of energy and emissions into the air

- **KEY MESSAGE**

From the analysis of the flows of energy, the cooperative environmental management system has to define the viable synergies to be developed, as well as the means to be planned to reduce the emissions of CO2 due to the estates as well as the consumption of not renewable energies.

- **METHODOLOGY**

As a part of the Cooperative Environmental Management System (CEMS), a joint energetic management system is essential.
The role of this system is to improve energy management by searching for actions that are feasible at the level of the industrial area.
This system is divided into 3 parts; the figure below shows the organisation of the different parts of this joint energy management system:

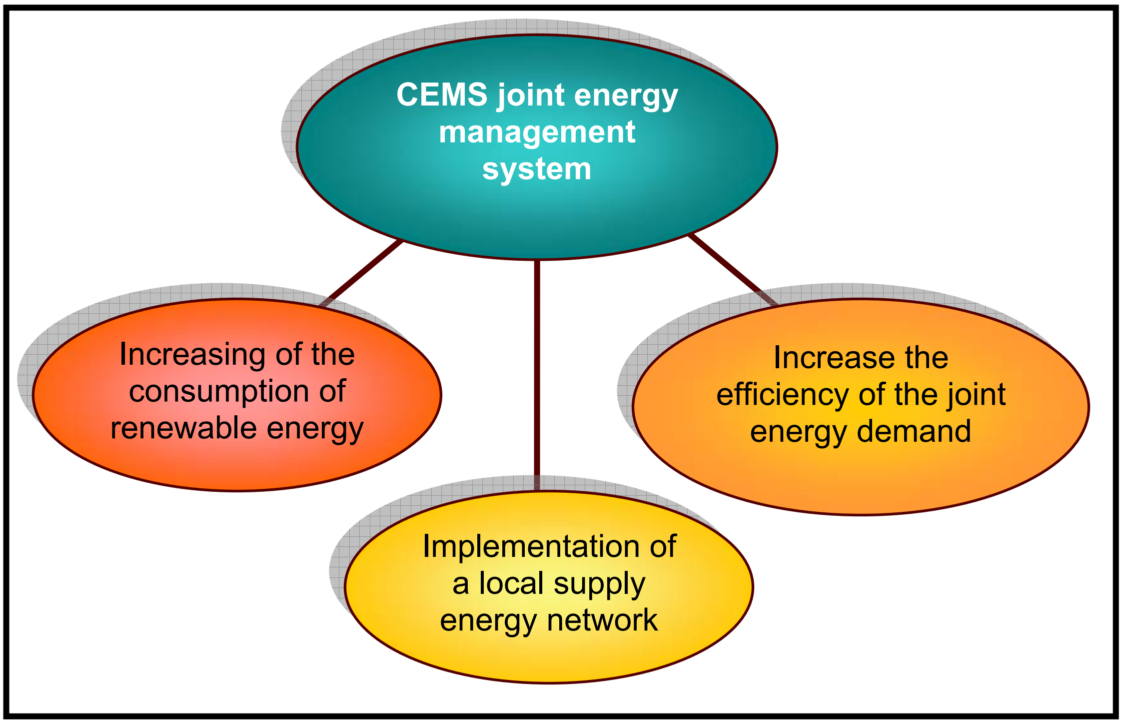

Figure 30: Organisation of Management Recommendation 3

PART 2: ECOSIND RECOMMENDATIONS

• RECOMMENDATION

Wherever possible it will be preferable to develop a system of joint energy management. Like a part of the IEMS, this system must search for actions which can be carried out in common with several companies. The idea is to group together streams in order to improve the efficiency of the networks, and thus reduce energy loss.

From a supply perspective, the actions will be:

- Implementation of a local supply energy network
- Increasing of the part of renewable energy

From a demand perspective, it will be:

- Increasing of the efficiency of the joint energy demand

An initial reflection can be carried out within the association to evaluate the principal approaches to be taken, depending on the resources available in the area. Then in order to implement a joint system, an expert in energy systems will have to be consulted.

The following are some elements which may be useful when carrying out the initial reflection:

✓ *Energy supply*

- **Implementation of a local supply energy network (district heating and cooling based on a cogeneration system)**

The implementation of a local supply energy network is especially recommended for industrial areas containing small and medium-sized enterprises.
The ECOSIND sub-project MITCO2, lead by Fundació URV (Crever), established a methodology in order to make a pre-diagnosis of the situation and to verify whether there is a possibility of developing the network.
The mains points to be studied are as follows:

Demand analysis

1. Physical and geographical aspects related to the energy system in the area
2. Characteristics of the energy demand of the system specified depending on the energy applications, peak rates :
   a. Electricity demand
   b. Heating demand
   c. Cooling demand
   d. Compressed air demand

3. Study of the typology of energy consumers (buildings, industrial facilities, etc.) projected or existing

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Configuration of the energy supply

1. Definition of the reference situation or conventional energy supply system
2. Calculation of associated costs of the reference situation
3. Definition of alternatives
    a. Technology
    b. Fuels
    c. Energy sources

Decisions

The decision could be taken from different aspects, social, economical, technical, environmental. Nevertheless, some figures need to be studied:

1. Cost balance basic calculation of the technological alternative.
2. Calculation of the feasibility with respect to traditional technologies
3. Analysis of sensitivity.

The economic results obtained by the choice of one technology may also depend on the following factors:

- Fiscal incentives
- Subsidies for these technologies

In addition to economic criteria, there are a large number of external aspects which could be evaluated in a feasibility analysis:

- Energy aspects:
    - Energy supply safety
    - Network independence
    - Use of renewable energies
- Energy supply safety:
    - Fossil fuel saving
    - Stability of the fuel prices
- Environmental aspects:
    - Limitation on emissions of CO^2 and harmful gases
    - Improvement of the environment
- Social aspects:
    - Jobs
    - Increased wealth
    - Emblematic projects
    - Dissemination mechanisms

If the result of this analysis is positive, a more detailed study of the project may be carried out by engineers or experts on the specific solutions.

According to the CREVER, district heating is the best means of employing local resources (biomass, integrated energy management, waste incineration), so that it is important to carefully consider possibilities for setting up this type of network.

A higher initial investment than for conventional systems may be required, but this will subsequently be recovered as a consequence of energy savings. It is important to define the return on investment periods for each installation related with the environmental benefits.

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- **Increasing the consumption of local renewable energy**

Local resources, such as solar energy, biomass or wind energy, have to be developed.
In particular, solar energy seems well suited to the case of industrial areas.
Roofs and facades of industrial buildings or on other private or collective spaces are surfaces which can be used to install solar panels in order to produce thermal or electric energy. The use of wind or biomass depends on the resources of the territory.

✓ ***Energy demand***

- **Increasing the efficiency of the joint energy demand**

To increase the efficiency of the joint energy demand, firstly it is important to define indicators to monitor energy consumption in order to detect where it is possible to save energy.
One of the first easy actions at the level of the industrial area could be the reduction of electric consumption for outdoor lighting.
Classic light bulbs can be replaced with more efficient energy-saving light bulbs or solar-powered lighting could be installed.

• LINKS WITH EXPERIENCES OR TECHNIQUES

File EXP 4 C3 - MITCO2: Integrated supply of energy services to an important petrochemical industry, location: Catalonia – Spain

File EXP 5 C3 – MITCO2: Application of cogeneration in Tuscan production districts, location: Toscana – Italy

File TEC 3 C4 – PLASOS: Installation of a centralised trigeneration system (cold, heat and electricity supply) in a District Heating and Cooling (DHC) network including renewable energy (biomass and solar energy), location: Catalonia – Spain

Catalan institute of the Energy (ICAEN): www.icaen.net

Spanish department of Commerce, Tourism and Business: www.mityc.es/es-ES/index.htm

Institute for the Diversification and the Economy of Energy (IDAE): www.idae.es

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2.5. RECOMMENDATION 4: Implementing measures for improvement - Reduction of water consumption or re-use

- **KEY MESSAGE**

The study of the flows of water has to facilitate the definition of appropriate and viable means to reduce the consumption of drinking water and facilitate the re-use of waste water produced in the industrial estate.

- **METHODOLOGY**

The third system of management contained by the CEMS is called the waters recovery service. This system will have to analyse all the possibilities of creating synergies of mutualisation and substitution with water in industrial areas.

- The first step of this system will be the analysis of inputs and outputs of water,
- Then, the second part will consist of the identification of mutualisation and substitution of water streams and the implementation of synergies.

This recommendation does not seek to propose solutions for improving individual processes within each company; there are already a large number of techniques in the field of cleaner production. However, this recommendation proposes joint solutions common to several companies.
The goal is to reduce individual costs linked to the common treatment of water, improve environmental impacts and reduce the consumption of water.

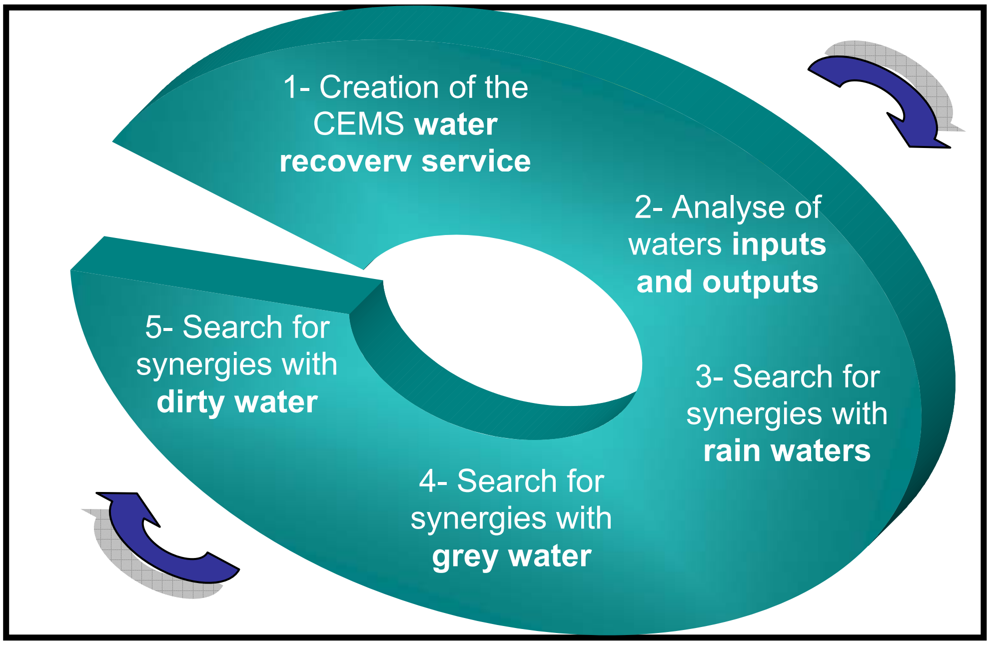

Figure 31: Organisation of Management Recommendation 4

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- **RECOMMENDATION**

✓ *Analysis of inputs and outputs*

Before searching for synergies, information is required on the streams of different types of waters in the industrial area.
Thus, the first step is to analyse the inputs and outputs of waters in order to evaluate what the possibilities of synergies are.
Waters can be classified into 5 types:

- Mixed waters from discharges, already treated by the purification plant
- Rain water
- Weakly polluted waters
- Polluted waters
- Groundwater and surface water

This differentiation is important to facilitate the identification of substitution and mutualisation synergies.

The study of inputs of water flows has to define the quality of the flows used and the quality that is really necessary: in some cases potable water is used by the process instead of more polluted water (rain waters, etc.).

In this recommendation, the five types of water are defined more precisely, as follows:

- Rain water is water from precipitation collected in tanks,
- Weakly polluted waters are waters which are slightly polluted. They can be reused directly for another function, or may require light treatment or filtration prior to reuse, just as they are, or integrated with surface waters and groundwater.
- Polluted waters are waters with an important organic load or with particles which must be eliminated and treated before re-use.
- Surface waters and groundwater are important for the water service for drinking water, and to produce hot water for use in specific industrial process. Integrated management with other kind of waters could satisfy the requirements of many industrial processes.
- Waters from discharges treated by a purification plant close to the industrial area could be an important source for treatment and reuse in certain industrial processes.

The main necessary information about the streams of water is:

- Origin
- Quantity
- Composition
- Temperature
- Means of elimination

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✓ *Synergies of mutualisation and substitution*

Both graphs below show the difference between a synergy of substitution and a synergy of mutualisation:

A synergy of substitution is established when waste or effluents from one company become a potential resource for another.

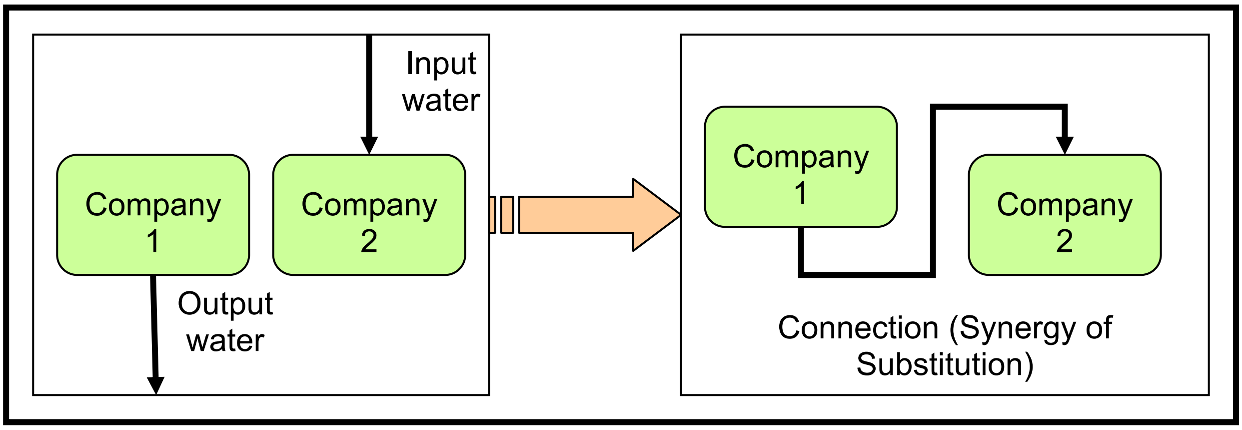

Figure 32: Diagram of a Substitution Synergy

Then a synergy of mutualisation consists of regrouping several streams into one single stream.
When 2 nearby entities consume an identical product, supply costs can be reduced by pooling their needs, notably by rationalising the transport connected to the delivery.

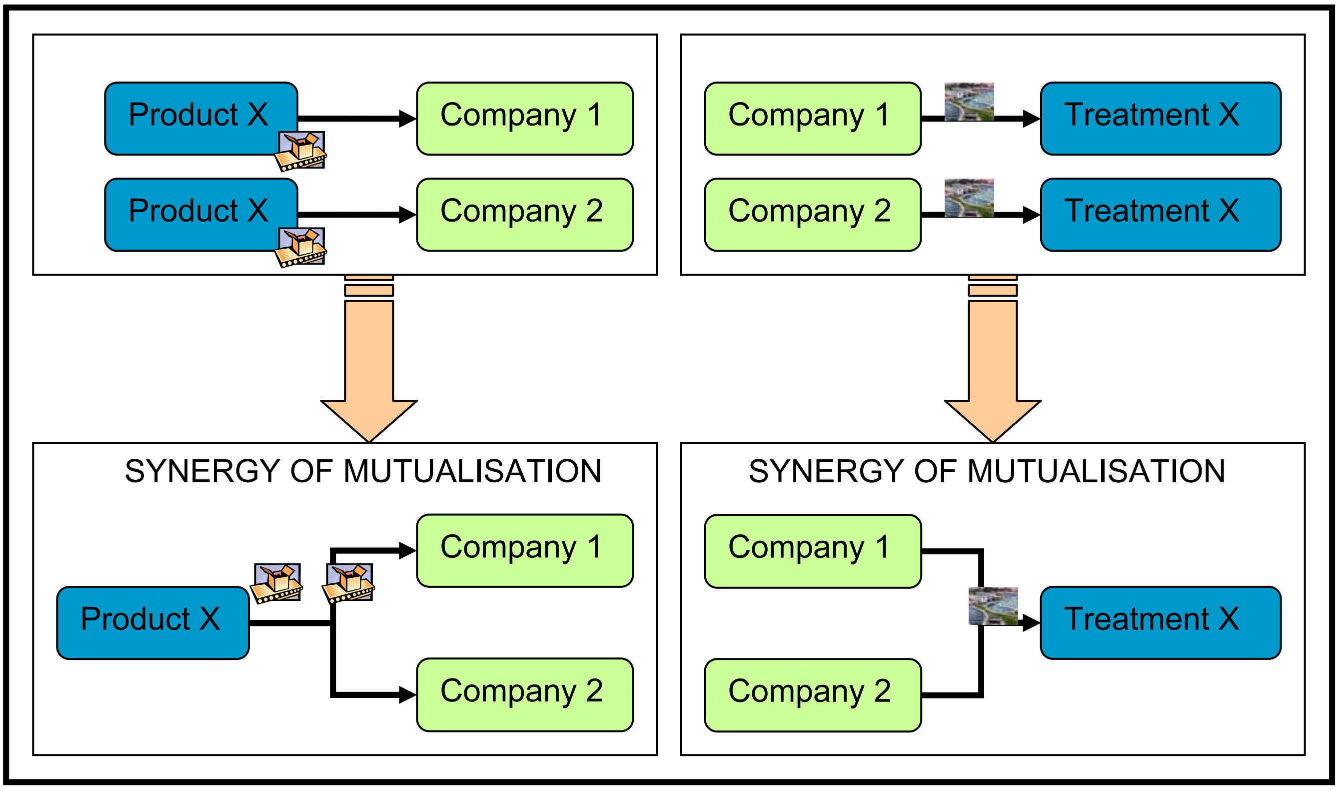

Figure 33: Diagram of mutualisation synergies

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✓ *Synergies for treated discharge water*

Waters from discharges are treated by the purification plant in accordance with legal requirements. They guarantee a sort of continuity in the future, and represent a good input for creating new enterprises in the refinery sector, and the distribution of water for industrial reuse and non-food irrigation.

✓ *Synergies for rain water*

First, a network must be set up in the industrial area to permit the collection of rain water.
The installation of a rain water collection tank in the industrial area will allow this water to be reused for:

- Irrigation of public spaces (lawns)
- Reserve Supply in case of fires
- Supply for street cleaning operations, etc.….

✓ *Synergies for weakly polluted waters*

The reuse of industrial effluents without treatment is a very interesting way of implementing substitution synergies. The possibilities of establishing these synergies depends to a great extent on the compatibility of industrial effluents with other applications, and the water quantity and quality must be carefully evaluated.
Below are some examples of implementation of this type of synergy that can be implemented between companies in the industrial area:

- Water from the purging of cooling towers for cleaning or cooling or for preliminary treatment.
- Waters from the purging of high pressure boilers to fill low pressure boilers, etc.

These techniques already exist within companies, but they can also be applied between companies in an industrial area.
It can widen the possibilities of re-use for grey waters and increase the economy of water for companies.
These types of substitution synergies do not imply important supplementary costs, taking into account that this type of water does not require specific treatments.

✓ *Synergies for polluted waters*

Before reuse, polluted waters require a specific treatment. This treatment has a cost, but it contains a double advantage:
On one hand, it allows water consumption to be reduced, and on the other hand, it separates the residual currents, allowing the total volume to be treated to be reduced, and allows the possible recovery of products.
Nevertheless, the possibilities of establishing these types of synergies depend to a great extent on the characteristics of the water. The establishment of common treatment is more feasible in the case of a “district” (industrial area with similar activities), due to the fact that the characteristics of the water will be similar.

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Below are some types of technologies that can be utilised for these treatments:

- Osmosis inverts (ultra filtration),
- electrodialysis
- Ionic exchange
- Filtration
- Evaporation, etc.

These technologies of re-use of effluents also bring profits, thanks to the economy of water, the reduction of residual waters and treatment which derives from it.
However they require a significant amount of seed money. Moreover, companies that generate industrial effluents of similar composition can invest together (synergy of mutualisation) or pay off the initial investment more rapidly and to use the technology more effectively, taking into account that the quantities to be treated will be greater.

The treatment of residual waters re-use not only makes it possible to reduce water consumption and optimise the management of residual effluents, but it also allows the recovery of contaminants and by-products. There are a number of techniques and they can result in economic benefits, water savings, reduction of residual currents and reduction of the process in the water treatment plant. Nevertheless, the initial investment is relatively high.
Thus, companies that generate residual water with similar characteristics can promote the installation of the common equipment required to reprocess and reuse the water.

- **LINKS WITH EXPERIENCES OR TECHNIQUES**

File EXP 6 C3 – RESHUI: Integrated Management of Olive Oil-Mill residues and waste water, location: Peloponnesus.

File EXP 18 EXT – KALUNDBORG – Industrial Symbiosis of Kalundborg– Assessing the symbiotic material flows on site: the Kalundborg Centre for Industrial Symbiosis, location: Kalundborg – Denmark

File TEC 4 EXT – PRESTEO – Program of Research of Synergies on a TErritOry, location: France

Industrial estate of Port of Cape Charles, Eastville, Northampton County, Virginia: installations for the re-use of waters and recycled water distribution system for the companies in the industrial estate.

IDR, Igualadina de Depuració i Recuperació, SL, Igualada : Wastewater treatment plant for tanneries in Igualada, Catalonia

Catalan agency of the Water: http://mediambient.gencat.net/aca

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2.6. RECOMMENDATION 5: Implementing measures for improvement - Reduction of the consumption of resources and the production of waste

- **KEY MESSAGE**

The knowledge of the used materials and the characterization of the waste produced within the industrial estate constitutes a basis to define the possibilities of recycling in situ, to group together similar flows and to reduce the individual costs of waste management of each company.

- **METHODOLOGY**

Another part of the IEMS is called the service of mutualisation and replacement of raw materials and waste.
The objective of this system is to analyse inputs and outputs and find ways for:

- The mutualisation of the delivery of goods
- The mutualisation of waste treatment
- The use of outputs as inputs (synergies)

This system requires information on streams of materials in the industrial area. This has to be obtained by the information area of the IEMS.
In this recommendation, we have to consider the inputs of new materials and the outputs which are the waste and unused new materials.

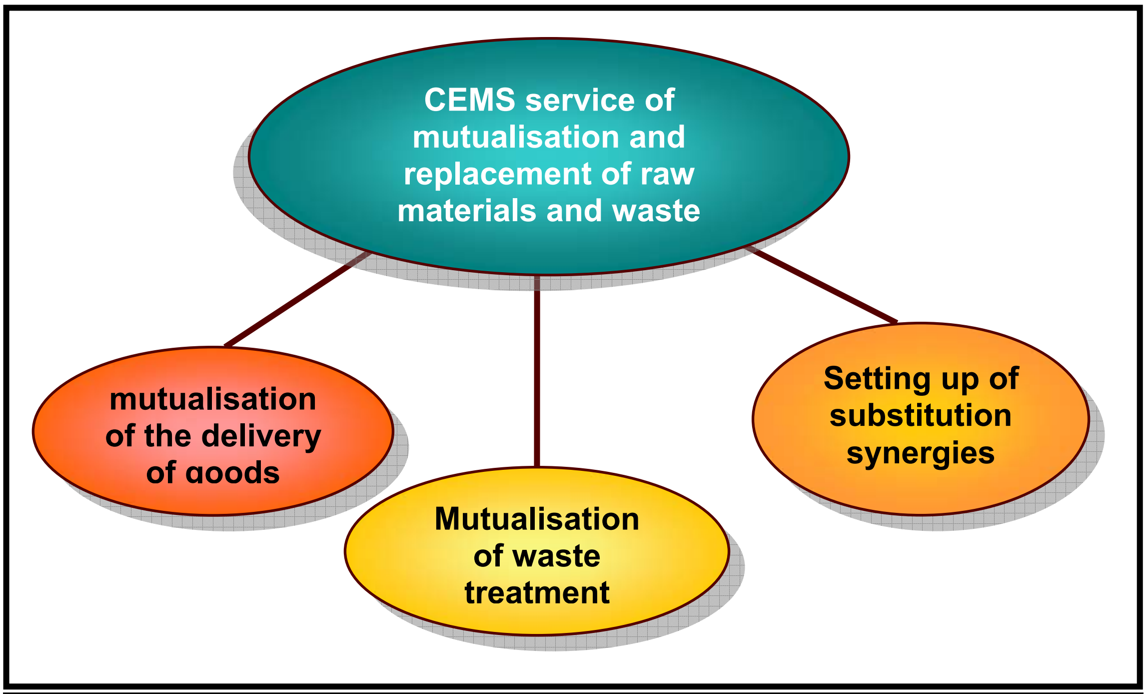

Figure 34: Organisation of Management Recommendation 5

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• RECOMMENDATION

The service of mutualisation and replacement of raw materials and waste seeks to reduce the utilisation of raw materials as much as possible.

➢ *Collecting data*

The first step is to search for data obtained by the information area on streams of materials and waste in the industrial area.
The next 3 steps of this recommendation will depend on the quality of the information collected by the information area.

➢ *Searching for the mutualisation of the delivery of goods*

In order to reduce costs for the delivery of goods, it can be interesting to analyse what can be done at the level of the industrial area.

To this end, a comparison of the inputs and suppliers of each company has to be carried out:

- If 2 or more companies import products with similar characteristics but with different suppliers, the possibility of placing a group order with the same supplier must be studied.

- Moreover, if 2 companies have the same supplier but as they are delivered separately, it is necessary to study also the possibility of grouping together the orders to reduce the costs of delivery.

This can help to reduce individual costs, road traffic around the industrial area, CO_2 emissions, use of packaging and can improve communication between companies.

This may start with the common purchase of stationery, and if the cooperation works it can be taken further.

➢ *Searching for the mutualisation of waste treatment*

In order to improve the cooperation and reduce individual costs, the common management of waste is a good solution.
To this end, a space must be set aside in the industrial area intended for waste storage.
Once the common containers are full, the service of mutualisation and replacement of raw materials and waste must call a company to eliminate the waste.
The common storage space will be bigger than for a single company, so transport and treatment costs will be reduced.

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Moreover, in most industrial areas, dangerous chemical products are used, which can produce explosions or fire if they are not subjected to rigorous controls.

In order to reduce these risks, the common management of dangerous waste can be a solution.
Furthermore, the quantity of dangerous waste generated by each company is usually weak; the common management will thus make it possible to significantly reduce individual costs.

The plan below shows the possible organisation for the waste collection: a shuttle regularly visits each company to collect hazardous and non-hazardous waste, and will deposit it in the waste storage area.
When there is a sufficiency quantity to fill a lorry, the waste is cleared.

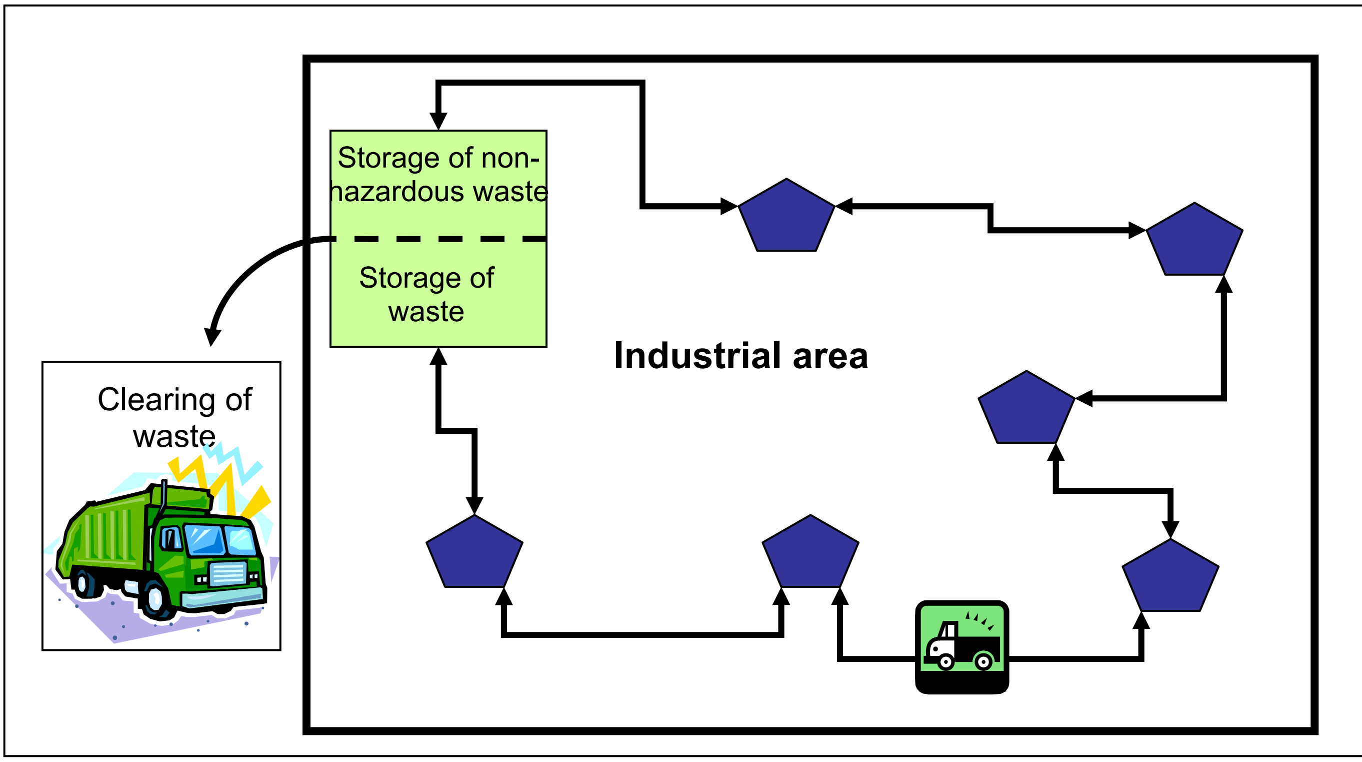

Figure 35: Diagram of organisation of common waste management on an industrial estate

> ***Searching for the substitution of outputs in inputs (synergies)***

To substitute outputs in inputs, we can propose 2 possibilities:

- Create synergies between companies
- Create a waste and sub products sock exchange

Creating synergies between companies is initially difficult due to the need for information.
Nevertheless, it may result in relevant environmental, social and economic benefits.

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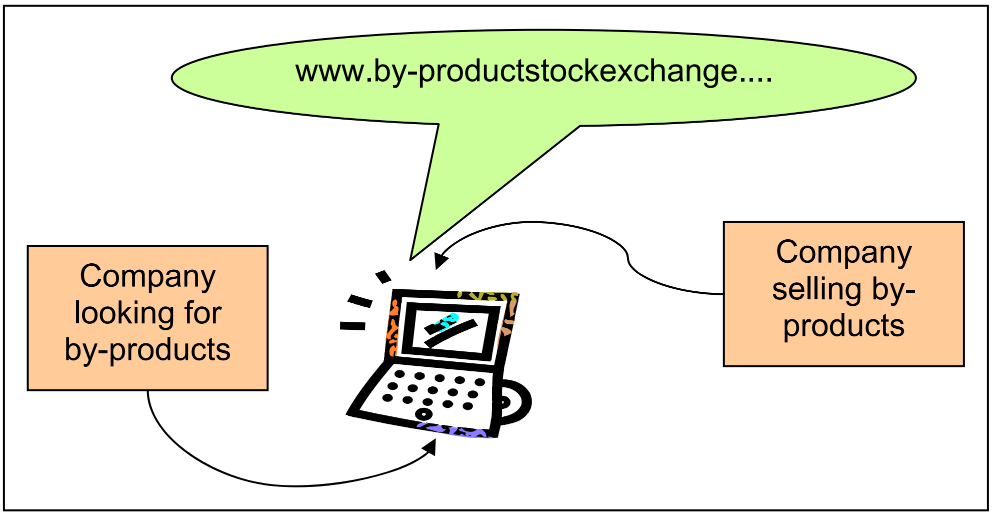
To help in this step, a recently released software package called Presteo can search for feasible synergies.
Once the inputs and outputs of concerned companies have been fed in, this software can indicate which synergies are possible.

The main factors to take into account are:

- Geographical feasibility
- Qualitative and technical feasibility
- Quantitative feasibility
- Legal feasibility
- Economic interest
- Acceptability by companies

These factors have been defined by Dr. Cyril Adoue in his thesis "Methodology of identification of practicable eco-industrial synergies between companies in French territory", and they are explained in Recommendation 3 of the Recommendation for the Planning of New Industrial Areas.

The creation of a waste and sub products stock exchange is also a good way of reducing the consumption of raw materials.
It is important to precise that the by-products stock exchange will be maybe more easily feasible that the one for waste. This is because the status of waste is subjected to a stringent regulations, so it is difficult to sell waste.
This stock exchange can be organised by means of a web site, as shown in the graph below:



But in order to have the idea of using a waste stock exchange, companies first have to be aware that they can reuse it, or that their waste has a potential for recovery.

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• LINKS WITH EXPERIENCES OR TECHNIQUES

File EXP 13 EXT - GENEVE – Industrial ecology in Geneva – creation of eco-industrial synergies between the companies of the cantonal territory, location: Geneva – Switzerland.

File EXP 18 EXT – KALUNDBORG – Assessing the symbiotic material flows on site: the Kalundborg Centre for Industrial Symbiosis, location: Kalundborg – Denmark.

File TEC 2 EXT – MESVAL - Methodology to find the most sustainable synergies on a territory and examples of application in Catalonia.

File TEC 4 EXT – PRESTEO – Program of Research of Synergies on a TErritOry, location: France.

File TEC 5 EXT - Eco park Hartberg – Creating an infotainment park based on industrial ecology principles, location: Hartberg – Austria.

File TEC 7 EXT – SEMPRE – Implementation of the 3R strategy, location: Brazil.

Documentary resources of the biodiversity foundation: Under the sponsorship of the Ministery of Sciences and Technology, the foundation developed a pilot program for the promotion of the sustainable development of industrial estates: www.fundacion-biodiversidad.es

Catalan Waste agency : www.arc-cat.net

CONAMA Foundation: www.conama.org

Industrial symbiosis in the Philippines: Re-use of waste as raw material.

Science and technological park for the environment - Turin - Italy: It has been achieved to integrate environment, sustainable architecture and energy economies.

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2.7. European regulation link to the management of industrial estates

- ✓ ***Regulation link with all the recommendations***

Regulation (EC) No 761/2001 of the European parliament and of the council of 19 March 2001 allowing voluntary participation by organisations in a Community eco-management and audit scheme (EMAS).

Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (IPPC).

- ✓ ***Regulation link with recommendations 3, 4 and 5***

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol.

Directive 2006/12/EC of the European Parliament and of the Council of 5 April 2006 on waste (Text with EEA relevance).

Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC (Text with EEA relevance).

PART 2: ECOSIND RECOMMENDATIONS

PART 3: FEEDBACK FROM THE EXPERIENCE WITH SUB-PROJECTS AND CONCLUSIONS ON THE REGIONAL AND EUROPEAN LEVELS

1 Feedback from the experience of the ECOSIND sub projects

1.1. Experience feedback of sub-projects of the C3 component concerning environmental management of the existing industrial network

1.1.1. CICLE PELL

✓ ***Synthetic description of the project***

The objective of Cicle Pell is to increase competitiveness as well as taking into account the environment in the industries of leather tanning and slaughter-houses, while basing itself on their co-operation and improving the exploitation of waste (lost energy and materials) in various associated industrial sectors.
The results will be presented in four documents:

- Analysis of the Life Cycle of leather tanning in Italy and Spain
- Database of animal waste and options for co-operation
- Analysis of the networks existing in Europe among the industries of leather tanning and slaughter-houses
- Installation of an eco-industrial estate for tanning industries at Igualada (Spain).

✓ ***Benefit for the efficiency of the territory***

The document relating to the eco-industrial estate is based on opening a line of work for the improvement of the efficiency of the territory in the sense of developing the integration in the same estate of industries from the sectors studied, by overcoming the difficulties of urban quality of life due to the existing separation.

✓ ***Environmental benefits***

The environmental improvement is clear from the results of CICLE PELL, the aim of which is to increase knowledge of the industrial processes and their impacts as well as solutions for reducing waste.

✓ ***Socio-economic benefits***

The socio-economic benefits of CICLE PELL concentrate especially on the analysis of the existing networks, allowing superior knowledge of the structure and relations between the companies.

✓ ***Key message to retain for future experiments***

The sectors related to the slaughterhouse and the tannery, which are traditionally highly contaminating, made a major effort to understand the external negatives and environmental impacts. Thus these industries have considerable potential to quickly become a key sector in the establishment of industrial ecology.

1.1.2. MESVAL

- ***Synthetic description of the project***

MESVAL establishes the scientific-technical bases and a strategy for the search for new ways of regional recovery of industrial waste.

- ***Benefits for the efficiency of the territory***

From the territorial point of view, MESVAL is especially important in the sense that the development of synergies studied may lead to the reduction in the costs of mobility.

- ***Environmental benefits***

The contribution to the reduction of the quantity of raw material used and dangerous industrial waste generated is the most important benefit of MESVAL.

- ***Socio-economic benefits***

The economic recovery of certain waste analysed and the possibility of co-operation between sectors are the main benefits in the socio-economic field

- ***Key message to retain for future experiments***

The technical capability of offering the economy new waste recovery solutions is very important. The MESVAL project offers the possibility of developing various lines of recovery or synergies among different sectors and production lines. Thus new relations were founded thanks to industrial ecology. They made it possible to create links between the sectors of tannery, metal surface treatment, textile industries, and companies producing industrial lubricants and insulation panels. A sustainable indicators set is applied to the waste valorisation method in order to choose the most sustainable one.

1.1.3. MEDUSE

- ***Synthetic description of the project***

Advanced methods and techniques for the environmental analysis of areas with high industrial density with the help of opto-electronic probes.

- ***Benefits for the efficiency of the territory***

It is shown that a concentration of industries with the same or similar processes may favour the implementation of follow-up methods. The comparison between the textile sector in Catalonia (dispersed) and Tuscany (concentrated) is the basis for this conclusion.

- ***Environmental benefits***

The use of the methods developed supports the effectiveness of the environmental follow-up (water and air) and also for the support of the capacity of intervention by the responsible administration and the more rapid solution of problems or constraints.

- ***Socio-economic benefits***

The savings derived from the implementation of the methods and techniques developed and the ease of obtaining data are the principal benefits.

- ✓ ***Key message to retain for future experiments***

The control of air pollution and water in the textile industry is viable.

1.1.4. GAT-SPOT

- ✓ ***Synthetic description of the project***

The substitution of synthetic oils by vegetable-based oils (sunflower oil) for carding. The possibility of using compost in sunflower cultivation (non food) is also being studied. These cultivations would make it possible to operate in the agricultural and territorial sector, recovering neglected areas.

- ✓ ***Benefits for the efficiency of the territory***

It was shown that the improvement of the economic conditions of agricultural production (a better offer of quantity and price) may help the recovery of the agricultural sector and thus finance the development of territorial balancing functions.
The development of sunflower (non-food) cultivation and the use of compost produced in surrounding areas as a fertiliser make it possible to plan in a sustainable way with regard to other matters that are linked to environmental management, such as, for example, waste disposal and reuse.

- ✓ ***Environmental benefits***

The non-use of synthetic oils allows pollution to be reduced, as shown by the Life Cycle Assessment study concerning the comparison of 1t of yarn production using vegetal and synthetic oils. This pollution reduction is due both to the different composition of the oils and the quantities used. Moreover, the renewability index calculation concerning the two kinds of oil shows that the carbon content from renewable sources is greater for vegetal oil (74% as opposed to <30%). Hence, by using vegetal oils it is possible to reduce the non-biodegradable components along with the bioaccumulation of these substances in wastewaters. In addition, the use of compost from the textile activity allows a reduction in the quantity of synthetic fertilisers used for the production of the sunflowers.

- ✓ ***Socio-economic benefits***

The economic recovery of the agricultural sector is one of the most important challenges for the European economy and society. In this sense, the possibility of establishing input-output relations between agriculture and industry can improve the competitiveness and durability of both sectors.

- ✓ ***Key message to retain for future experiments***

This sub-project shows the viability of co-operation between the agricultural sector and the industrial sector. It is an experiment in mutualisation which includes interests from both sectors. For agriculture, products need to be found to replace those supported artificially by the European Community. For industry it is necessary to find in agriculture the possibility of substituting expensive and polluting raw material by exploring new ways of recycling organic waste.

1.1.5. RES-HUI

- ***Synthetic description of the project***

This study deals with alternative techniques for the management of solid waste and liquids of the oil industry. Three hypotheses were studied:
Comparison between thermal and combustion recovery without control of green waste
Drying and thermal recovery of used water
Anaerobic digestion of used water

- ***Benefits for the efficiency of the territory***

The importance of developing production and the agricultural sector for the balance of the territory was demonstrated.

- ***Environmental benefits***

The thermal recovery of green waste and used water in the production of oils means a reduction of emissions into the atmosphere with the hydrous system. There is even an environmental benefit in the recovery of the energy content of green waste and used water.

- ***Socio-economic benefits***

The environmental benefits derived from the saving are clear but it is necessary to study and analyse the usefulness of the measurements at a more regional level.

- ***Key message to retain for future experiments***

The RES HUI sub-project establishes the bases for the recovery of waste from the production of olive oil.

1.1.6. MITCO2

- ***Synthetic description of the project***

This is a study of the possibilities of reducing CO^2 emissions in existing industrial estates. Various technology alternatives for the combined and centralised production of electrical energy, thermal energy and refrigeration are presented and applied in different Case Studies.

- ***Benefits for the efficiency of the territory***

The implementation of the systems for centralising energy production on industrial estates helps to increase territorial efficiency, in the sense that production is located close to where it is needed, and in this sense, it suggests a reduction of the territorial impact of the industrial estates: there will be less demand for external energy transport.

- ***Environmental benefits***

Improvement in the overall efficiency of the production and distribution system.

PART 3: FEEDBACK FROM THE SUB PROJECTS AND CONCLUSIONS

✓ *Socio-economic benefits*

The implementation of systems for centralising energy production in the existing industrial estates can generate significant economic benefits through the reduction of the cost of energy caused by increased global energy efficiency.

✓ *Key message to retain for future experiments*

The viability of the reduction of the CO^2 emissions coming from industrial estates is clearer thanks to project MITCO2. Moreover the project allowed the creation of new avenues of thought. Co-generation and distribution through distribution networks, as well as the use of renewable energies, are lines of work which must be developed in all the industrial estates which aim to be independent and competitive from the point view of energy.

1.1.7. EMAS

✓ *Synthetic description of the project*

The general objectives of EMAS are the following:

- Reduction of implementation costs when setting up an environmental management system
- Definition of the significant aspects of the environmental impacts on the reference industrial estate
- Training of entities of the reference area concerning the implementation of EMS in the entities of the reference area
- Drafting of the environmental declaration of the estate
- The operational experimentation of an environmental management system on the estate

✓ *Benefits for the efficiency of the territory*

The implementation of environmental management systems in existing industrial estates can improve efficiency in the management of the territory; as a result it will be possible to improve the mobility of people and materials.

✓ *Environmental benefits*

The benefits are in relation to the rationalisation of the management, resulting in the implementation of measures for reducing pollution or consumption of natural resources.

✓ *Socio-economic benefits*

Rationalisation of management even produced socio-economic benefits.

✓ *Key message to retain for future experiments*

The development of integrated environmental management systems will be key to the implementation of various measures and recommendations of the ECOSIND project in the existing industrial estates. Without the structuring of joint management, it will be impossible or very difficult to develop industrial ecology.

1.2. Experience feedback of sub-projects of the C4 component concerning durable planning of industrial development

1.2.1. RECIPOLIS

✓ ***Synthetic description of the project***

The objective of RECIPOLIS project is twofold:

to contribute to the development of a strategy for the planning of the territory with the aim of reorganising industrial activities related to the recovery and recycling of cars, electric household appliances and products made of various materials;

to prepare a study for the creation of a protected Recycling Park.

✓ ***Benefits for the efficiency of the territory***

The development of RECIPOLIS allows the development of a strategy for spontaneous recovery of the territories of industrial activities with very low levels of installation.

✓ ***Environmental benefits***

The recovery of the territory is effected in the same way as environmental recovery i.e. recycling of waste and the reduction of emissions.

✓ ***Socio-economic benefits***

Improvement of the working conditions of the activities is one of the most important benefits resulting from the development of RECIPOLIS.

✓ ***Key message to retain for future experiments***

The re-conversion of the industrial estates without installations will be easier after RECIPOLIS.

1.2.2. ESEMPLA

✓ ***Synthetic description of the project***

Study for the implementation of the EMAS Regulations for industrial districts.

✓ ***Benefits for the efficiency of the territory***

The implementation of ESEMPLA allowed a demonstration of the benefits derived from:

- The constitution of an initial organisation called the Promotion Committee (PC) with the essential function of supporting co-ordination and co-operation among the various public and private agents.
- The definition of the Environmental Policy of the district, which will be useful for directing the activity of the PC and of the activities of the district.

✓ *Environmental benefits*
The development of a study model of Initial Environmental Analysis (IEA) allows consideration of which are the most important aspects, in the sense that the IEA facilitates the definition of which measures and actions are the most urgent for improving the environment.

✓ *Socio-economic benefits*
The saving of money and social effort is applicable to:

- the definition of common infrastructures for environmental management
- the planning and development of joint education and training programmes for the whole district
- creation of a team of auditors to monitor the whole process of individual and collective discussions in the district
- joint guide for the applicable environmental legislation

✓ *Key message to retain for future experiments*
One of the most important aspects for the development of industrial ecology is to integrate consideration for the creation of a promotional committee in all plans and programmes aimed at industrial or commercial development. This promotional committee must constitute a base for collaboration among the companies to develop environmental management systems of the EMAS type on industrial estates.

1.2.3. PLANCOST

✓ *Synthetic description of the project*
The principal objectives of PLAN-COST are:

- To equip administrations with a tool which gives support to the durable development of the area, so that the area can develop its economic and tourist activity without damaging the environment.
- To demonstrate, with the help of pilot experiments to be carried out, that industrial and tourist activity is not mixed up with the environment but that the use of supra-municipal and environmental criteria in its planning can help companies to be more effective, durable and can improve their integration within the territory which hosts them.

And finally, as a principal objective, there is also the participation of citizens and of all the agents involved in promotion and dissemination in order to better evaluate symbiosis in industry, the environment and the company.

✓ *Benefits for the efficiency of the territory*
The use of the supra-municipal criteria for planning industrial estates can lend a major degree of rationality to the regional planning that is normally carried out with highly sectorised criteria.

✓ *Environmental benefits*
The search for indicators of environmental impacts in the industrial estates can help to find solutions and corrective measures.

✓ ***Socio-economic benefits***

The possibility of a participatory implementation in industrial estates opens up opportunities for public debates on finding the best strategies.

✓ ***Key message to retain for future experiments***

The demonstration of the utility of geographical information systems (geo-referenced databases) for the planning and adaptation of industrial estates located close to coastal zones is one of the most important and interesting contributions of the PLANCOST project.

1.2.4. BLU

✓ ***Synthetic description of the project***

The objective of this project is to work out a methodological instrument for strategic and durable planning of industrial activities and of services located in coastal zones. This methodology profits from the experience contributed by the "Blue" quality control label as regards industrial ecology adapted to the nautical sector and will take into account the obligations arising from Directive 2001/42/CE on strategic environmental evaluation.

✓ ***Benefits for the efficiency of the territory***

The coastal zones will obtain good results for balance through the phased introduction of the BLU criteria and methodology.

✓ ***Environmental benefits***

The application of EMAS criteria in the nautical sector clearly presupposes a reduction of pollutant emissions, dangerous waste and the use of water and energy by this sector.

✓ ***Socio-economic benefits***

The application of environmental management systems also opens up the possibility of a major economic rationality in the sector.

✓ ***Key message to retain for future experiments***

The companies of the nautical sector have, thanks to the project BLU, the possibility of obtaining a similar label to EMAS to prove the implementation of a system of environmental management adapted to the nautical sector. Moreover, BLU opens the door to sectoral planning integrating the environmental criteria for specific sectors constituted by SME.

1.2.5. PLASOS

✓ ***Synthetic description of the project***

The essential objective of the project is to show the environmental, social and economic utility of continuous environmental evaluation in planning of the industrial base.

This utility was demonstrated in the plan of the management centre de Cerdanyola del Vallès, the municipality of Seravezza and the prefecture of Arcadia.

PART 3: FEEDBACK FROM THE SUB PROJECTS AND CONCLUSIONS

✓ *Benefits for the efficiency of the territory*

Implementation with environmental criteria has had as a result, normally, a saving of land and other natural resources, such as bio-diversity, water and energy. In this case, the detail in the methodological definition of PLASOS ensures that its implementation will be very useful for the balance of the territory.

✓ *Environmental benefits*

The application of the criteria and methodology defined in PLASOS will allow and support the reduction of $C0_2$ emissions through energy measures especially developed in the case of Cerdanyola, the reduction of water pollution in the case of Arcadia, and waste management in the case of Seravezza.

✓ *Socio-economic benefits*

The economic saving derived from implementation with environmental criteria was demonstrated *a posteriori* but normally no data are available in this sense. The three developments will be models for the future, and will provide data to show the economic and social importance of this type of installation.

✓ *Key message to retain for future experiments*

The application of the European Directive on the environmental evaluation of plans and programmes is facilitated thanks to the results of project PLASOS. This project made it possible to create a very complete set of tools for carrying out preliminary studies to develop the objective evaluation of plans and programmes.

1.2.6. GPP

✓ *Synthetic description of the project*

The objective is concretised in the achievement of two principal objectives:

- The definition of a method of selection of materials/goods which leads to a reduction in production rejects.
- The definition of a method to identify these goods which can be re-used in the production process of new goods.

✓ *Benefits for the efficiency of the territory*

The use of “Green Procurement” in industries has the following benefits for the efficiency of the territory:

- Ecological awareness of industries
- Reduction of costs
- Reduction of environmental pollution
- Less waste
- Use of less hazardous materials

✓ *Environmental benefits*

The application of "Green Procurement" substantially reduces environmental impacts and incorporates environmental policies into industrial activities.

These green processes decrease the environmental impact of industrial activities, and principally the pollution that is created during the production of products.
Certain environmental benefits that have been recorded include the following:

- Product manufacture using fewer materials, water, energy, etc. and produces less waste for management.
- Manufacture of reliable and durable products that will need less energy or consumables in order to function.
- Increase of availability of resources for products or services by avoiding likely damage in the environment.
- Reduced use of natural resources at the phase of manufacture.
- Reduced use of natural resources at the phase of use.
- Reduced production of waste at the end of useful life and at the duration of the life circle of the product.
- Reduced content of dangerous materials via the prohibition of substances.
- Continuous improvement of environmental performance of products and services with the growth of the green market and the application of new legislation.

✓ ***Socio-economic benefits***

The Green Procurements represent a shift of interest in the reduction of environmental impacts of products and services, not only activities.
The industry faces a series of obstacles in the examination of the environmental demands and legislation owing mainly to the perception of environmental aspects as restrictions and expenses, and not as opportunities and commercial profits.

✓ ***Key message to retain for future experiments***

The use of "Green Procurement" is essential in industries due to its environmental and socio-economic benefits. It is an important step for the reduction of pollution and sustainable development.

1.3. MECOSIND – Master of industrial ecology

The **aim of the Master Programme in Industrial Ecology** is to prepare students to **develop more sustainable economic activities in industry, government and research institutions by implementing preventive methods and integrating both economic growth and environmental protection on the same framework.**

The Industrial Ecology graduate will learn how to solve problems from different perspectives such as design for the environment, integrated environmental impact assessment, risk assessment, material flow analysis, multricriteria analysis, etc. So, the master offers a strong background on the application of those tools and the potentials to develop by themselves innovative proposals and solutions for the decision making in environmental management.

In the first year of the masters program, students will have the opportunity to gain general knowledge of the methodologies and tools of industrial ecology. Such as Life cycle Analysis and management, design for environmental friendly products, material flow analysis, social participation, multicriteria analysis, risk analysis, water management, waste management, prevention tools.

The second year, the students can specialize in their topic of interest for specialization and masters thesis, which for professionals could be topics specific to their industries. This will allow students to access to the PhD programme in environmental science and develop further its master project.

Students can and are encouraged to study abroad, especially in the second year, where a research interest might only be available in one region.

✓ ***What does the Master in Industrial Ecology offer?***

- Interdisciplinary Formation
- Professionals capable to work in the environmental yield with companies and productive sectors.
- Professionals able to work in administration areas, especially in planning, programming, industry and other sectors.
- Professionals capable to manage productive sectors from the sustainable development approach at different scales: regional, industrial park, companies association,

The master in Industrial Ecology was launch in autumn 2006 at the Institut de Ciència i Tecnologia Ambientals of the Universitat Autònoma de Barcelona.

Moreover, since the master has been created by the collaboration within different universities from Toscana, Abruzzo, Peloponnesus and Catalonia; and the programme has been designed based on the Bologna Declaration for academic staff, students and researchers mobility, there is a possibility of doing some modules in the MECOSIND project partner universities.

2 Conclusions and future prospects for management and planning of industrial estates in the south of Europe

2.1. Environmental management, one of the limits to industrial development in Southern Europe

During the development of the Ecosind framework operation, it was noted that environmental management and respect of the environmental European Directives are an important challenge that SMEs must face in the South of Europe.

This problem is even more important when one speaks about areas with an old industrial tradition and a predominance of small and medium-sized enterprises which have difficulties of autonomous management. This is the case in Catalonia and Tuscany, and this implies that investments are moving towards activities closer to the service sector, leading to a tertiarisation of the economy.

In traditionally less industrial regions which are more dedicated to the primary sector and the agriculture, such as the Peloponnese and the Abruzzi, difficulties vis-à-vis environmental management were also observed. This constitutes major limits to the durable development of these areas.

2.2. A very high potential of industrial ecology to overcome these limitations

In the various sub-projects, especially MESVAL, CICLE PELL, GAT-SPOT, PLASOS and BLU, it was noted that industrial ecology has major potential to overcome the limits related to environmental management.
Above all, it makes it possible to offer knowledge to industrial zones and sectors: a very innovative organisation and a vision of the development with a strong economic and environmental added value.

The strength of industrial ecology constitutes very important potential for planning and arranging new zones of viable activities, as much from an economic standpoint as from the environmental point of view. It makes it possible to consider, envisage and plan synergies of substitution and mutualisation which offer highly innovative complementarities between the various economic activities of a territory. But also concerning the existing industrial areas, the MESVAL sub-project encourages us to develop even more research tasks for the recovery of the material which is usually described as industrial waste, but which may constitute very interesting, economically viable possibilities for raw material resources.

For all this, the ECOSIND experiment will be very useful for areas which, like the Peloponnese or Abruzzo, do not have a highly developed industrial base, but the ECOSIND results are also very useful for the areas which have a mature and developed industrial base like Catalonia or Tuscany and which need innovative and new solutions and tools to improve the overall return of the economic activity in the future.

2.3. ECOSIND developed very practical tools for the development of industrial ecology

In this ECOSIND guide, in particular in the second and fourth part, it is possible to find very interesting tools which are directly applicable to new projects, but also for the improvement of existing industrial estates.

All of these tools allow regions without a promising future to initiate a process of progressive implementation of industrial ecology, but they also allow practical solutions in response to the problems expressed in the first part of this ECOSIND guide.

2.4. All of the ECOSIND results allow the development of framework operations at the regional level

The ECOSIND action has allowed the development of a new line of work which is aimed at the improvement of synergies between activities in the same sector (BLU), various sectors (MESVAL, GAT-SPOT) or on the same industrial estate (PLASOS, MEDUSE, ESEMPLA). Moreover, at the regional level, ECOSIND has supported the creation of geo-referenced databases of the industrial estates which constitute the base of the various regional framework operations of the partner regions.

These operations will be able to give structured answers to the four major types of problems described in the first part of this guide.

3 Proposal and open questions for European decisions concerning the management and planning of industrial estates

At the level of the European Union, ECOSIND has made it possible to begin a debate on:

- ✓ The interest in a European strategy of industrial ecology.
- ✓ The interest in services countering the delocalisation of industries out of Europe.
- ✓ The efficiency of the industrial base and economic activities.

This efficiency is especially necessary in four essential aspects which were considered in this guide:

- ✓ Efficiency in the **use of land** by the economic activities has become a very important aspect in the Europe of the future. Considering the intensity of urbanisation, the added value per built-up square metre is increasingly high

- ✓ Efficiency of the **use of energy** for economic activities is also a very important aspect. It is obvious that all Europe must consider a progressive independence from oil and other sources of fossil energy, as well as an important reduction in greenhouse gas emissions. The quantity (KWh) of renewable energy produced per square meter has to be increased significantly.

- ✓ The efficiency in the **management of waste** produced by European economic activities. Day after day, solutions vis-à-vis the continuous increase of the quantity of waste produced per square meter, and vis-à-vis the increase in the associated costs of management and elimination are difficult to find, and are not always economically viable.
  Moreover, the environmental regulations concerning the treatment of waste limit the implementation of synergies.

- ✓ Efficiency in the **organisation and relations** among European economic activities to overcome the current levels of competitiveness. The percentage of companies collaborating for environmental improvement inside industrials estates is weak.

All this led to ECOSIND and the conclusion that a real European strategy is required for industrial ecology development which will allow us to consider with credibility the progress made towards the durability of the base formed by the economic activities of Europe.

During the ECOSIND project, numerous projects of industrial ecology implemented through all Europe were identified. One of first actions to be implemented could be to create a network of the various actors involved in these projects, so that the experiences can be shared and capitalised on. This knowledge would constitute the pedestal necessary for a development of the industrial ecology.

All this leads the ECOSIND approach to conclude that a real European strategy is required for the development of the industrial ecology, one which will allow us to envisage with credibility the progress made towards the durability of the fabric formed by the economic activities of Europe.

PART 4: FILES OF EXPERIENCE AND TECHNIQUES AND PROJECTS LINKED TO INDUSTRIAL ECOLOGY

PART 4: FILES OF EXPERIENCES AND TECHNIQUES

1 Experiences files linked to industrial ecology

➢ ***From experiences of ECOSIND projects***

File EXP 1 C3- CICLE PELL: Planning for moving an industrial area containing tanneries in Igualada - Catalonia

File EXP 2 C3- ESEMPLA: Use of EMAS for local environmental monitoring and planning - Tuscany

File EXP 3 C3 - GAT SPOT: Replacement of chemical oils with vegetable-based oils in the textile sector through sustainable regional planning - Tuscany

File EXP 4 C3 - MITCO2: Integrated supply of energy services to an important petrochemical industry - Catalonia

File EXP 5 C3 – MITCO2: Application of cogeneration in Tuscan production districts - Tuscany

File EXP 6 C3 – RESHUI: Integrated Management of Olive Oil-Mill residues and waste water - Peloponnesus

File EXP 7 C4 – BLU: Project about environmental improvement in industries and local public administrations associated with the naval sector - Tuscany

File EXP 8 C4 – PLANCOST: Experience of intermunicipal industrial and urban planning in La Selva - Catalonia

File EXP 9 C4 – PLASOS: Energy planning for a new industrial and residential zone in the municipality of Cerdanyola del Vallès - Catalonia

File EXP 10 C4 – PLASOS: Planning new ecologically equipped and sustainable production areas on the Versilia plain (Seravezza) - Tuscany

File EXP 11 C4 – PLASOS: Organisation of Urban Areas according to Environmental Standards – Peloponnesus.

File EXP 12 C4 – RECIPOLIS: Experience of planning for the requalification and the reorganisation of a degraded industrial zone in Viladecans – Catalonia.

PART 4: FILES OF EXPERIENCES AND TECHNIQUES

File EXP 12A C4 – GPP: Guide of Green Procurement in Industries of Arcadia Prefecture – Peloponnesus.

- ***From experiences of non-ECOSIND projects***

File EXP 13 EXT: Industrial ecology in Geneva – creation of eco-industrial synergies between the companies of the cantonal territory - Switzerland.

File EXP 14 EXT – ECOPAL: an alliance of companies engaged in the take up of Industrial Ecology – France.

File EXP 15 EXT – EIDC: Network for promoting eco-industrial development in North America – United States/Canada.

File EXP 16 EXT – CTTEI: Technology Transfer Centre on Industrial Ecology (CTTEI) – Creating a value chain for industrial by-products – Canada.

File EXP 17 EXT – ROI: Enhancing industrial ecology practices in emerging economies: the Resource Optimisation Initiative (ROI) – India.

File EXP 18 EXT – SYMBIOSIS: Assessing the symbiotic material flows on site: the Kalundborg Centre for Industrial Symbiosis – Denmark.

PART 4: FILES OF EXPERIENCES AND TECHNIQUES

EXPERIENCE FILE 1

Name of ECOSIND project: CICLE PELL **Code: EXP 1 C3**

Title of the experience: Planning for moving an industrial area containing tanneries in Igualada.
Location: Catalonia - Spain

Context

The tannery sector is a traditional one which is important in Catalonia. It is grouped around 2 main local production systems:

- The first involves small hides, includes 29 establishments and 1,918 workers, and is located in Osona and Vallès Oriental (2005 data)
- The second involves large hides (from cattle), and includes 46 establishments and 791 workers, located in Anoia (2005 data)

These tanneries are currently facing:

- Financial difficulties due to the economic situation.
- Environmental difficulties stemming from regulatory requirements, particularly concerning the treatment of dirty and wastewater.

It is therefore necessary to act to help this sector to restructure in order to make it more competitive and reduce its environmental impacts.

The aim of this experiment is to plan a new sustainable eco-industrial zone for several of these tanneries, including:

- Environmental co-operation between the industries,
- The creation of synergies with other activities.

The aim of this is to increase the competitiveness of tanneries and to reduce environmental pressures, in order to make the permanence of this sector in Catalonia less fragile.

Participants in the project

- **Leather Technology School of the College of Industrial Engineering of Igualada** (*L'escola d'Adoberia - Escola Universitària d'Enginyeria Tècnica Industrial d'Igualada* - EUETII), Spain,
- **"G. d'Annunzio" University** *(Università degli Studi "G. d'Annunzio")*, Pescara, Italy,
- **Pisa University** *(Università degli studi de Pisa),* Italy,
- **Bari University** *(Università degli studi di Bari)*, Italy.

PART 4: FILES OF EXPERIENCES AND TECHNIQUES

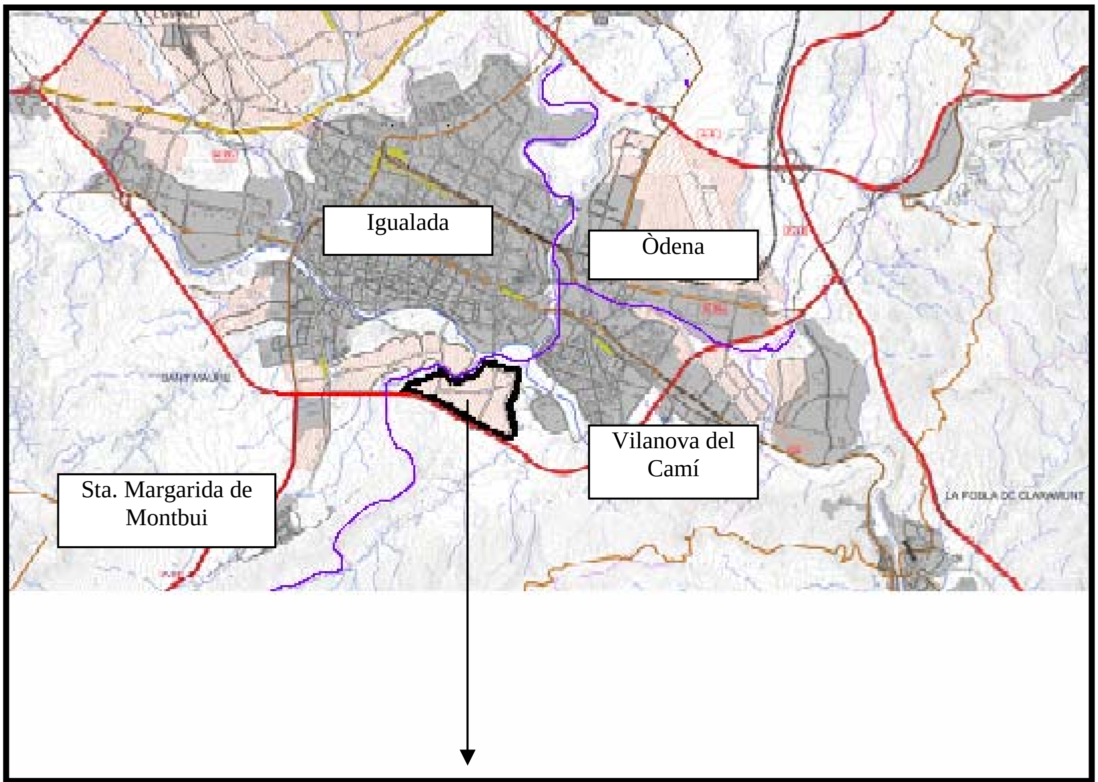
Location of the experience

The experiment is in Igualada in Catalonia, a town where a large number of tanneries (large hides) are concentrated, as 44 establishments are included in the census there.

General information on the studied area

Igualada's tanneries are currently located beside the river and near the town centre. Nevertheless, the area around this river must be reorganised to create a natural public space.
The aim of the project is to relocate these tanneries in another area, the choice of which has been greatly influenced by the position of a new wastewater treatment plant, which is essential for treating water used by tanneries.

The map shows the location of the new industrial area; the current businesses are located along the river separating Igualada from Santa Margarida de Montbui:



Area intended for the new activity site

Card 1: Location of the new industrial area

PART 4: FILES OF EXPERIENCES AND TECHNIQUES

Summary of the experience

In planning the new eco-industrial district and seeking synergies between the tanneries and with outside activities, the methodology used was the following:

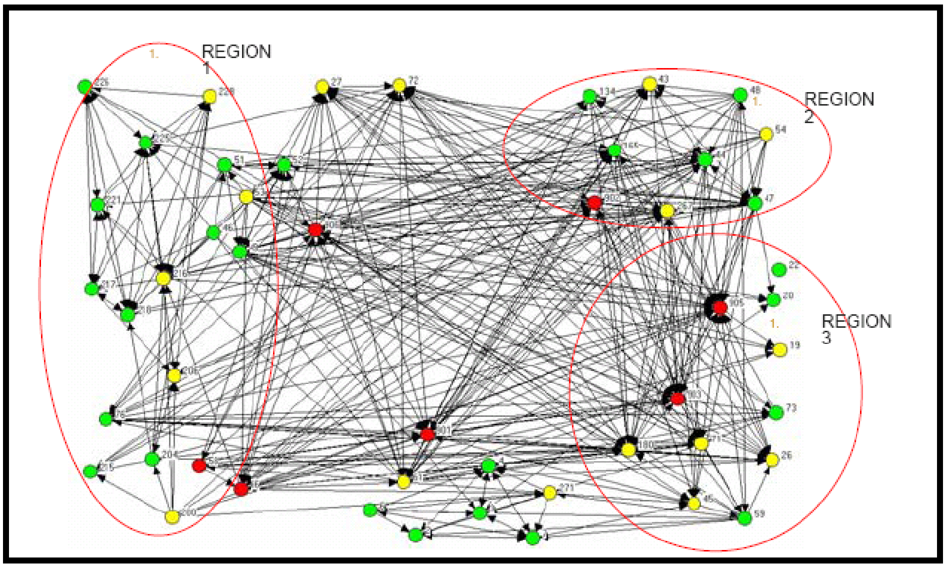
- **Part 1: Analysis of the data concerning tannery activities**
  - Environmental data (impact analysis)
  - Data concerning co-operation and information exchange

- **Part 2: Design of the eco-industrial park for the Igualada tanneries**
  - Model of the flows of different industries with possible synergies with tanneries, environmental assessment of the different proposed scenarios
  - Planning of the eco-industrial zone in accordance with the municipal plans, legislation and concepts of sustainable development

➢ *Part 1*

In part 1, **the environmental data analysis** was carried out using LCA (Life Cycle Analysis) with Sima Pro software. The functional unit chosen was "obtaining 100kg of finished cattle leather for women's shoes (with a variable thickness of between 1 and 1.3mm)".

To analyse the degrees of co-operation and exchange of information, questionnaires were drawn up and sent to the chosen industries. The method used to model the network of relationships is SNA (Social Network Analysis).
The graphic below represents a model network:



Graph 1: General representation of a network

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➢ *Part 2*

This part consisted of the assessment of different models of industrial zones to find out what kind of industry to establish with the tanneries. This was carried out regardless of the location of the new industrial zone, and taking into account the environment impacts of the synergies envisaged.
Research was carried out on the flows of material in each type of industry: slaughterhouses, warehouses, tanneries, bio-gas and composting installations and solid waste treatment installations, as well as on alternatives such as installations of composting, biogas generation, cogeneration, etc.
The data obtained was fed into GABI 4 software (a tool calculating life cycle balances), which permits an environmental assessment of the current situation, together with the new scenario envisaged.

Finally, concerning the planning and design of the eco-industrial zone, a series of requirements has been established. Below are a number of examples:

- ***During the planning phase***
  - Ensure the suggested zone is not a protected area, liable to flooding or a water protection area.
  - Ensure the zone is near public transport networks.
  - Ensure infrastructures in accordance with the zone's needs.
  - Integrate the buildings into the landscape, etc.

- ***While the project is being set up***
  - Study the operation of the different businesses attentively.
  - Listen to the opinion of all those taking part in the production process.
  - Orientate the buildings in accordance with the Mediterranean climate.
  - Plan the demolition of the buildings and the reuse of the material making them up, etc.

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Results and impacts of the experience

The following diagram is a representation of the future industrial estate, including the different industries chosen with their synergies:

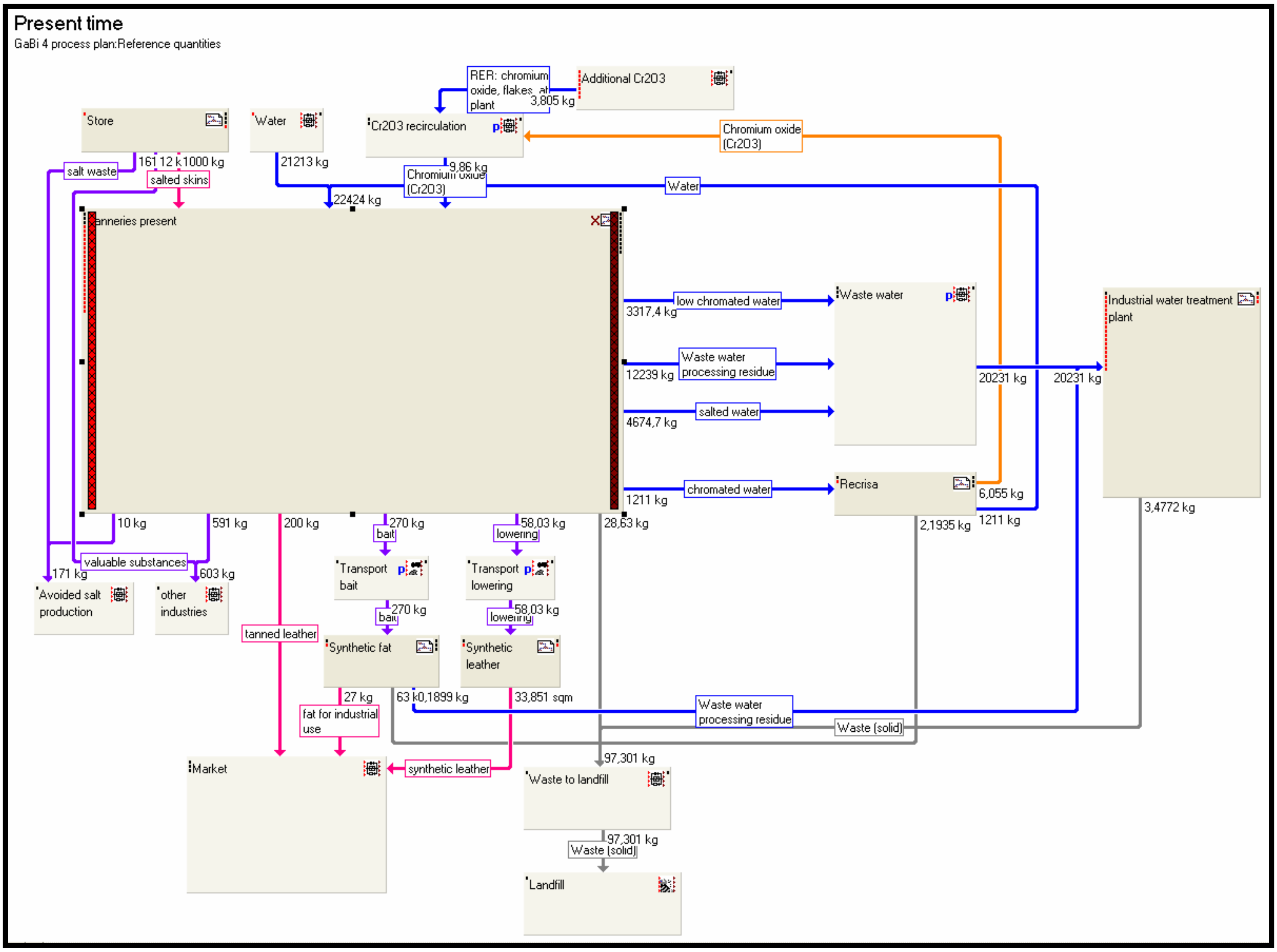

Figure 1: Representation of activities and synergies of the future industrial zone

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➢ *From an environmental point of view*

The relocation of the tanneries to the same area of activity and the integration of industrial ecology factors will make will make it possible to reduce the consumption of energy resources and greenhouse gas emissions.
In addition, manufacturing processes will be more efficient, thanks to:

- New facilities
- Carrying out the manufacturing processes on a single floor instead of two, as at present
- Modernisation of machines

Due to this, sound and visual impacts and risks induced by heavy road traffic are reduced.

➢ *From an economic point of view*

According to the hypotheses considered in the study, it is economically viable to move the tanneries. In fact, for each m^2 of the current site, it will be possible for each business to construct $2m^2$ on the new industrial estate
Moreover, it will be possible to create strategic alliances, making the relocation even more viable. A division of the manufacturing process is also envisaged.

➢ *From a social point of view*

In order to obtain different opinions on the setting up of the zone, the different local councils involved in the setting up of the zone have been consulted, as well as an ecology group and the trade unions.
It has been found that there was little communication between the neighbouring councils and that they had diverse and ambiguous points of view. Work has been begun to reach a common agreement.
The ecologists did not declare themselves against the project. They asked that the flora and fauna of the new area should be respected.
The new estate is socially viable if agreement is achieved between the 3 councils involved.

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EXEPRI EXPERIENCE FILE 2

Name of ECOSIND project: ESEMPLA **Code: EXP 2 C3**

Title of the experience: Use of EMAS for local environmental monitoring and planning
Location: Tuscany - Italy

Context

The project is aimed at the experimental application of an approach based on co-ordination and co-operation in sustainable planning and environmental management in order to ensure monitoring and prevention of pollution in industrial areas with high concentrations of micro and small businesses. The aim is to define and implement industrial activity and environmental performance improvement development programmes inspired by the industrial ecology approach. The experiment with the co-operative planning and management approach is based on the regional application of EMAS Regulations, as established by the EC Decision of 19 September 2001 accompanying the Regulations 761/2001.

In this sense, the innovations provided by the new Regulation (EC) No 761/2001 and by the following Decision of the Commission of September 2001 make it possible for EMAS to be a key method for putting into practice planning policies aimed at improving the environmental performance of organisations operating within the region in question.

Within this project, the industrial areas where the approach has been tried have particular features establish them as "industrial districts", or a regional setting where many small businesses operating in the same sector or line of production are concentrated. This industrial structure is very common in the Mediterranean area and, particularly, in the Italian and Spanish regions involved in the ECOSIND sphere of operation. The project's activities have involved two pilot districts in Tuscany (Prato textile district and Santa Croce sull'Arno tanning district).

The idea for the project originated from the statement that perfect conditions for ensuring that the EMAS approach can be implemented successfully at regional level exist in many industrial districts. The Regulations and accompanying Decision effectively promote forms of co-operation and reciprocal enrichment, making it possible to overcome restrictions and shortages of resources that an individual business (above all a small or medium-sized one) might have to face in environmental management.

Such conditions concern the homogeneity factors that traditionally distinguish the districts. From the point of view of impacts on the environment, the businesses in a district in fact show many common features:

- Very often they have to face similar environmental problems.

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- Their production specialisation and generally very small size makes it possible to think of the district as a homogeneous industrial area.
- Very often they share infrastructures for reducing pollutants.
- Given the difficulty of attributing environmental effects to a particular production unit, they are considered by those who have to deal with them as being similar to a single entity.

The industrial areas of the regions involved show there is a possibility of sharing resources and experiences to achieve unitary solutions to the same environmental problems and to reconcile environmental and financial requirements, a possibility of activating synergies between private and public service companies operating in the area involved, and a possibility of establishing an active co-operation agreement for production activities with local authorities, those responsible for authorisations and environmental monitoring authorities.

Over the last few years, the conditions set out below have made the application of environmental certification schemes, particularly EMAS, practical and desirable at a regional level. The willingness to share skills, human resources and availability, and to bring them together in the form of consortiums to achieve the necessary infrastructures, along with openness to collaboration with institutions, the consolidated support of sectoral associations and the close links with the local interlocutors are, in most cases, determining factors for businesses with fewer resources to make this a strong point and contribute to the sustainable planning of local development. This project therefore began with the aim of developing a transferable methodological approach acting in LPS (local production systems) based on co-operation between the different agents in the district.

On the basis of emerging indications of the situation in many industrial districts, ensuring that co-operative mechanisms can be trusted has ultimately been fundamental in achieving a regional approach to sustainable planning. A limiting factor has been that synergies in environmental planning and management of the district could only be maintained by making the Emas approach coherent with the principles of industrial ecology, or by basing planning on the willingness of the local private and public agents to co-operate. In this sense, carrying out this project has required the definition of a close partnership between the various local agents (institutions, sectoral associations, universities, etc..) which have shared their knowledge through the project and developed their common resources for solving environmental problems.

Participants in the project

- **University College of Sant'Anna di Pisa** *(Scuola Superiore di Studi Universitari e di Perfezionamento Sant'Anna di Pisa)* - Project head, Italy,
- **Province of Pisa** (Provincia di Pisa), Italy
- **Prato Town Council** *(Comune di Prato*), Italy
- **Province of Prato** *(Provincia di Prato),* Italy
- **Technical University of Catalonia** (*Universitat Politécnica de Cataluña),* Spain

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Location of the experience

The project's activities concerned two pilot districts in Tuscany, where the proposed approach has been developed and the related operational means set up; the validity and effectiveness of the approach have also been tested in the laboratory districts in Catalonia. The pilot districts in Tuscany are the tanning district of Santa Croce sull'Arno and the textile district of Prato. The former is located between the provinces of Pisa and Florence and includes the towns of Castelfranco di Sotto, San Miniato and Santa Croce sull'Arno (in the province of Pisa), and Fucecchio (in the province of Florence).
The latter is located between the provinces of Prato and Pistoia and includes the towns of Prato, Cantagallo, Carmignano, Montemurlo, Poggio a Caiano, Vaiano and Vernio (in the province of Prato), and Agliana, Montale and Quarrata (in the province of Pistoia).
The laboratory districts represent the tanning, textile and cork industries and have been identified through the in-depth activities of the Technical University of Catalonia in Barcelona.

General information on the studied area

The tanning district of Santa Croce sull'Arno has 70,000 inhabitants in an area of 233km^2, and represents one of the most important tanning areas in Italy and anywhere in the world. The first tanning activities began during the 19th century. The district includes 35% of national cork production and 98% of national production of sole leather.
The production model is characterised by a very fragmented structure of small and medium-sized businesses integrated with specific subcontracted activities. In the district there are around 900 businesses, with a total 10,000 employees and an average size of 12 workers.
Over the years, businesses associated either directly or indirectly with tanning have become established in the district (e.g. chemical products, equipment for tanning, services, clothing manufacture, leather goods and shoes) and these have therefore determined the growth of employment, becoming relatively important at national level.
The local economy, in particular, is based on the sector and on the activities either directly or indirectly associated with it.
The Prato textile district, which has 288,525 inhabitants, contains around 60% of the textile businesses in the region of Tuscany and about 8% of the total for Italy. Prato represents the most important centre, covering 340 km^2, with a population of 165,000 habitants.
The Prato district therefore represents the largest textile and clothing industry agglomeration in Italy, with around 9,000 businesses and a total of 50,000 employees (corresponding to 30% of the active population and 60% of those employed in the industrial sector). In addition to being the most important grouping in central Italy, it represents one of the largest concentrations of textile activity in Europe and in the world.
The Prato enterprises specialise in producing spun yarn for knitwear, to which are added fabrics for men's and women's clothing in carded and combed wool, cotton, linen, silk and artificial and synthetic fibres.

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Summary of the experience

The project concerns the experimental application of an approach based on co-ordination and co-operation in sustainable planning and environmental management, in order to ensure the monitoring and prevention of pollution in industrial areas or where there is a high concentration of micro- and small enterprises. The purpose of this is to define and carry out development programmes for industrial activities and to improve environmental performance, inspired by the industrial ecology approach.
The methodology has supported a co-operative approach, completed with sustainable planning at local level. The particular features of the district will be exploited to implement and develop the provisions of the European Commission Decision of 07/09/2001 in an innovative way. The sub-objectives of the project are therefore:

1. To use the situation in the district to determine, measure and monitor the most important environmental aspects in the region (also through the use of a set of environmental indicators);
2. To use this knowledge base to establish and consolidate an effective approach to sustainable local planning.

The project began by drawing up an initial analysis of the region, essential for a thorough application of the Emas regulations to an industrial district.
The analysis method follows the indications of the Regulations, taking the DPSIR (Driving force-Pressure-State-Impact-Response) model as a reference. The structure of the environmental analysis has been developed on two levels:

- The first with a view to determining the district's environmental problems,
- The second in order to identify and assess the environmental aspects of the reference region.

The analysis has therefore traced environmental problems back to the activities that contribute to producing them through the examination of the means of interaction between driving forces and pressures.
The analysis has been structured in order to define improvement objectives for offering benchmarks to encourage the preparation of initial analyses for single organisations.
In addition, in the project area, a measurement and monitoring system for the indicators has been created, based on computer support.
The methodology with which the set of key indicators has been defined for the district takes as a reference the most widespread international approaches (i.e.:ISO14031, DPSIR). During the process of drawing up this analysis, Recommendation EC 10/07/03 on the choice and use of indicators for the application of Emas has also been taken into account, with reference to the possibility of developing environmental condition indicators (ECI) and making them "common standards" to ensure that comparison is possible. Indicators covering the following have been included in the set:

- The state of the environment in the district.
- Environmental driving forces and pressures.
- Responses raised by the various agents in the district.

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- Environmental aspects directly correlating to the characterising sector and its local pattern.

The final outputs from the project are:

1. A methodology for making an initial environmental analysis within the district, according to the requirements established in Emas Regulations.
2. Initial environmental analysis document to be made available as an essential cognitive basis for sustainable planning and co-operative environmental management.
3. Information on environmental aspects collectively considered important and the publicising of assessment criteria and methodologies to the organisations in the district.
4. Set of key environmental indicators for the district and, in particular, for the small and medium-sized businesses in the zone involved.

Results and impacts of the experience

✓ ***From an environmental point of view***

1. The achievement of an initial environmental analysis of the pilot districts in the ways established in Emas Regulations and with a view to identifying the most important environmental aspects of the district where it may be possible to intervene through actions and programmes. The initial environmental analysis was carried out thanks to the identification, measurement and assessment of environmental aspects, either from a regional viewpoint or with reference to the characterising sector. The collection of data and environmental information and the assessment of environmental aspects is an information asset available to individual organisations (above all micro and small businesses) in order to guide their initiatives. Analysis in the districts is an essential basis for proper planning of the development of industrial activities, as it is the cognitive basis necessary to provide information for the activities of policy makers.

2. Description of a system of indicators and collective environmental performance measurements in the pilot districts, through the creation of monitoring systems and the collection of data at a regional level. The monitoring and data collection system supports the environmental management system established by Emas, used experimentally at regional level, and makes it possible to monitor the environmental performance of the whole district. At the same time, it makes it possible to intervene with co-ordinated actions in order to provide sustainable planning of the development of future industrial activities, above all if environmental performance shows evidence of (current or prospective) criticalities.

3. The analysis has made it possible to link the region's environmental criticalities with the activities present in the region, with particular reference to the characterising sector and its pattern, in analysing the means of interaction between the driving forces (the activities carried on in the region) and the pressures they exercise on the existing environmental situation (state).

The environmental advantages of the ESEMPLA project from an ecological point of view, beyond the achievement of the project outputs, will also be linked

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to the future spread of environmental certification in the industrial districts of Tuscany.
Consequently:

- the businesses operating in the two sectors will introduce forms of environmental management with a view to taking better care of the environment and economising on natural resources.
- The local authorities, with useful instruments for future programming, will be able to define their governmental choices in accordance with environmental concern.

In addition, the result of the project concerning the identification in each district of the most critical environmental aspects has made it possible to carry out two feasibility studies (one for each district) with a view to reducing the impacts of the two production sectors on the region.

✓ ***From an economic point of view***

From an economic point of view the advantages of the project are, above all, connected with the businesses in the sector.
The businesses interested in environmental certifications will have an advantage, as they can make use of an environmental analysis document for the district (regional and sectoral) and indicators calculated within the same activity as their own environmental analysis.
In addition, the choice to activate a district-wide approach to "environmental competitiveness" for both districts could represent a way of relaunching the sector, producing a formula for economic growth after a period of depression and thereby making it possible to relaunch the commercial image of the district as well, beyond the encouragement of the rationalisation of processes leading to more efficient production.

✓ ***From a social point of view***

At a social level, the advantages of the project are associated with the awareness-raising activities carried out in the two districts to publicise issues of environmental sustainability.
Training seminars and initiatives undertaken by employers' association were organised in both districts, and many businesses interested in environmental certification for their management systems have been involved.
This has made it possible to contribute to the spread of environmental management tools in the region; in particular, the activities of publicising the results of the project have been considered by the two sectors characterising the districts, which have welcomed and made use of them, as the participation and interest of businesses has shown.

Contact(s)

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EXPERIENCE FILE 3

Name of the ECOSIND project: GAT SPOT **Code: EXP 3 C3**

Title of the experience: Replacement of chemical oils with vegetable-based oils in the textile sector through sustainable regional planning.
Location: Tuscany - Italy

Context

In Tuscany, the textile industry is one of the most important production sectors. One of the most important aspects of this activity in terms of impacts on environmental matrices, particularly on water, is due to the use of auxiliary and chemical products. In fact, over the many production phases in the textile cycle, synthetic lubricants (mixtures of ethoxylated nonylphenol surface-active agents) and chemical substances (alkylbenzenes) are used. These are considerable sources of pollution, due to their slow biodegradability and to bioaccumulation phenomena in the receiving body of water.
The purpose of such products (in particular at the carding and spinning phase) is to reduce the risk of breakage of the fibres, limiting losses due to dust separation and reducing the formation of electrostatic charges, facilitating subsequent treatments. The quantity of these products that is generally used varies between around 6 and 8%, depending on the material for carding. The scale of the problem in the area concerned can therefore easily be deduced.
The application of Directive 2003/53/EC, limiting the sale and use of certain substances, including ethoxylated nonylphenols, and which has been in force since 01/01/05, has led to the requirement to use new compounds allowing sustainable production management and use.
There is an alternative to synthetic lubricants, namely vegetable-based lubricants, largely consisting of sunflower oil, water, and low-environmental-impact emulsifiers (ethoxyl alcohols). These oils are highly biodegradable and do not require the use of nonylphenols. In addition, the development of non-food crops, such as specific sunflower growing, would make it possible to intervene in the agricultural and regional planning sector in order to recover abandoned areas and ensure proper rotation, thus ensuring the profitability of agricultural resources. The proposed crops, the production of which has fallen in recent years, are highly suitable for sloping land and can be grown on marginal land with few alternative crops. They also have an excellent visual impact on the landscape. In addition, in order to develop such crops, it is possible to use quality compost produced directly in the Prato area or in Tuscany as a soil conditioner. This also makes it possible to follow a sustainable path for the other problems linked to environmental management, such as water treatment and the reuse of waste.

Participants in the project

- ***Project leader(s):***

- **Department of Energy "Sergio Stecco"** – University of Florence, Italy

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- ***Structures involved in the experience (partners):***

- **Department of Agronomy and Agro-ecosystem Management** – University of Pisa, Italy
- **Technical University of Catalonia**, Spain,
- **Laconia Development Company,** Italy

- ***Organisations that have co-operated with the project:***

- **Experimental institute for industrial cultures** (CRA – ISCI), Italy
- **Buzzi technical institute**, Prato, Italy
- **Draplane spa**, Italy
- **Cerealtoscana**, Italy
- **Gea,** Italy

- ***Organisations that have shown an interest in the project:***

- **Prato Town Council,** Italy
- **Province of Prato,** Italy
- **Union of Industrialists,** Italy
- **ASM Prato,** Italy

Location of the experience

- ***Prato textile district for the replacement of synthetic oils with vegetable-based oils:***

- application at the company Draplane spa; (Prato)

- ***Agricultural area of Tuscany for the assessment of the fertilising capacity of compost for sunflower crops:***

- Application on the Rottaia farm, San Piero a Grado – Pisa (University of Pisa);
- Application on the Fattoria di Oliveto farm, town of Montespertoli, Florence (Cerealtoscana).

General information on the studied area

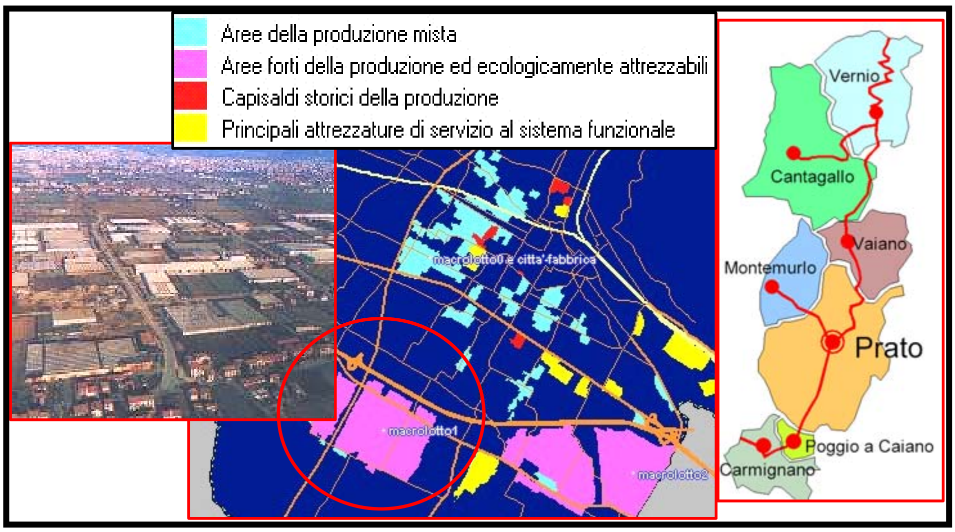

Figure 1: The Prato industrial district

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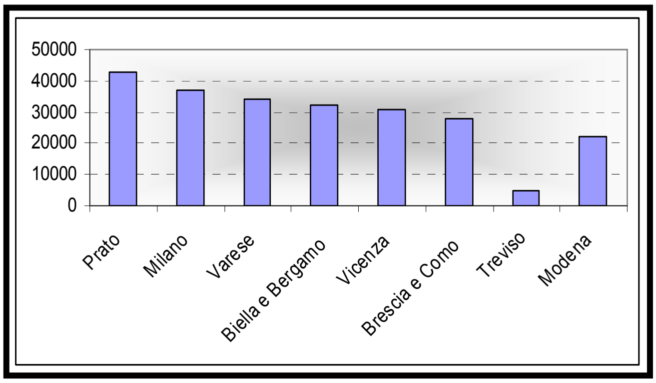
The Prato district extends over an area including the whole province of Prato and certain neighbouring towns (Agliana, Montale and Quarrata in the province of Pistoia; Calenzano, Campi Bisenzio and Barberino del Mugello in the province of Florence). The Prato industrial district covers an area of 700km^2 (including the towns in the province of Florence), with a population of around 300,000. With its 180,000 inhabitants, Prato is the most important centre. The urban development of the whole Prato area is strongly conditioned by industry, with clear problems linked to environmental impact and exploitation of water resources and land. In order to establish a highly industrial area, a "Macrolotto" (big industrial park of around 1,500,000m^2) was designed for the western part of the Prato area, where approximately 350 other businesses are based.

A second industrial estate, called "Macrolotto East", has been added to the first "Macrolotto", located close to the original one. Financial incentive measures have encouraged business people to move industries from residential areas to new areas which are far from inhabited centres, near motorway exits or easily accessible for heavy loads.
Since the beginning of the last century, the textile industry has been the most important activity in the Prato region. It provides work for a total of 43,000 people producing yarn, fabrics, knitwear and other textile items. The local industrial system has equipped areas and other infrastructures, textile businesses have a centralised system for the treatment and recycling of wastewater. Professional training is provided by certain establishments, among which we would highlight the "T. Buzzi" Textile Institute and the engineering faculty.
Prato is the most important textile and clothing industry centre in Italy, with around 7,000 businesses and 43,000 workers.



Graph 1: The Italian textile districts: workers.
Prato Industrialists' Union

Workers in the different sectors	Tuscany (%)	Italy (%)
Textile industries	*84.1*	*16.3*
Knitwear	*42.3*	*3.9*
Clothing, making up and accessories	*31.6*	*2.8*
Furs and leather goods	*8.3*	*2.3*
Total textile and clothing	***61***	***7.9***

Table 1: The importance of the district in the textile and clothing sector compared with the regional total (% of workers). Activity in the Prato industrial district based on Istat data

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One of the most original trends in the district is the organisation of a system based on subdivision into thousands of independent companies, each specialising in a specific activity (spinning, twisting, warping, weaving, dyeing, finishing). "Outsourcing" is the most common form of connection between businesses. The number of full cycle factories, where all stages of the manufacturing process are carried out, is very limited. Production is co-ordinated by wool professionals who take care of the sample study phase, sales and different aspects of logistics and organisation The 43,000 employees in the textile and clothing sector are divided between about 7,000 companies, with an average of around 6-7 workers per factory.

	Number of factories	%	*Workers*	*%*
Micro (1-9 workers.)	*7,199*	*84.9*	*19,848*	*41.4*
Small (10-49)	*1,194*	*14.1*	*21,286*	*44.4*
Medium and large (> 50 workers)	*85*	*1*	*6,780*	*14.2*
Total	***8,478***	***100***	***50,270***	***100***

Table 2: Sizes of the businesses in the textile and clothing sector in the district. Activity in the Prato industrial district based on Istat data

In practice, as indicated in the above table, and according to the definitions adopted by the European Union, more than 8 out of 10 businesses are micro businesses. The remaining businesses are almost all "small": there are 85 "medium and large" businesses (> 50 employees) and their share of the total does not exceed 1%.
The textile factories in the Prato region cover all stages of fabric manufacture, from spinning to finishing. Nowadays, the Prato factories specialise in producing:

- Yarn for knitwear (carded and combed wool, mixtures of different fibres).
- Fabrics for making up clothes in carded and combed wool, cotton, linen, silk and synthetic fibres.
- Various types of textile items (single yarn fabrics, coated fabrics, floconnés, non-woven fabrics, etc.) for the clothing, footwear and furniture industries and for technical, sanitary and geotextile uses.
- Equipment for the textile industry and, in particular, for wool manufacture (carding and spinning, twisting, finishing), for non-woven fabrics and for weaving (warping machines).

Type of products	Quantity
Yarns for knitwear	70,000t/year
Fabrics for making up clothes	340 million metres
Fabrics for furniture and upholstery	45 million metres
Other types of fabrics	40 million metres
Knitwear	1,100 billion.

Table 3: Annual production in the district

The typical production of the Prato district has, for a long time, been carded fabrics (covers, fabrics for clothing and yarns for knitwear), often made with

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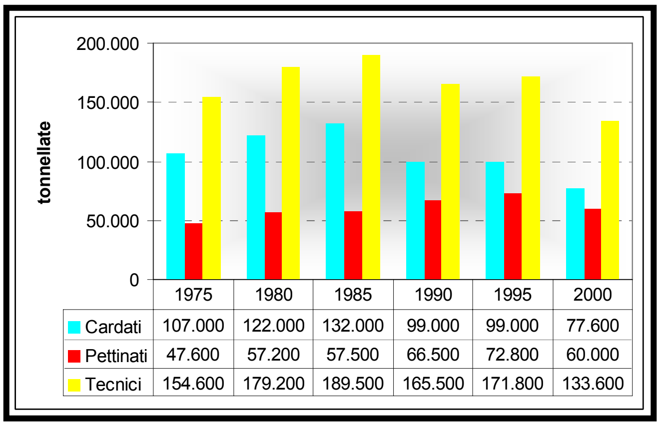
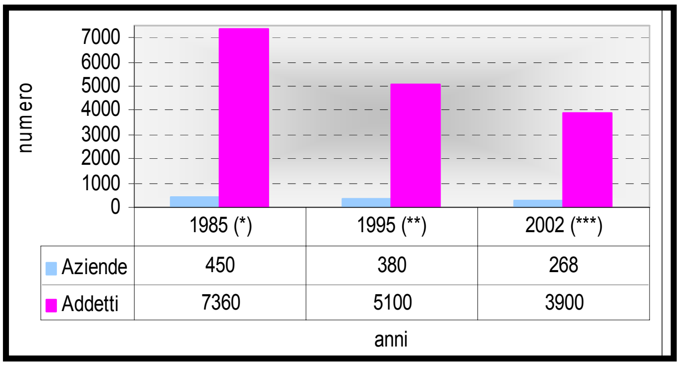
recycled fibres from chiffons and waste wool or from off-cuts of new fabric. Even now, despite the diversification of production, the production of carded fabrics forms the most important and original specialisation in the district. However, over the last few years, the production of carded fabrics in Italy has fallen markedly, above all due to of various market demands. Although total volumes have fallen, Prato businesses are still leaders in international markets for yarns and woollen fabrics, as can be seen in the graph on the left.



	1975	1980	1985	1990	1995	2000
Cardati	107.000	122.000	132.000	99.000	99.000	77.600
Pettinati	47.600	57.200	57.500	66.500	72.800	60.000
Tecnici	154.600	179.200	189.500	165.500	171.800	133.600

Graph 2: Italian production of woollen fabrics.

Yarns are the sector where synthetic oils are most used. In this sector, the crisis has had very significant effects: from 1985 to 2002, the number of factories has moved from 450 to 268, with a fall of around 40%, while the number of employees has dropped from 5,100 to 3,900 (-47%).



	1985 (*)	1995 (**)	2002 (***)
Aziende	450	380	268
Addetti	7360	5100	3900

Graph 3: Carded spinning in Prato

Summary of the experience

In accordance with the objectives of ECOSIND, the project is intended to promote production activities and an innovative management system for a very densely industrial district within the programming of strategies for sustainable development. The aim of the proposed model is to promote the concept of eco-efficiency in the district through the development of the agro-industrial cycle (non-food crops) and the use of a product that can meet production needs and, at the same time, gradually reduce the impact on environmental matrices. In addition, the project has made it possible to free up some means of developing the proposed cycle, and it has shown many correlations with other sectors and environmental problems (reuse of waste water and compost for sunflower production). By developing the proposals, it has therefore been possible to:

- Experiment with and apply low-environmental-impact vegetable oils in the textile sector in order to increase their use and to propose an alternative to synthetic oils.
- Consolidate co-operation networks between public and private organisations (RPMI) belonging to different sectors (agricultural and industrial) in order to meet the needs for technical innovation in the agri-industrial sector by

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seeking synergies between the sectors, monitoring and transferring technologies that have been studied and implemented.

- Increase the capacity of businesses in the sector to be able to use the results of research in order to create possible subsequent uses of products of vegetable origin in Tuscan industry, respecting the environment and the health of workers and consumers.

The project was developed in several stages, and it offered experiments involving both sunflower crops and the use of vegetable-based oils on an industrial scale.

➢ *Use of compost and assessment of its fertilising capacity on sunflower crops*

Concerning the agricultural experiment, an assessment of the fertilising capacity of quality compost on sunflower growing was proposed. The use of quality compost could actually make it possible to reduce production costs and energy inputs for sunflower growing, a basic element of the whole production pattern under study. The environmental emphasis of the project inspired the idea of focusing studies on nitrogen, a fundamental element for crop yield which, at the same time, has a strong environmental impact. Two parallel studies have been carried out in different environments:

- The Rottaia site (San Piero a Grado, Pisa), near the University of Pisa experimental station, on a flat site representing the alluvial plains of western Tuscany;
- The Oliveto site, on the "Fattoria di Oliveto" experimental farm, (town of Montespertoli), representing the hilly areas of inland Tuscany.

Based on a plot test, the two compared the effects of compost and other mineral and organic fertilisers on sunflowers. Two types of compost were used: quality compost produced by the Prato provincial composting station (compost A); mixed compost with biological certification produced in the province of Sienna (compost B).

	Compost A	Compost B
Moisture (%)	17.5	18.1
PH (%)	7.1	7.3
Organic carbon (%)	27.8	27.3
Organic nitrogen (%)	1.61	1.64
C/N	16.6	15.3
Salinity (%)	33	31

Table 4: Characteristics of the composts used at the experimental phase

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With traditional mineral fertilisers, which are so common on the market, diammonium phosphate and urea are released. By reducing the dose of nitrogen, the objective is to study the true value of compounds as fertilisers and any effects on crop yields. Consequently, as well as the control fertiliser without nitrogen, to which only phosphoric fertiliser was added (triple superphosphate), three substances containing urea were added in increasing doses, obtaining contributions of 50, 100 and 150kg N ha^{-1}.

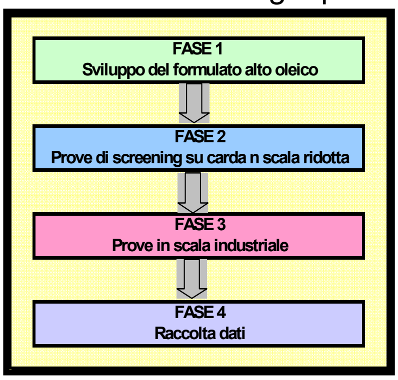
Treatments	N (kg N·ha^{-1})	P_2O_5 (kg N·ha $^{-1}$)
CONTROL	0	46
UREA +DIAMMONIUM PHOSPHATE	50	46
UREA +DIAMMONIUM PHOSPHATE	100	46
UREA +DIAMMONIUM PHOSPHATE	150	46
METHYLENE-UREA (*)	100	46
PROTEIN FLOUR	150	75
COMPOST A	150	50
COMPOST B	150	50

Table 5: Treatments and levels of fertiliser used in the two studies

Overall, the results of the experiments support the hypothesis of a local crop cycle project to produce and transform sunflowers to make oil that can be used in the Prato industrial region. The possibility of reducing the amount of nitrogen fertiliser in sunflower growing and possibly replacing conventional mineral fertilisers with innovative slow-release fertilisers (organic, condensed urea) or with additives (compost), strengthens the sustainable management of the economy and the environment in the area. The use of artificial nitrogen fertilisers actually represents one of the greatest costs (in terms of money and energy) in the sunflower production process. Alongside this, the use of slow-release, anti-corrosive nitrogen fertilisers and/or soil conditioners would offer other environmental benefits at local level (preservation of land fertility) and global level (reduction in the quantity of energy used, more complete cycle of the nutrient elements) which, taken together, would represent a positive opening up of the cycle. The public administration should give a certain importance to this in assessing any cycle projects.

➢ *Replacement of synthetic oils by vegetable-based oils*

The industrial stage provided for the development and use of a high-grade sunflower-based compound of oleic acid to be used at the carding and spinning stage for the production of fabrics.



Graph 4: Structure of the industrial stage

A compound based on high-grade oil refined from sunflowers in oleic acid with the addition of surface-active agents (eco-compatible and without ethoxyl nonylphenols) applied on an industrial scale by Draplana S.p.A was studied and developed (Houghton Italia S.p.A).

To choose the ideal dose of oil, carding tests were carried out with small-scale carding. This machinery is generally used for preparing mixed and coloured wools to be presented to those placing orders. The lubrication tests were

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carried out on small samples of mixed wool (100/200g of different composition and different levels of lubrication - 6 tests). The samples were assessed by touch by a group of experts (4-5 people).

All tests on an industrial scale involved 20 lots (yarns and textiles) of different composition (47,646 kg of products that made by 71% using 4% oil with respect to the weight of the wool to be carded, and by 29% using 5% oil).
Samples of all the material produced with vegetable-based oil were submitted for analysis and were subjected to of studies of eco-toxicology (CRA -ISCI), strength, etc. (Buzzi).
As with the previous phases, the collection of data for carrying out the life cycle assessment (LCA) was launched thanks to the availability of special forms making it possible to determine entry to and exit from each manufacturing phase, including any consumption, as well as the production of off-cuts and waste.

Results and impacts of the experience

- ***From the point of view of the production model activation:***

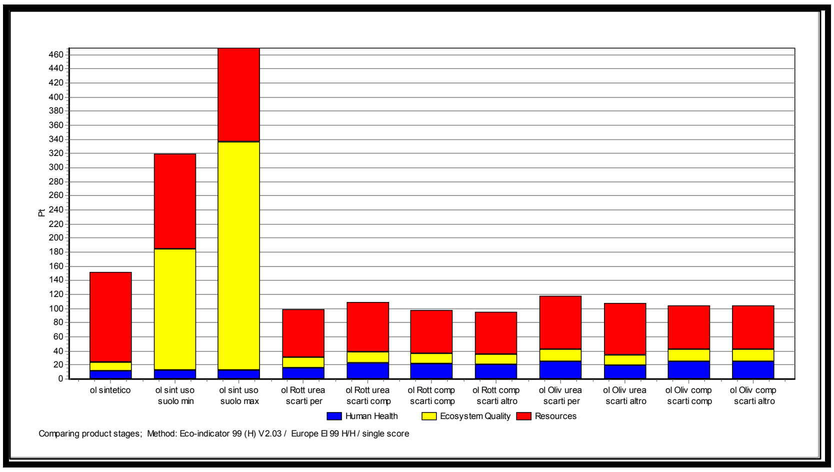
Agronomic tests have shown the improved cultivation techniques for sunflower cultures, and the results for the use for this phase of compost produced in the district were good. This solution makes it possible to implement integrated territorial management strategies in a sustainable way.

Yields and fabrics produced in the industrial experimentation phase and tests carried out on these products show that the use of vegetable oil gives results similar to those attained with the use of traditional oils. During the industrial tests the following points were noted in the manufacturing process:

- Absence of anomalies in the operation of the machines.
- No difference from mineral oil in terms of the quality of material produced.
- No great slowing down.

Therefore there are no restrictions to the use of the proposed product.

- ***From the environmental point of view:***



Graph 5: LCA Analysis

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LCA analysis shows that the impact of 1 ton of yield produced with traditional oil (synthetic) is greater than the impact of 1 ton of yield produced with vegetable oil. This result is due to the composition of the vegetal oil, and to the small quantity that is used in the process.

Oil renewal index assessment shows that the carbon content coming from renewable sources in vegetable oils is greater (>74%) than for synthetic oils (< 30%);

From an eco-toxicological point of view, the comparison between vegetable and synthetic oil shows that there are no significant differences: both products are toxic in relation to the crustacean *Daphnia magna* (LC_{50} in 24 hours is approximately 6 mg/l or <10 mg/l for all products). Oils are not toxic for *Folsomia candida* insects present in the soil (LC_{50} in 24 hours >150 mg/L for all products). The relevant aquatic toxicity does not seem to be connected with the oily bases used, and it is probably due to other compounds present in the product.

Other studies concerning the oil disposal phase in the textile production show a possible minor impact linked to the use of vegetal oils with respect to the effects of wastewaters on receivers. This effect is linked to the biodegradability of the main compounds. Therefore if the product's acute toxicity is also comparable, it could be supposed that the same test could have different results considering enough time for the products aerobic biodegrading.

Indicators:

- Replacement of chemical substances with vegetable substances
- Use of compost in the cycle as a soil conditioner
- Crops for industrial purposes
- Green labelling
- Regional planning from point of view of sustainable development
- Reuse of used water for non-food production
- Reduction in saline penetration phenomena in agricultural areas on the Tyrrhenian coast.

➢ ***From an economic point of view***

In spite of the possibility of using vegetable oil in smaller quantities for the production of the same product, vegetable oil is between 2-40%more expensive. Therefore, the economic factor is extremely relevant for the start up of this production system. It is clear that at local and district levels it may be necessary to politically support this prospective with economic measures that can make it sustainable.
In this way they have been studied possible solutions for making the cost of vegetal oil competitive. The project has shown synergies between the agricultural phase and the reuse of compost in the sunflower cultivation. Hence the proposed way to offset the cost of oils is to study possible types of territorial indemnities on the waste disposal system.

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Vegetable oil price	1.122	1.656	€/ton
Synthetic oil price	1.000	1.100	€/ton
Oil price	122	556	€/ton
Compost for 1 ton of vegetable oil	2,68	2,68	Ton
Economic gap abatement - Compost placement cost	45,47	207,24	€/ton

Total production urban waste (*)	ton/year	250.000 (*)	250.000(*)
Compost production estimation	ton/year	16.000 (*)	16.000 (*)
Oil used in 1 year (**)	ton/year	4.000 (**)	4.000 (**)
Compost used for vegetable oil	ton/year	10731,76	10731,76
Costs that have to be allocated on waste disposal system	€/year	488.000	2.224.000
Growth of the industrial cost for the management of waste disposal system	€/ton	1,952	8,896

Table 6: Possible types of territorial indemnity on the waste disposal system
(*) year 2010: Piano di Gestione Rifiuti della provincia di Prato
(**) mean value estimated: 4000 ton/a

As summarised in the above tables, at district level the difference between the market price of the two products is €854,000 - €3,892,000. This amount spreadover the compost cost or on the waste rate could lead to indemnities varying between €1.9 and €8.9 /t. Obviously, whereas in the first case costs could be sustainable in the second one the amount estimated is too high.

Indicators:

- Sustainable cycle management: equitable cost of vegetable oil, use of compost and in smaller quantities.

➢ ***From a social point of view:***

Indicators:

- Recovery of degraded and/or abandoned areas for growing sunflowers, particularly important from an aesthetic point of view in terms of opening up tourism in the area.
- Development of market niches (natural material and recycling) for taking the production from the district: production classification

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EXPERIENCE FILE 4

Name of ECOSIND project: MITCO2 **Code: EXP 4 C3**

Title of the experience: Integrated supply of energy services to an important petrochemical industry.
Location: Catalonia - Spain

Context

The chemical and oil industries are great consumers of energy, and also great emitters of greenhouse gases.
In the current legislative context, they must find solutions for reducing their emissions. In addition, a more secure energy supply would be desirable. The establishment of cogeneration combined cycle facilities seems to be a good answer to these problems.

The aim of the following experiment was to analyse the viability of this system for an important petrochemical industry from an energy and environmental point of view, but also how it can be set up and what the benefits are.

Participants in the project

- **Centre for Technological Innovation in Energy Recovery and Refrigeration** (*Centre d'Innovació Tecnológica en Revalorització Energètica I refrigeració/CREVER – Universitat Rovira I Virgili/URV*), Spain
- **Tarragona Chemical Business Association** *(Associació Empresarial Química de Tarragona/AEQT)*, Sapin
- **Tarragona Town Council** *(Ajuntament de Tarragona)*
- **Tarragona Official Chamber of Commerce, Industry and Shipping** (*Cambra Oficial de Comerç, Indústria I Navegaciódе Tarragona/ COCINT),* Spain

Location of the experience

The project is located in the Tarragona petrochemical complex in Catalonia. This area forms a conglomerate of companies manufacturing chemical products and an oil refinery.
It is known by the name of the "petrochemical industrial estate" and constitutes the greatest concentration of the chemical industry in southern Europe, representing 30% of Spanish activity, and 80% of such activity in Catalonia.

General information on the studied area

The Tarragona petrochemical complex includes, for the most part, large international chemical and oil industries, which have been established there

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since the 1960s, as the area offers good communication links by sea (with the port of Tarragona), rail and road (motorways).
The industries are also established in Tarragona thanks to the mild climate, flat land, availability of electrical energy and water, proximity of areas of great consumption, such as Barcelona, good infrastructures, the ease of employing qualified staff, etc.

The petrochemical complex is made up of 2 large, differentiated areas:

- The Northern Zone (470 hectares), where the REPSOL refinery is located
- The Southern Zone (720 hectares), where the chemical industry predominates.

Figure 1: Map of the position of the northern and southern zones of the Petrochemical Industrial Estate

The diagram above shows the main industries in the industrial area of Tarragona, with their sectors of activity:

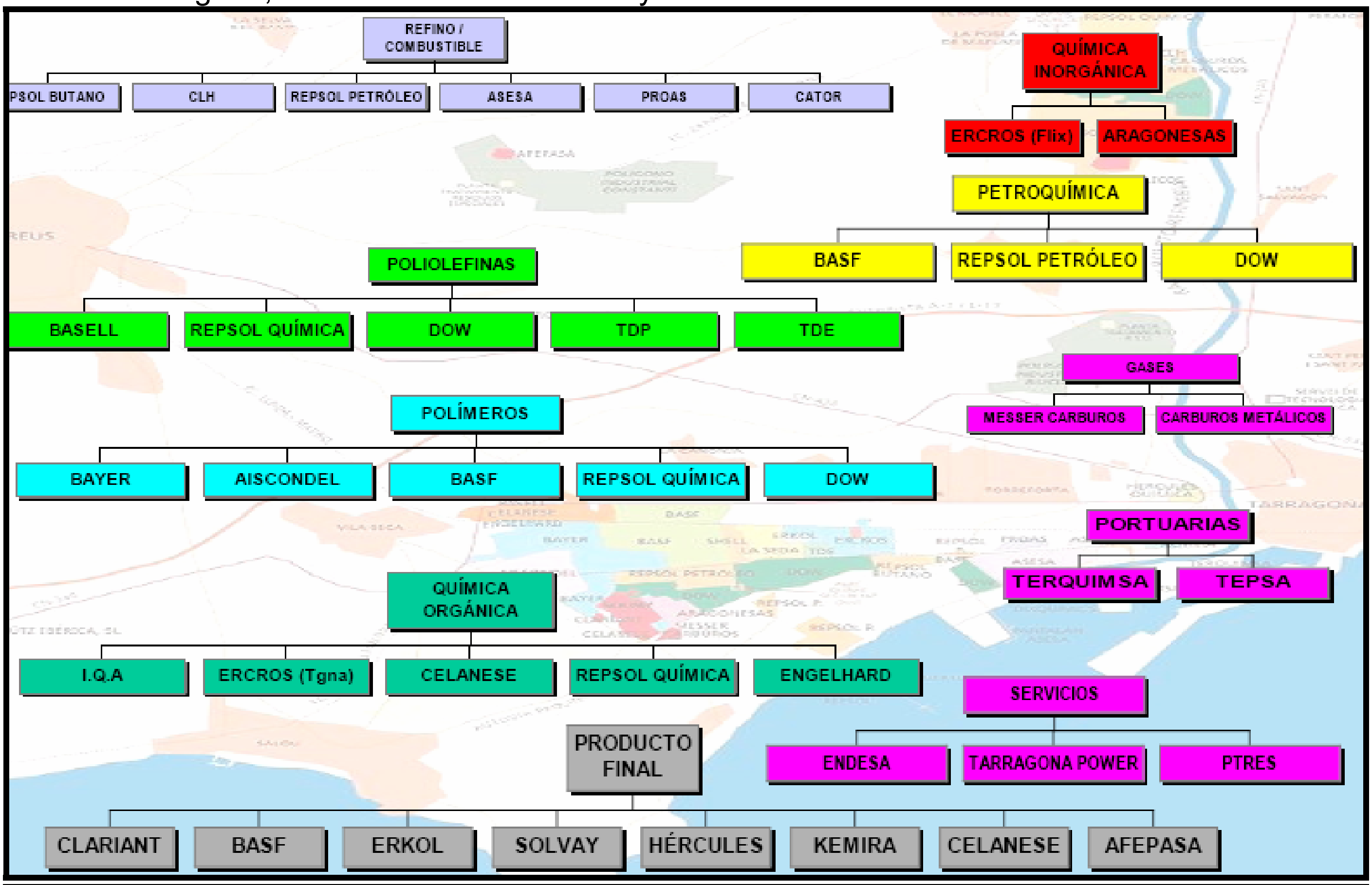

Image 2: Representation of different businesses present in the petrochemical complex and their associated industrial sectors

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The table below shows the production capacities of the Tarragona petrochemical complex and its percentage contribution to Spanish production as a whole:

Product	Capacity of Tarragona (Tonnes/year)	Percentage of Spanish capacity
Refinery capacity	8,500,000	17%
Ethylene	1,100,000	78%
Asphalt	1,000,000	38%
Polypropylene	815,000	95%
Propylene	565,000	60%
LD Polyethylene	450,000	94%
HD Polyethylene	435,000	97%
Caustic soda	235,000	35%
Vinyl chloride	185,000	44%
Benzene	180,000	49%
Butadiene	175,000	97%
Vinyl chloride	100,000	27%
ABS Plastic	60,000	86%
Polyester	70,000	33%
Polyols	70,000	60%
Strong nitric acid	39,000	95%

Table 1: Production capacities at the Tarragona petrochemical complex according to the chemical substances produced and compared with Spanish production capacity.

Summary of the experience

The Tarragona petrochemical complex contains several cogeneration facilities and 2 combined cycle power stations, the powers and investment values of which are indicated below:

Cogeneration facilities		
Company	**Power**	**Investment value**
Aiscondel	17.8MW	
Asesa	1.5MW	
Tarragona Power	12MW	
Bayer	13MW	
TAQSA Complex	12.9MW	
Dow	14.7MW	
Ercros Industrial	43.5MW	
Repsol Petróleo	96.2MW	
Repsol Quimica	159MW	
TOTAL POWER CAPACITY	**370.6 MW**	**412 million euros**
Combined cycle power stations		
Companies	**Power**	**Investment value**
Tarragona Power	420MW	220 million euros
Endesa	420MW	180 million euros

Table 2: Businesses in the Petrochemical Industrial Estate having cogeneration and combined cycle systems with respective powers and investment values.

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Of those mentioned above, the TARRAGONA POWER facility, including cogeneration and combined cycle, is the subject of this file.

Image3: Photo of the TARRAGONA POWER facilitv

The project, based on similar experiments in Germany, concerns the establishment of a cogeneration facility with a combined cycle and an electrical potential of 420MW. TARRAGONA POWER also includes an auxiliary steam generation facility, a compressed air manufacturing facility and a demineralised water production facility. TARRAGONA POWER belongs in equal shares to the companies IBERDROLA and RWE.

This installation also makes it possible to supply electricity, compressed air and demineralised water to the BASF Española Company.
In addition, TARRAGONA POWER is equipped to burn the off-gases produced in BASF's chemical processes.

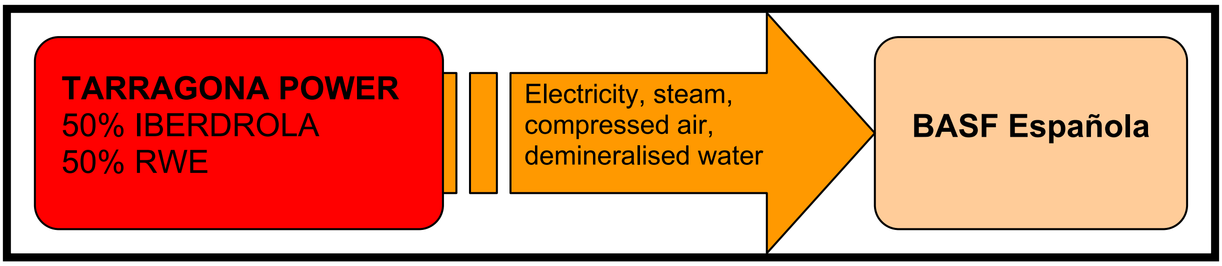

Figure 36: Illustration of the connection between Tarragona Power and BASF Española

The project began in 1999 with the administrative applications to obtain the necessary authorisations, and the power station was commissioned in June 2004.
The table below shows Tarragona Power's production and the consumption of BASF Española:

TARRAGONA POWER		BASF	
Combined cycle power station	**Steam**: 240 t/h	**Steam**	- Max: 300 t/h - Average: 200 t/h
	Electricity: 420 MW	**Electricity**	- Max: 35 MW - Average: 23 MW
Steam boiler power station	**Steam**: 2 x 150 t/h **Feed Water**: 20 t/h		
Air compression unit	**Air**: 26,800 Nm^3/h	**Air**	- Max: 24,000 Nm^3/h - Average: 16,000 Nm^3/h
Demineralised water production facility	**Demineralised water**: 55-165 m^3/h	**Water**	- Max: 150 m^3/h - Average: 100 m^3/h

Table 3: Comparison of possible production of TARRAGONA POWER and the consumption (average and max.) of BASF Española

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Results and impacts of the experience

➢ ***From an environmental point of view***

The TARRAGONA POWER experiment, and in particular the integration of a cogeneration process with a combined cycle, makes possible an improvement in overall performance compared with a combined cycle facility and, even more so in comparison with a coal-fired thermal power station using new technologies.

Some comparative data for similar powers are given in the table below:

	Conventional thermal power station and boilers (A)	Conventional combined cycle power station and boilers (B)	Integrated power station: Tarragona Power
Total natural gas consumption	1,168.5 MWth	882.4 MWth	756.7 MWth
Natural gas consumption in the power station	983.6 MWth	697.5 MWth	695.1 MWth
Natural gas consumption in the boilers	184.9 MWth	184.9 MWth	61.6 MWth
Off-gas consumption	-	-	120 MWth
Natural gas saving compared to solution (A)	-	-	35.24%
Natural gas saving compared to solution (B)	-	-	14.24%

Table 4: Gas consumption comparison for different types of facility

These calculations have been made considering the following performances:

- 39% efficiency for a new conventional thermal power station
- 55% efficiency for a combined cycle thermal power station
- 94.4% efficiency for generation by steam boilers

A combined cycle cogeneration facility makes it possible to achieve 70% efficiency for a steam supply of 225 t/h.
In addition, in comparison with option (B), presented in Table 4 above, it allows:

- A reduction of 18%, i.e. 28 t/h, in CO_2 emissions
- A reduction of 9%, i.e. 6 kg/h, in NO_x emissions

The efficiency of the combined cycle without cogeneration is around 54-55%, but with cogeneration this performance can rise to around 61% (the theoretical figure is 65% of the maximum exported).

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➢ *From an economic point of view*

The marginal operating costs of cogeneration mode compared with a normal mode make it possible to reduce costs by almost 10%.
In comparison with other technologies, the problem is the price of natural gas and its strong indexation to the dollar and to the price of a barrel of oil (Brent), the market prices of which have suddenly become very high for cost-effective operation. In addition, the CO_2 quota imposed by the State increases operating costs by 7-9 euros/MW, which reduces the competitiveness of cogeneration systems, even if emissions are tremendously reduced.

➢ *From a social point of view*

The TARRAGONA POWER power station directly employs more than 45 people and, indirectly, the use of outside resources involves an equivalent of more than 100 jobs.

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EXPERIENCE FILE 5

Name of ECOSIND project: MITCO2 **Code: EXP 5 C3**

Title of the experience: Application of cogeneration in Tuscan production districts.
Location: Tuscany - Italy

Context

One of the objectives of the project was to draw up a technical guide for reducing CO_2 emissions in the different industrial sectors (Kyoto Protocol and IPPC Directive) involving SMEs by using cogeneration and trigeneration technologies in order to strengthen the financial and environmental benefits to enterprises thanks to the greater efficiency of these systems compared to traditional systems. The choice of technologies has taken account of the energy requirements in each sector examined. In addition, the aim of the project was to extend the benefits that could be obtained with these systems to enterprises, which, due to their size, could not have access to them individually.
In addition to this, the activities were intended to estimate the potential for applying the proposed methodology on a large scale and to assess the results obtained in terms of the reduction in greenhouse gas emissions.

Participants in the project

➢ ***Project leader***

- **Centre of Technological Innovation in Energy Recovery and Refrigeration** (*Centre d'Innovació Tecnológica en Revalorització Energètica I refrigeració/CREVER – Universitat Rovira I Virgili/URV*), Spain

➢ ***Structures involved in the experiment (partners):***

- **Department of Energy "Sergio Stecco" of the University of Florence** *(Dipartimento di Energetica "S. Stecco" – Università degli Studi di Firenze),* Italy

Location of the project

➢ ***Prato textile district***

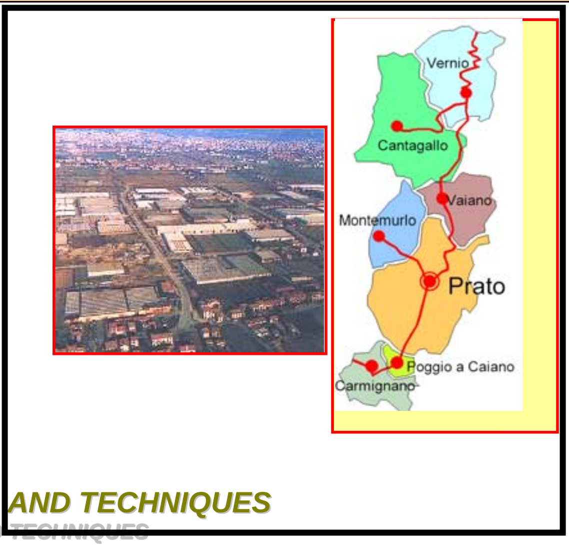

Figure 1: The Prato textile district

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➢ *Santa Croce tannery district*

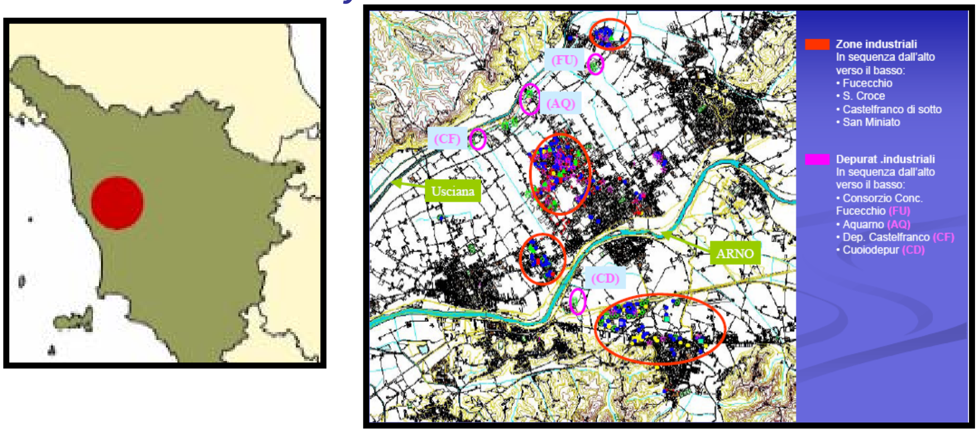
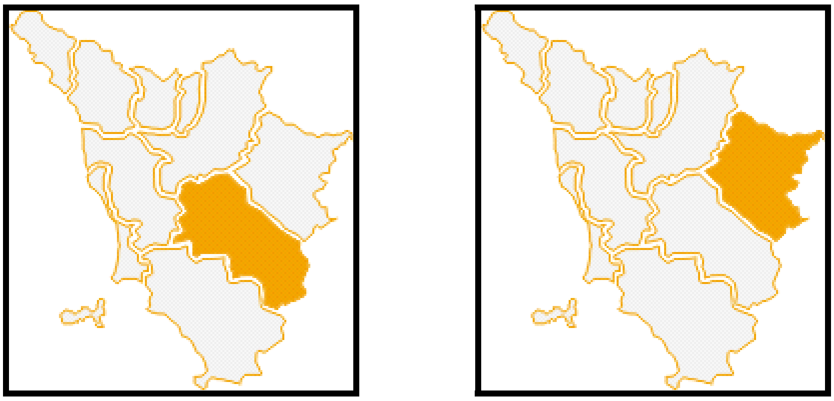


Figure 2: The Santa Croce tannery district

➢ *Tuscan breeze block district*



Province of Sienna **Province of Arezzo**

Image 3: The Tuscan breeze block district

General information on the studied area

The Tuscan textile industry is, above all, concentrated in the Prato district, specialising in wool textile production. The district covers an area of around 700 km^2, where there are approximately 310,000 inhabitants. The district includes the towns of Cantagallo, Carmignano, Montemurlo, Poggio a Caiano, Prato, Vernio and Vaiano which, together, make up the province of Prato; the towns of Agliana, Montale and Quarrata in the province of Pistoia; and the towns of Calenzano, Campi Bisenzio and Barberino del Mugello in the province of Florence. Two large areas (Macrolotti) are established to the south-west of the town to house the new concentrations of production and transfer the factories from the urban areas with denser population.

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Tabella 1.1 Le dimensioni delle imprese T&A nel Distretto di Prato				
Imprese T&A	Val. ass. aziende	Val. rel. (%)	Val. ass. addetti	Val. rel. (%)
Non dichiarati[1]	3.141	34.6	N.D.	N.D.
Micro (0-9 addetti)	4.953	54.5	12.078	35.2
Piccole (10-49 addetti)	923	10.2	16.751	48.8
Medie e Grandi (>50 addetti)	63	0.7	5.492	16.0
Totale	**9.080**	**100.0**	**34.321**	**100.0**

Elaborazioni su dati ISTAT 2004

Table 1: Size of textile and clothing industries of the Prato district

The textile cycle includes a huge range of manufacturing process which can be combined in the most varied ways, making it possible to change the final characteristics of the fabrics produced very quickly. This characteristic means that it possible for the district to be a system capable of adapting quickly to the changes required by the market.
Tuscan tanned leather production is above all concentrated in the district of Santa Croce sull'Arno, which extends over a radius of 10 km and includes around 90,000 habitants, including the towns of Castelfranco di Sotto, Montopoli Valdarno, Santa Croce sull'Arno, Santa Maria a Monte, San Miniato, in the province of Pisa, and Fucecchio, in the province of Florence.
The district is largely made up of craft operations and small and medium-sized enterprises, with an average of 10.4 employees per enterprise. It is a typical example of an industrial district, with the clear predominance of tertiary enterprises specialising in certain phases of the production cycle.
In Tuscany (%), manufacturing in the tannery sector ranges from the treatment of newly arrived hides to their transformation into technologically produced, weather-resistant finished products.

Table 2: Size of the tanning industries

Dimensione delle concerie italiane		
Dimensione concerie	**Imprese (%)**	**Addetti (%)**
Con 1 addetto	14.8	1.2
Con 2 addetti	9.7	1.5
Da 3 a 5 addetti	19.2	5.8
Da 6 a 9 addetti	17.7	10.4
Da 10 a 15 addetti	15.6	15.1
Da 16 a 19 addetti	7.0	9.7
Da 20 a 49 addetti	12.4	28.4
Da 50 a 99 addetti	2.6	14.7
Da 100 a 199 addetti	0.9	9.3
Da 200 a 249 addetti	0.1	2.3
Da 250 a 499 addetti	0.0	1.6
Totale	**100.0**	**100.0**

Fonte: stime UNIC su dati ISTAT

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In Tuscany, the production of breeze blocks is provided almost entirely by about 11 medium-sized enterprises (average of 70 employees) largely located in the provinces of Sienna and Arezzo.

Summary of the experience

First, the thermal and electricity consumption of the production sectors examined was defined in order to reveal its specific contribution to the production of greenhouse gas emissions. Then, a technical, economic and environmental feasibility study was carried out for each sector by applying a suitable cogeneration system for a representative enterprise in the sector or for the district itself.

The most common thermal energy production technology in the Prato textile district involves the use of a thermal power station made up of one or two steam generators, each one of them with a nominal power of around 5-6 MW. Concerning electrical energy, no enterprise in the textile district currently uses cogeneration, and this is why, up to the liberalisation of the electricity market, almost all enterprises were supplied via ENEL. However, over the last few years, consortiums have emerged for buying electrical and natural gas energy at better prices.

	Production of CO_2 eq. by EE (t/year)	Production of CO_2 eq. by NG (t/year)	Production of CO_2 eq. Total (t/year)	Change compared to 1990
1990	120,200	206,100	326,300	-
2004	75,400	160,000	235,400	-28%

Table 3: Estimation of the greenhouse gas emissions produced by dyeing and finishing operations in the Prato district

The possibility of setting up a cogeneration station based on a consortium in the Prato textile district has been assessed several times in the past, with interesting results. In fact, the different energy needs of the enterprises in the consortium would make it possible to make better use of the electricity and heat produced by the system, increasing the load factor and benefiting from the scale effect. The Prato Macrolotti are well suited to this type of power station given that the presence of other textile enterprises nearby would reduce losses and costs resulting from the transport of the steam and the electrical energy produced.
As well as reproducing the main characteristics of the cogeneration project at the level of the consortium presented for *Macrolotto I,* a feasibility study was carried out on a representative enterprise from the sector.

In the Santa Croce sull'Arno tannery district the most common heat energy technology involves the use of a steam generator with average nominal power of around 1,100 kW which consumes around 160,000 m^3 (st)/year of natural gas. The average power for a tannery is estimated at around 790 kWt (the result of fuel consumption), of which only 670 kWt are transferred to water for steam production of an average of 8,000 kg/d, i.e. 1,000 kg/h.

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Concerning electrical energy production, in the tannery district almost all the enterprises have energy supply contracts with ENEL, except the tanneries forming the various energy consortiums spread around the region. An average commitment per enterprise can be estimated at around 250 kWe for 2,000h/year, for an annual consumption of around 500,000 kWh.

	Production of CO_2 eq. by EE (t/ year)	Production of CO_2 eq. by combustion (t/year)	Production of CO_2 eq. total (t/year)	Change compared to 1990
1990	37,200	46,300	83,500	
1997	39,000	52,500	91,500	+10%
2004	46,700	67,000	113,700	+36%

Table 4: Estimated greenhouse gas emissions for all tanneries in the district

The project reproduces a study carried out in 1991 on the feasibility of a cogeneration station for an energy consortium comprising 5 tanneries (Santa Croce sull'Arno) which demonstrated the economic viability of the proposed power station.

In the breeze block sector, the most common thermal energy production technology involves the use of a tunnel kiln in which a series of burners, fed by natural gas and/or fuel oil, generate the heat necessary to fire the material. Most of the heat produced is recovered by the kiln in the cooling area and sent to the drying furnace. In general, this energy covers about 80% of the heat requirements of the drying kiln. An auxiliary heat generator must therefore be used to meet the remaining heat demand. It can be considered that an average of 21% of the fuel is burned in the drying kiln and 79% in the kiln. The total power required is around 6,800 kWt, which, taking into account 100% burning efficiency, exactly represents the fuel consumption. In general, heat consumption is constant, 24 hours a day, 5 days a week. The average consumption is therefore around 5,600,000m^3 (st)/year, i.e. 54,000,000 kWh/year. Concerning electrical energy consumption, an average commitment per enterprise of around 850kWe for 5,280h/year (daytime hours) and 420 kWe for 2,460 h/year (night-time hours), can be estimated, giving an annual consumption of 5,600,000 kWh/year and an average commitment of around 710 kWe.

	Production of CO_2 eq. by EE (t/ year)	Production of CO_2 eq. by combustion (t/ year)	Production of CO_2 eq. total (t/ year)	Change compared to 1990
1990	207,000	55,000	262,000	
2004	190,200	29,000	219,200	-16%

Table 5: Estimated greenhouse gas emissions produced by Tuscan breeze block companies

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Results and impacts of the experience

- ***from an environmental and economic point of view***

There are no other cogeneration applications in the Prato textile district; consequently, the actual reduction in GHG omissions obtained thanks to cogeneration must, at the moment, be considered as nil.
The dyeing and finishing factory analysed in our study is one of the largest in the province of Prato. The steam production necessary for manufacturing is provided by three thermal generators with a maximum total power of around 33,000 kg/h of saturated steam at 12 bars. The factory operates 24 hours a day, 230 days a year, for a total of around 5,500 h/year.
Heat consumption varies enormously over the day and there is an estimated ratio of 1:8 between minimum heat power (910 kW) at night and maximum power (7,700 kW) during peak daytime hours. The ratio between average power (4,000 kW) is 1:4.
To generate power for a cogeneration station, a reciprocating engine with maximum heat recovery has been chosen, with the capacity to generate electrical power that can guarantee average power for the daytime phase - 1,412 kW - using all recoverable thermal power from the engine to reheat the water for the first bath for the machines in the dyeing workshop. It has been considered reasonable to adapt the power station to the average daytime electrical load, and to plan to turn the co-generator off during the night.

	CURRENT	FUTURE
Electricity costs (euros/year)	720,000	230,000
Natural gas costs (euros/year)	990,000	1,200,000
Maintenance and operating costs (MCI)(euros/year)		100,000
Total energy costs (euros/year)	1,710,000	1,530,000
Saving (euros/year)		220,000

Table 6: Comparison between current and future energy bill

The useful life of this station is estimated at around 50,000h of operation (around 13 years). For the first ten years (10-year amortisation period and interest rate of 8%), the saving, after calculation of the amortisation rate, will be 41,000 euros/year, obtaining an NPV of 270,000 euros, which therefore makes the investment worthwhile.

Concerning the tannery district of Santa Croce sull'Arno, a reduction of greenhouse gas production is forecast at around 510 t/year for each energy consortium, based on the natural gas consumption of consortiums currently using cogeneration. Taking into account the current presence of three consortiums, the reduction in greenhouse gas emissions (GHG) has been estimated at 1,530t/year, corresponding to 1.3% of total production for 2004.

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In the case studied, the five enterprises in the consortium were similar – they were of a very similar production type characterised by almost identical electrical consumption charts.
The cogeneration station chosen has been provided with a reciprocating engine powered by natural gas (Caterpillar model 3512 SI-TA Lean Burn) capable of providing 755 kWe of net electrical power and 1,123 kWt of thermal power. The total recoverable thermal power, after calculating distribution losses, was around 950 kWt. The engine would operate 14 h/d for 250 d/year, i.e. 3,500 h/year, from 5:30 am to 7:30 pm, in order to optimise heat recovery. The power station would produce saturated steam at 2 bars, usable for drying the hides, and hot water at 65ºC, necessary for fulling (notably dyeing and tanning).
The turnkey investment amounted to 498,400 euros, but a saving of 205,000 euros/year would be generated, with a net present value (NPV) of around 950,000 euros, and an investment period calculated prudently at 12 years (in fact the useful life was estimated at 18-20 years). The financial need for the investment was therefore made clear, leading to the establishment of the energy consortium in 1991.
The power station was built and is still working well today, largely thanks to optimum design and regular maintenance carried out by subcontractors, with which the consortium has concluded a full assistance contract.

Thanks to the Tuscan breeze block production sector, a saving of GHG emissions equivalent to 9,200 t/year , i.e. 4%,has already been produced, also due to the current use of cogeneration.

The typical enterprise examined in the case study produces 500 t/day of breeze blocks and works 24 hours a day, 330 days a year. The heat recovered from the kiln covered around 70% of the heat requirements of the drying kiln, where the rest (1,417 kW) is currently provided by an aspirated natural gas-powered hot air burner. This energy share establishes a maximum limit for dimensioning any cogeneration station, which must not produce more heat than that required for the remaining share. To provide the remaining heat energy needed by the drying kiln, 3,530 m^3(st)/day, consumed by the aspirated hot air burner (burning efficiency of 100 % is calculated).
Given the notable difference between the electrical power required during the day and during the night, it has been decided to adapt the cogeneration station to the average daytime load. In addition, it has been decided to turn off the power station during the night, given the low electrical power required and the low purchase price of electricity at night; in this way, the power station will always work at full capacity. A Jenbacher JMS 316 GS-N.LC natural gas-powered engine has been chosen to generate the power in the station. It has been noted that the heat energy produced by the chosen engine (1,046 kW) is less that the average energy used in the drying kiln, (1,417 kW), even in the case when this falls by 25% during the summer (1,063 kW). The company must, of course, sign an appropriate electricity supply contract with ENEL in order to fully meet its remaining electricity needs and covering the case of breakdown or maintenance of the cogeneration station.
For an estimated investment of around 690,000 euros, the total energy bill would fall by 120,000 euros/year. The useful life of this power station is estimated at around 60,000 hours of operation (around 11 years). In the first ten years, after the calculation of the amortisation rate (10 years at an interest rate

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of 8%), the saving will be 18,000 euros/year, obtaining a PNV of 120,000 years; the investment therefore proves to be worthwhile.

Tabella 1.14 Confronto fra la bolletta energetica attuale e quella futura

	Attuale	Futura
Bolletta elettrica (euro/a)	580.000	230.000
Bolletta del gas naturale (euro/a)	1.400.000	1.560.000
Costi di manutenzione e di esercizio MCI (euro/a)	-	70.000
Bolletta energetica totale (euro/a)	1.980.000	1.860.000
Risparmio (euro/a)	-	120.000

Table 7: Comparison of the current and future bills

Contact(s)

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EXPERIENCE FILE 6

Name of the ECOSIND project: RESHUI **Code: EXP 6 C3**

Title of the experience: Integrated Management of Olive Oil-Mill residues and waste water
Location: Peloponnesus - Greece

Context

At the current moment in time, the industry has not yet found economic interest to support a certain traditional olive oil mill wastewater treatment technique (thermic, chemical, biological).
The main reasons for the failure of the treatment techniques that have been tried are the very high concentrations of solid, olive grove and phenolic compounds, the complexity of the proposed solutions, the often high investment and operational process costs, the limited time of the olive oil production, the small size of the oil factories, as well as the great quantitative and qualitative fluctuations of liquid waste after a duration of one year.
The Development Agency of Argolida, through the RES-HUI project within the framework of the ECOSIND program, and in collaboration with the European partners of the project (Italy and Spain), aimed to derive useful conclusions regarding the recognition and evaluation of the environmental problems of businesses involved in the olive oil production sector.
Quantities of olive oil mill waste arising from olive oil production processes were also recorded by all three project partners. The situation in the three regions has been described, while the national legislation that applies in each of the three countries has been reported. The environmental management systems applied in these three regions were also investigated.

Participants in the project

- **Prefecture of Argolida, Development Agency of Argolida/AN.N.AP**, Coordinator, Greece
- **Department of Energy "Sergio Stecco" of the University of Florence** *(Dipartimento di Energetica "S. Stecco" – Università degli Studi di Firenze),* Italy
- **Federation of Catalans companies** *(Federacio de sosietats laborals de catalunya/FESALC),* Spain

Location of the experience

The project was carried out in the area of the Prefecture of Argolida, in the Peloponnese region, with similar studies conducted in the two other regions that participated in the project (Tuscany in Italy and Catalonia in Spain).

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General information on the studied area

The main transformation sector in the Peloponnese region is the production of olive oil and the treatment of olives that are produced there. While local enterprises would have difficulty in penetrating new, international markets, this sector remains a driving force for the economy of the region, providing the main source of potential growth for the next ten years.
The companies in the sector face serious environmental problems regarding the management of their wastes (particularly the liquid waste) which are toxic and harmful to the environment. As well as olive oil, the treatment of the olive-crop in the oil factories also produces a number of by-products.
These include the oil-stone (which is constituted by the treated solid components of the crop), the leaves that have been transported with the olive-crop, and a significant quantity of liquid waste, by volume and organic load, which is known as "katsigaros". The direct repercussion of "katsigaros" in the environment is the aesthetic problems that it causes.
At the same time, due the high organic load that it contains, eutrophic phenomena may be created in cases where the wastewater is discharged into confined spaces (closed marine gulfs, lakes etc.).

Summary of the experience

Within the framework of the ECOSIND (INTERREG IIIC) program and through the activities of the RES-HUI project, the main axes of an innovative culture were investigated concerning the environment and the recycling of waste that originate from olive oil production activities.
The current situation has been described regarding the businesses' adherence to the legal requirements concerning the protection of the environment. The participants of the project attempted to determine the most significant environmental repercussions of their methods. Further efforts have been made to initiate communication links with the local prefecture with the aim of creating a culture of "environmental values".
In the analysis of the data reported in the region, emphasis has been placed on energy needs, as well as to the exploitation of the waste that originates from the cultivation of olive trees and olive oil production processes.. Innovative methods and technologies have been recorded for the treatment of the solid and liquid wastes from these processes. There has also been an exchange of experiences with the project partners.
Guidelines were created on the management of olive oil mill wastes (with a description of technologies, relevant legislation, and proposals for future actions – both for regional administrations and for those enterprises active in this sector). Furthermore, a web page was created to publicise the results of the project.

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Results and impacts of the experience

➢ *From an environmental point of view*

Existing studies show that there is currently no system anywhere in the world that is 100% effective. There are, however, various systems in use in Europe that should be examined further at a local level with the help of pilot projects, so that the most effective and feasible applicable systems can be determined and selected , taking the needs of each specific region into account.
The potential short- and long-term consequences of all proposed actions must be evaluated, including the growth of the companies that will participate, the number of new companies that will be created and that will contribute to confronting the problem, the income that will derive from the sales of new products etc.
The energy consumption of both solid and liquid waste was examined in the wider region of the Peloponnese. Furthermore, the study "Assessment of the Potential of the Biomass to energy implementation in Peloponnese" from the Centre of Renewable Energy was consulted. The results were sufficient to convince several investors to seriously consider proposals for the constitution of an Investment Institution, with the involvement of Development Agencies in the Peloponnese region and other private companies to manufacture production units of electric power from biomass.

➢ *From an economic point of view*

A fundamental objective of olive oil mill waste water management is to effectively manage environmental hazards. At the same time, it is possible to exploit the energy of rural biomass, such as that of secondary by-products. This action can particularly be attractive to a region facing problems of energy supply.
By means of an appropriate administrative plan that will achieve environmental management of olive oil mill wastewater (katsigaros), or even its eradication through the extensive application of two-phase olive oil presses, as in the Spanish model, with the simultaneous energy exploitation of rural biomass. The combination of these two actions will involve economies of scale and will lend an important added value to the proposed enterprising plan. The installations will be included in the more stringent environmental requirements of the management of "katsigaros".
The proposed administrative plan will achieve the following objectives:

- Recuperation of secondary products (eg. Compost)
- Exploitation of rural biomass
- Production of electric energy from biomass in a base station.

➢ *From a social point of view*

The issues concerning the activities, the products and the services of the enterprises and their effect on the environment may also include other sectors, beyond the use of natural resources and the production of waste or pollutants.

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It is very important that the enterprises can recognise and also evaluate the environmental aspects through an environmental management system for identifying significant environmental hazards that may have important environmental repercussions. In this way, future efforts for the improvement of the problem may be socially acceptable for all parties involved in the region.
An effective diffusion of the results from the project ECOSIND among users and industrial players would contribute to the diffusion, transfer, exploitation and broad take-up of such results.

Contact(s)

More information regarding the project is available at the following URL:
http://www.anarg.gr/web/ecosind/intex-gr.html

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EXPERIENCE FILE 7

Name of the ECOSIND project: BLU **Code: EXP 7 C4**

Title of the experience: Project about environmental improvement in industries and local public administrations associated with the naval sector.
Location: Tuscany- Italy

Context

Objectives

- Helping organisations associated with the naval sector to be more competitive in a new global and technological market, on an environmental basis
- Providing tools for Public Administration to stimulate Present and Future Sustainable Growth of naval sector economy, minimising its environmental impact as regards population.
- One of the main ones turns out to you attended of the BLUE plan is represented from the development and interregional consolidation of the Blue Quality (DQB, in the continuation).
- Develop a planning methodology applicable to other naval areas.

Context of the experience

The nautical field has, in fact, a role pulling ahead also in European economic within, but haven't a bad impact in the comparisons of the marine ecosystem. The European Union is strongly to do a program for Integrated Management in the coast area (GIZC, in the continuation) in Europe. The attempt of such program is to conform the various political adopted inside of the European Union in the within of the GIZC, being facilitated the dialogue between the interested parts (companies, Public Administration, etc), stimulating the application of best practice in the integrated management, and promoting the industrial ecology in economic fields with impact acclimatises them considerable. The BLUE Plan is born just as instrument of strategic sustainable management face to development and to the introduction of the directives approved of from the European Parliament "on the integrated management of coastal zones in Europe", published 30 May of 2002.

Participants in the project

- **Municipality of Pisa** (*Comune di Pisa)*, Italy
- **Nautical Hall of Barcelona** *(Salò Nàutic de Barcelona),* Spain

The BLUE project has been promoted from the Municipality of Pisa and with the participation of Nautical Hall of Barcelona with the scope of putting to comparison and integrating the experiences matured in two different regions of the Mediterranean coast: the Catalonia Region and the Tuscany Region,

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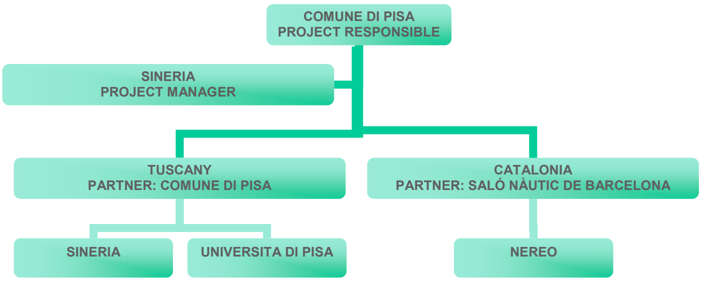
regarding which the Municipality of Pisa has carried out the role of main contractor.
The two partners of the project have been place in the development of the same one from other Italian and Catalan, identifiable collaborators in Institutes of Search, not Governmental University, Organisations and Companies of Cunsulting, which: the Department of Physical of the Pisa university, from the IPCF-CNR of Pisa, Nereo No-Profit Association and Sineria Consulting & Engineering.

PROJECT ORGANISATION



To the BLUE plan they have joined 10 Catalan companies of the nautical field and 7 Italian enterprises of shipbuilding naval located along the Channel of the Navicelli to Pisa.
The Italian industrial truth not only differs from that Spanish for the organisational structuring and the understood one you invest yourself various them (from the Catalan case, the Italian enterprises are Limited liability company or S.P.A. and not enterprises to familiar conduction), but also for the type of activity carried out.

Location of the experience

- **Catalonia : Naval sector**
- **Pisa municipality: "canale di Navicelli" area**

The BLUE project has had beginning in Catalonia in year 2000, the promoter of the initiative was the International Nautical Hall of Barcelona, he consider that the quality of environment is indispensable key factor to assure the economic development of the nautical field to world-wide level and we have to stimulate of the respect and the conservation**.**
The Positive Catalan experience has pushed to rethink to the DBQ in one optical more ambitious than to propose such certification like first passage for the implementation of a SGA.
In the light of how much till now asserted, is clear as the involvement of the Common one of Pisa is been born in nearly natural way: some important Italian shipyards are working along the Channel of the Navicelli and, for the type of production and for the area on which they insist, they are in a position to interacting directly and indirectly with marine ecosystem.

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General information on the studied area

The Channel has constituted in the centuries slid an important via of connection between the cities of Pisa and Livornoand measures 16 km.
The Navicelli Channel is wide 32 m and deep 3 m. For these its dimensions concur the transport on distances of 16 km of modest volumes of traffic, from 1.000 - 1,200 t.
The Navigation channel of the Navicelli, that it joins Pisa to the port of Livorno, is considered one of the strategic areas of the city, potentially in a position to throwing again of the development tourist economic and, thanks also to the ability to attract investments private publics.
The enterprises, in consideration of the frequent and complex interactions that take place between the environment and the same productive activities, play a determining role on the territory in which they insist. The production process demands the use of great resources; in particular energy and raw materials and workings can produce emissions in atmosphere of refusals with possible contaminations of the ground.
In other words, the productive activities have more in general terms of the fallen back ones on natural the surrounding and on territory in general.

Summary of the experience

The plan has been articulated in following is made:

- ***Phase 1. Environmental Diagnosis of Channel of the Navicelli.***

The Diagnostic of the zone of the Channel of the Navicelli has represented the first phase of BLUE plan.

- ***Phase 2. Environmental Impacts Valuation associated to Environmental Diagnosis***

Regarding the various environmental topics taken them under investigation in the phase of diagnostic, are emerged a series of points weak people and aspects regarding which they have been proposed corrective solutions.

- **Quality of the water**: they have been finds problems to you legacies to the quality of waters of the Channel, attributable to the drainages of not dealt waters refluxes and to the washing of the docks to work of waters. It has been, moreover, found the lack of connection to a system of public drain from part of the companies located along the Channel.
- **Water consumption**: during the study is emerged that the water requirements of the industrial field are not negligible.
- **Quality of the air acclimatises them:** the values derive to you from the telephone exchange mail in via Conte Fazio show concentrations to of over of the norm for the PM10 and ozone;
- **Ground:** the zone of the Pisana Dock is classified like area subject to episodes of flooding. They have been already you execute participations of hydrological rearrangement in order to avoid such uneasiness and in the new plan such participations have priority.

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- **Natural system and ecology**: the quality of waters of the Channel has one directed fallen back on the protect area of the Regional Park Migliarino-San Rossore when these waters cross the Park.
- **Mobility and transports**: it has been found the lack of lines of public transit, the lack of track for bicycle, and they have not been taken in consideration other measures of sustainable transport.
- **Refusals:** it has been observed an increase in the years of the production of refusals, is special that city and assimilable.
- **Acoustic Impact**: All the areas long the Channel of the Navicelli on which insist the various shipyards have been surveying object, even if greater attention has been turned to the zone of the Pisana Dock, interested in the next few years from widening and transformations.

From the analysis of all the acquired data emerges that for every considered company it can substantially to be confirmed not overcoming of the absolute values limit is they of emission or breaking in, also in relation to the more onerous condition from acoustic point of view. They have been, but, characterised some problems in the respect of the criterion differentiates them to some responsible production processes relatively of the greater acoustic impact.

- ***Phase 3. Environmental Improvement Program in Catalonia Naval Sector:***

The process of promotion of the DQB has been designed and tested initially in Catalonia with the participation of five companies of the Catalan nautical field with which it has been possible to begin the plan pilot whom it previewed in the phase begins them implementation of the DQB in companies of the nautical field of medium-small dimensions. These five companies have succeeded to obtain the DQB during the edition of 2005 of International the Nautical Hall of Barcelona from the Director of the same Nautical Hall.
In the second phase, of the BLUE ten Spanish companies, not only Catalan, thanks in the participation of which have been involved in the process also others have been possible to consolidate this shape of certification them.
The feedback obtained from the greater part of the companies with which we have worked during last the eighteen months has been decidedly positive, they turns out been involved very more in the management acclimatises them, above all considered the fact that, till now, single the environment respect always has been thought secondary and bound to the obligation it dictates to you from the norm. Moreover, a great added value that the DQB can bring is represented from its simplicity of application, with the exception of the job size and of the high costs that, instead, are previewed from whichever other SGA.

- ***Phase 4. Technical Analysis for normalise BLAU label and adapt it to Catalan and Tuscan Naval Sector characteristics.***

The phase of integration of the Italian companies in the BLUE plan has happened through a process of analysis and adaptation of the acquaintances thanks to the Catalan partners during the development of the BLUE plan in Catalonia.

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For which it is made of the process followed in Catalonia for the implementation of the DQB the same ones are used for the Pisa's companies. Given the differences of the organisational, social structure and it determine the proportions them of the two truths, "the Catalan" DQB has had to modify in order to adapt itself to the truth that are working along the Channel of the Navicelli.

The seven Italian companies that have joined to the plan are: Cantieri di Pisa, Fratelli Rossi S.r.l, CNT S.p.A, Società Navale di Pisa S.r.l, Cantieri Navali Arno S.r.l, Gas&Heat S.p.A, Cantiere Navale Giannetti S.r.l.. The first four companies are located in the Pisana Dock, while successive the three are found in Tombolo locality.

The second step has been addressed to the understanding and detailed acquaintance of the truth acclimatises of the Channel of the Navicelli and the lasted, it is consisted in the process of adaptation of the DQB, previously tested on smile medium size companies dimensions of the Catalonia, to the requirements and the operating truths of the present companies along the Channel of the Navicelli. With the job carried out during last the eighteen months it has been able to demonstrate that the implementation of the DQB near the companies of the Channel could represent a valid instrument in order to reduce remarkably the impact today generated on the environment..

Results and impacts of the experience

With the job carried out it has been able to demonstrate that the implementation of the DQB near the companies of the Channel could represent a valid instrument in order to reduce the impact that these companies are generated on the **environment.**

The previewed economic expansion in the area of the Channel of the Navicelli represents for the insediate companies and those of new takeover, an opportunity in order to renew or to decide to implement a SGA, which could give life, moreover, to an obvious improvement the image of the companies, to the light of the specificity of category that they represent in the area.

Now we are in a position to proposing, in a structure to diagram, a Methodology of Sustainable Planning of the Industrial Zones that is articulated substantially in four is made operating:

1. Phase of diagnosis and analysis;
2. Process of the implementation to local level;
3. Consultation and validation from part of the customers;
4. Integration of turns out to you in the future planning of business development.

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EXPERIENCE FILE 8

Name of the ECOSIND project: PLANCOST **Code: EXP 8 C4**

Title of the experience: Experience of intermunicipal industrial and urban planning in La Selva.
Location: Catalonia - Spain.

Context

These last decades, the coast of La Selva (Catalonia) knew a strong increase of the tourist offer. It caused an uncontrolled growth of the services, the industry and the businesses in particular in the municipalities closest to the sea.
This fast growth was realised with important gaps concerning:

- The planning and the projection in the future,
- The definition of criteria of sustainability for the industrial sector,
- The definition of environmental criteria for the territorial planning.

In this context, it is necessary to equip quickly the administrations of tools of support for the sustainable development of La Selva's economic activities. It is necessary to:

- Test these tools with experiments
- Favor the participation and the information of the citizens.

Moreover, a harmonisation of the industrial development and the management of natural resources is indispensable. It is necessary to establish integrated environmental strategies and to use supramunicipal criteria for the planning of the territory.

Finally, it is necessary to strengthen the development through a sustainable supply in natural resources all thinks considered and to put into practice the principles and the criteria of industrial ecology during the establishment of new economic activities.

Participants in the project

- **Consell Comarcal de la Selva**, **Area of technical services and environment** *(Area de Serveis Tècnics I Medi Ambient),* Spain

- **DEPLAN enterprise**, **Development and environmental planning** (*Desenvolupament I Planificació Ambiental),* Spain

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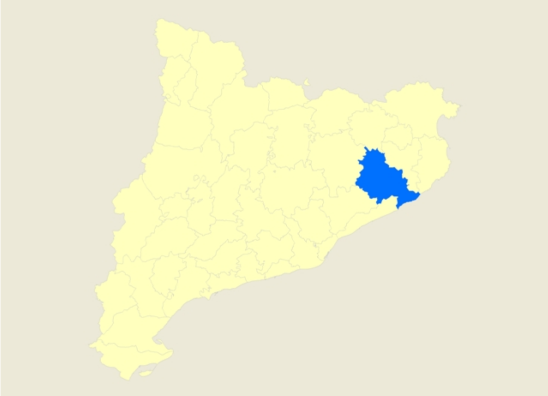
Location of the experience

The project is situated in the department of La Selva in Catalonia.



Card 1: Zone of the project (Catalonia to the left and La Selva to the right)

General information on the studied area

Here is some general information about La Selva:

- Surface: 991 km2
- Number of Municipalities: 26
- Number of inhabitants: 136 738
- Administrative centre: Santa Coloma of Farners

Here are municipalities involved in the project:

Name	Surface (km2)	Number of inhabitants	Density (Inhab/km2)
Blanes	18	35 577	1976
Caldes de Malavella	57	4 925	86
Fogars de la Selva	32	1 045	33
Hostalric	3	3 247	1082
Lloret de Mar	48	26 557	553
Massanes	26	588	23
Maçanet de la Selva	42	4 913	117
Riudarenes	48	1581	33
Riudellots de la Selva	13	1735	133
Sant Feliu de Buixalleu	62	752	12
Sils	30	3693	123
Tossa de Mar	38	5001	132
Videres	48	5762	120
Vilobi d'Onyar	32	5504	172
TOTAL	**497 (50%)**	**100 880 (74%)**	**203**

Table 1: Information about the municipalities involved for the experience

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Card 2: Municipalities involved in the project

Summary of the experience

This experience is mainly centred on the realisation of a diagnosis of the territory and on the reflection for the set up of an action plan.

This experience had for objectives:

- To ensure the compatibility of the industrial development with the natural resources of the studied zone, as well as to find a balance between the economic development and the conservation of the territory,
- To establish integrated environmental strategies to avoid a division between sectors, by taking into account as well social criteria as economic and environmental criteria,
- To use supramunicipal criteria for the planning of the territory,
- To develop the territory trough a reasoned and sustainable exploitation of the resources and a minimum of environmental impacts,
- To put into practice the principles and the criteria of industrial ecology for the implementation of new economic activities and the establishment of activities of environmental management in the new industrial zones.

To establish the diagnostic, in order to have reliable and quality data, the first thing was to contact town councils and administrations.

Town councils were requested to obtain the statutory instruments and the municipal plans of urbanisation in order:

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- To identify the industrial grounds of every municipality of the studied zone
- To be able to differentiate the already urbanised grounds and those ta can be urbanised.

This first step allowed to identify the existing industrial zones.

Then, a research of all the available data in the different administrations and the competent companies was realised to obtain information about the consumption of the natural resources of the activities installed in the studied zone.

Here are the various organisations which were contacted:

- **For energy consumption**: Fecsa-Endesa, Gas-Natural, ICAEN,
- **For waste generation** : the Waste Agency of Catalonia,
- **For water consumption** : the Catalan Water Agency,
- **For atmospheric emissions**: the Directorate General for Environmental Quality.

Certain number of information was collected but, in a lot of case, the information concerned municipalities generally rather than industrial zones themselves.

So, it was decided to visit every industrial zone defined by the municipal plans and to characterise them according to the following parameters:

- **Type of companies installed on the industrial zone**

Is it about a zone which contains big companies or rather SMEs? What are the main present sectors?

- **Access**

What are the various access roads to the industrial zone? What are the characteristics of streets, public road system, cross walks and parking zones inside the industrial zone?

- **Occupation**

What are the occupied parcels and those that are still not occupied?

- **Services**

What are the characteristics of the street lighting, which are the types of lampposts and used light bulbs? Are there municipal installations for the collection of waste? Are there the other services?

- **Environmental Impacts**

What are the dominant colours in the industrial zone (taking into account also the colour of the facades of buildings? Is there a "zone of amortisation" to decrease the visual impact between the industrial zone and the urban ground? Is there a zone of transition between the perimeter of the industrial zone and the non urbanisable grounds around?

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This collected information allowed to lead a reflection to define the criteria to be integrated into the bylaws of La Selva's municipalities for the economic industrial zones planning. An experiment was led on the POUM (general plan of urbanisation) by Lloret de Mar's municipality.

Here are the main points which were considered:

- ✓ **Section 1a: environmental criteria for the industrial zones urbanisation**
  - Economy of water and re-use (11 criteria)
  - Acoustic, luminous and electromagnetic conditions (5 criteria)
  - Resources and waste management (3 criteria)
  - Mobility (1 criterion)
  - Impacts in the landscape (6 criteria)

- ✓ **Section 2a: environmental criteria for the construction of industrial zones**
  - Economy of water and re-use (9 criteria)
  - Acoustic, luminous and electromagnetic conditions (6 criteria)
  - Resources and waste management (4 criteria)
  - Economy of energy (lighting and air conditioning) (28 criteria)
  - Warm sanitary water and other (9 criteria)

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Results and impacts of the experience

Below, is represented an example of file established for an industrial zone:

MUNICIPI:	Blanes

FITXA

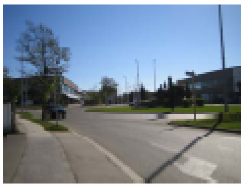
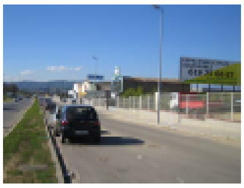
Sòl industrial		*Tipologia d'empresa*	
Construït:	414.904 m²	Gran empresa:	SI
En construcció:	23750 m²	PIME:	SI
No construït	37621 m²		
Sòl a urbanitzar:	- m²	Principals sectors:	Serveis, Química, Tèxtil
Equipaments:	24425 m²	Principals empreses:	Pneumàtics Blanes, Nylstar, Polímer Ibèrica, S.A., Toyota, etc.
Zona verda	19.846 m²		
TOTAL:	520.546 m²		

Impacte visual		*Serveis*	
Colors predominants:	Grisos	Recollida selectiva:	No
Zona d'amortiguació:	Millorable	Recollida rebuig:	No
Zona de transició:	Inexistent	Enllumenat públic:	Pantalla
		Xarxa elèctrica:	Soterrada

Urbanització

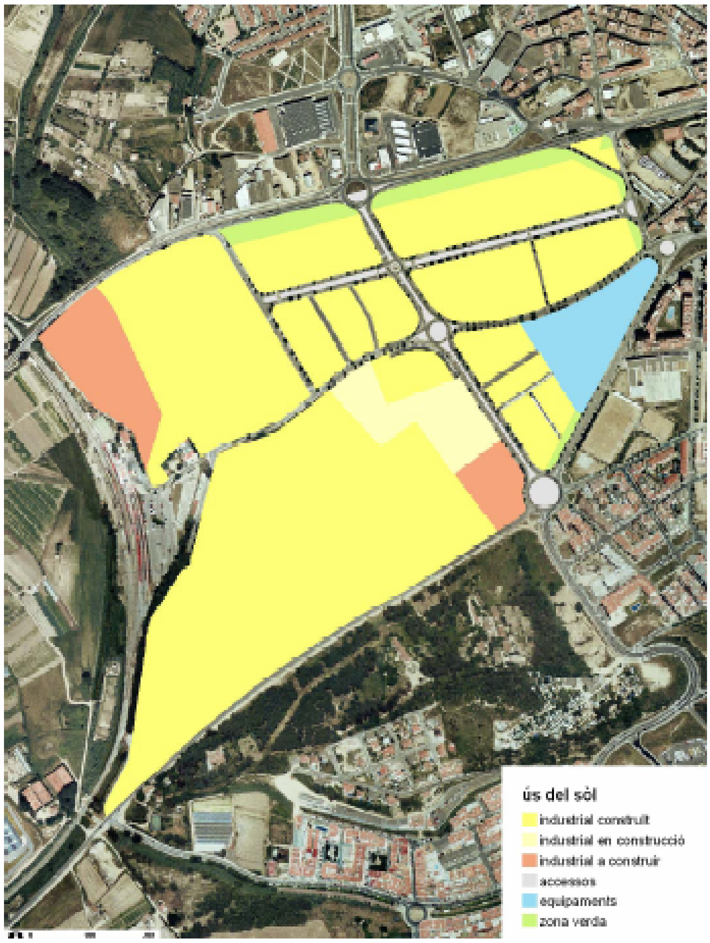
Vial d'accés:	Rotondes
Vial de serveis:	SI
Carrer: Amplada:	7 m
Descripció:	-
Vorera: Amplada:	2 m
Descripció:	No tots els carrers disposen de vorera
Vegetació:	SI
Passos de peatons:	SI
Tipus d'aparcament:	Majoritàriament particular

REPORTATGE FOTOGRÀFIC


POLÍGON INDUSTRIAL:	Polígon industrial carretera de l'estació

PLÀNOL



The use of a Geographic Information System (GIS) allowed to identify and to place on an orthophoto card the existing industrial ground of every municipality. The influence of the different present infrastructures was identified, in particular that of the main and secondary roads which pass by the area of study as well as the high-tension lines. This identification has been done thanks to the cards of the Cartographic Institute of Catalonia.

Also, were considered:

- The proximity of the urban zones,
- The distance to the natural spaces,
- The situation of streams.

The surface of the industrial ground of every municipality was differentiated between the constructed ground, the ground in construction, the ground to be built and to be urbanised, the green zones, the access zones to the industrial zones and the facilities. The surface of each of these spaces was calculated.

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A GIS was used to estimate the visibility of the industrial zones since the various accesses by basing itself on the curves of levels as objective criterion to determine the visual impact of the industrial zone.

A system of indicators was defined to characterise and estimate every industrial zones from criteria thought necessary. This system allows to determine which municipalities, and more particularly which industrial zones have the most positive results.

The defined indicators were distributed between 2 categories:

- Those who have a territorial aspect (Planning, mobility, landscape)
- Those who have an environmental aspect (energy, waste, water, atmosphere and noise).

For every indicator a file has been realised. This files defines the objectives of the indicator, the method of calculation, the wished tendency, the periodicity of the calculation and the sources from which the necessary information can be obtained.

The calculation of indicators was realised for each of the industrial zones considered for the territorial aspects. But for those who concern the environmental aspects, they were calculated from municipal data in view of the non-existence of more precise data.

Cards established for the industrial zones are available on the following Internet page: http://www.selva.cat/plan-cost/index.php

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EXPERIENCE FILE 9

Name of the ECOSIND project: PLASOS **Code: EXP 9 C4**

Title of the experience: Energy planning for a new industrial and residential zone in the municipality of Cerdanyola del Vallès
Location: Catalonia - Spain

Context

Catalonia, in particular Barcelona, is undergoing very strong urban development. The construction sector is expanding rapidly and energy consumption is increasing very strongly.

In this setting, it is important to act very quickly to set up construction projects which integrate an important reflection on the implementation of:

- An efficient energy supply.
- The generation of renewable and local energies.
- An efficient and reasoned consumption.

The strategic approaches by energy planning experiences must be increased and prove to be of environmental, economic and social use.

Participants in the project

- **CUCD of Cerdanyola del Vallès** *(Consorci Urbanistic del Centre Direccional de Cerdanyola del Vallès),* Spain
- **SINERIA (Coordinating company of the PLASOS project),** Spain

Location of the experience

The project is situated in Cerdanyola del Vallès, in the suburb of Barcelona, more exactly in its second ring of urban development.

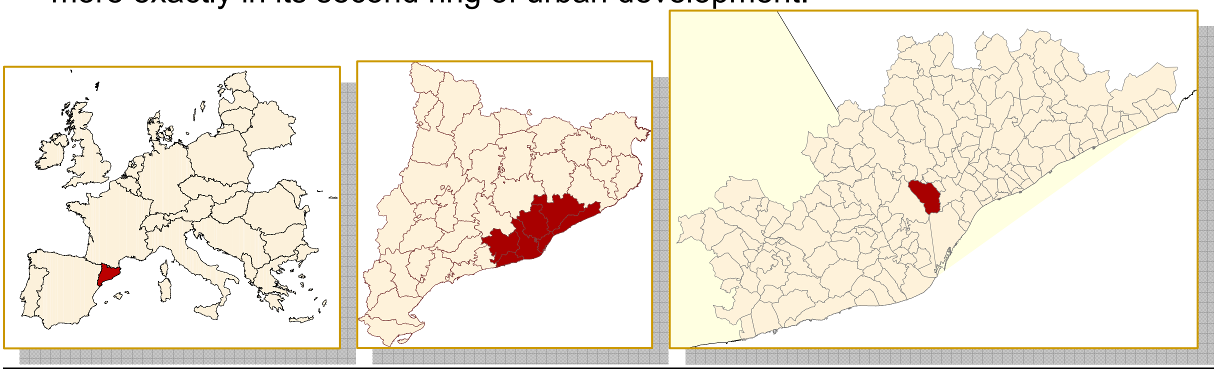

Figure 1: the geographic situation of the project

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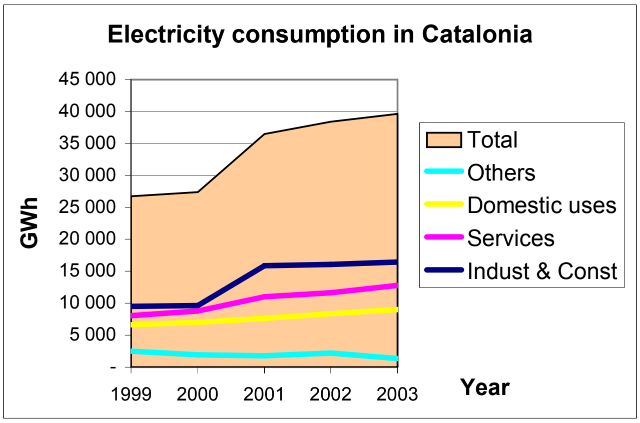
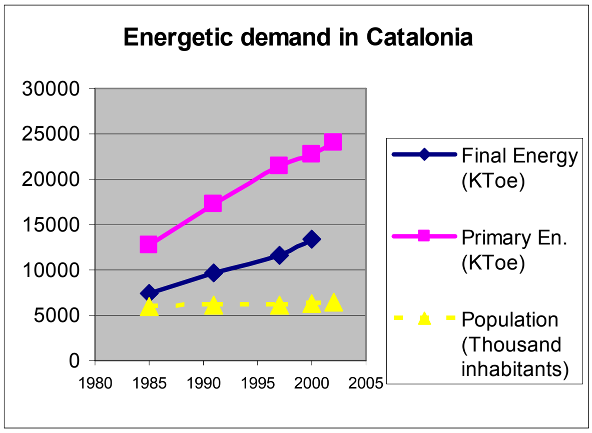
General information on the studied area

In the zone of the project there is a high rate of urbanisation, which is currently around 1000 ha / year. Between 1991 and 2002, the consumption of primary energy increased by 3.5% a year and the emissions, of CO^2 of 4% a year.
Furthermore, in Catalonia, the consumption of electricity has increased by 125% in 20 years. In the last four years, when the growth has been the fastest, it has increased by 50%.
The graphs below show the evolution of energy demand in Catalonia.





Graphs 1 and 2: evolution of the energy demand of Catalonia

With regards to the legislative context, the new national and regional energy laws have yet to be passed. A directive on energy efficiency should be transposed into national law within 2 - 3 years. But it is important to anticipate the new laws.
At the local level, the municipality possesses a prescription on the solar energy which imposes the use of this energy for the supply in household hot water supply in new buildings.

Summary of the experience

The project of planning of Cerdanyola del Vallès's is aimed, among other things, at the implementation of residential and industrial buildings. This project is focused on an energy planning which must be efficient and which has to integrate the use of renewable energies.

More exactly, it is planned to equip the town with:

- Green spaces (1,652,262 m^2)
- Public equipments (185,124 m^2)
- A science and technological park (1,458,880 m^2)
- A synchrotron
- Houses (429,900 m^2) – 1,200 public housing and 2,100 private housing.

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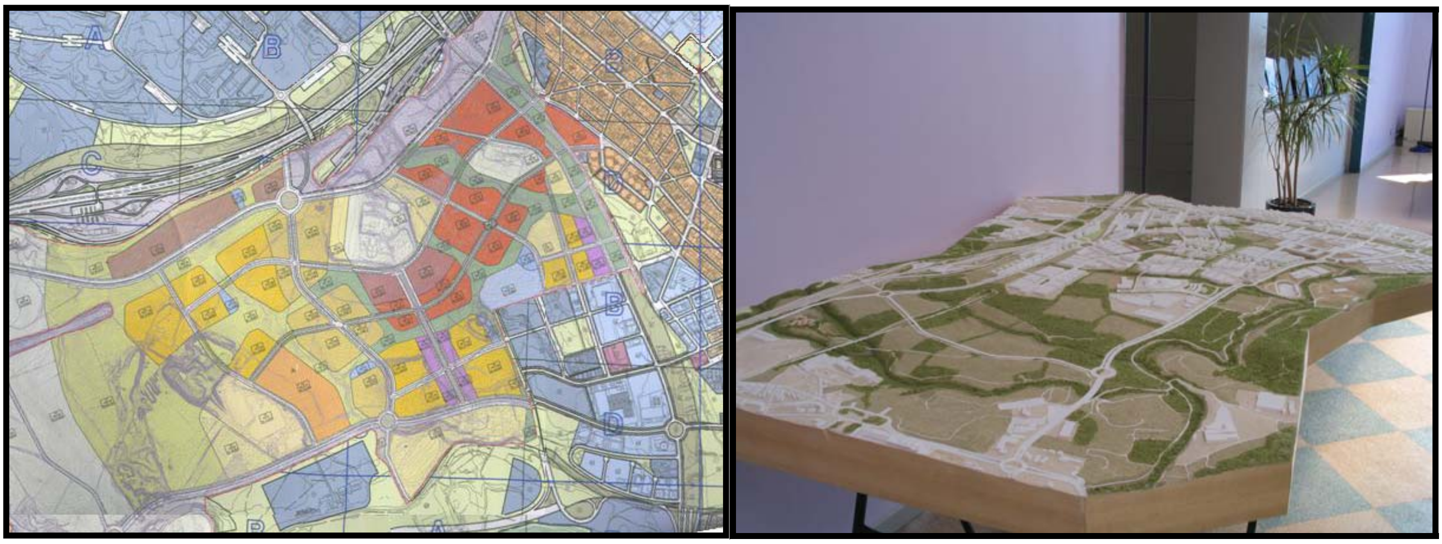

Figure 2: plan and model of the project of planning of Cerdanyola del Vallès

An evaluation of the global energy demand of the project was carried out, and the results of the study are summarised in the table below:

Thermal demand	
Domestic warm water	15 000 MWh/Year
Heat	93 700 MWh/an
Cold	198 200 MWh/Year
Electric demand	
Electricity	247 600 MWh/Year

At present, the initial energy situation for the supply is:

- 1 electric line of 220 kV
- 2 pipes of natural gas of 36 and 72 bar.

In view of the dimension of the planning project and the initial energy situation, it was decided to define a plan of high energy efficiency which integrates the following objectives:

- Optimisation of the urban design
- Analysis of possibilities of supply in alternative energies

Hence, the concerns of the planning were divided in 2 main parts:

- the reduction of the energy demand,
- the energy supply.

For the energy demand, the concerns were to:

- Optimise the urban design.
- Develop a local standard for low energy constructions.
- Improve the architectural design of eco-constructions.
- Increase the energy efficiency of buildings.

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For the energy supply, the concerns were to:

- Conceive a system of energy supply that is suitable for the zone of the project, integrating a high efficiency cogeneration system fed by natural gas and biomass,
- Conceive an important refrigeration generation system for optimum energy efficiency in summer, when the demand to feed the systems of air conditioning is extremely high ,
- To integrate renewable sources of energy,
- Intelligent design of a heating and cooling network for the air-conditioning of buildings.

And in every case, it is necessary to establish a suitable monitoring system to estimate the validity and the efficiency of the actions which have been set up.

Results and impacts of the experience

- ***From an economic point of view***

The setting-up of a system of tri-generation can reduce the annual cost of the energy for air conditioning of €8, 93 / m^2; approximately €13 million / year for all the Directional Centre of Cerdanyola del Vallès (see table below).

- ***From an environmental point of view***

The reduction of the consumption of primary energy of 28% thus supposes a reduction of the CO^2 emissions of more than 11,200 t for the entire Directional Centre (see table below).

System (value by m^2)	Energy costs (€/Year)	Primary energy (MWh/Year)	CO2 emissions (kg/Year)
Installation with heat pump (before)	6,595	0.136	28,855
Tri-generation	-2,33	0.0983	21,195
Reduction with tri-generation	8,925	0.0377	7.66
Reduction (%)	135%	27.7%	26.5%

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EXPERIENCE FILE 10

Name of ECOSIND project: PLASOS **Code: EXP 10 C4**

Title of the experience: Planning new ecologically equipped and sustainable production areas on the Versilia plain (Seravezza)
Location: Tuscany – Italy

Context

The best definition of the context in which our experiment is structured is given in the form of the objectives and criteria adopted beforehand to define the Plasos project. It specifically involves experimenting, sharing and setting up planning methods and techniques aimed at defining and establishing:

- An industrial area with ecologically equipped production sites.
- Suitably sized public spaces and structures.
- Facilities of general interest (improvement and development) aimed not only at achieving a site with higher production quality but also at providing services for a wider regional system.

In order to guide the project under an "ecological" profile, within sustainable development and integrating it with existing resources in the region, the following target criteria have been determined and will be applied during the aforementioned experiment:

- **"environmental":** unit management integrated into the infrastructures and services, making it possible to ensure the prevention of pollution, the protection of health and the proper management of resource cycles (air, water, land, waste, etc.) but also the compensatory measures capable of defining the ecological footprint of the site.
- **"planning":** quality of facilities and sites in order to minimise operational and landscape impacts, with effectively organised accessibility, improved planning quality as a whole and the promotion of positive regional relationships in accordance with the functions carried out in neighbouring areas.
- **"construction":** creating buildings and infrastructures that can reduce the consumption of resources, maximise synergies between the various activities, reduce the impact on the visible landscape of the area and also constitute elements of integration and continuity with local culture and tradition.
- **"Infrastructure":** providing the area with general services (health, training, and organisation), network services, and also facilities (production, distribution, transmission, etc.) to guarantee high levels of efficiency and collective management, as well as overall control of activities meeting the environmental criteria.

Participants in the project

- **Seravezza Town Council – Planning management and protection service,** *(commune di Seravezza),* Italy

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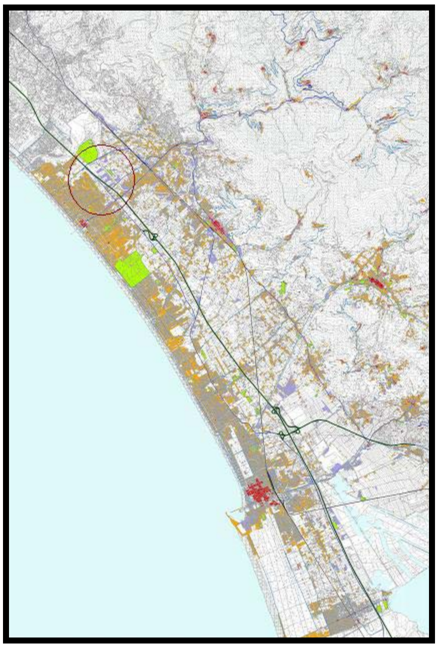
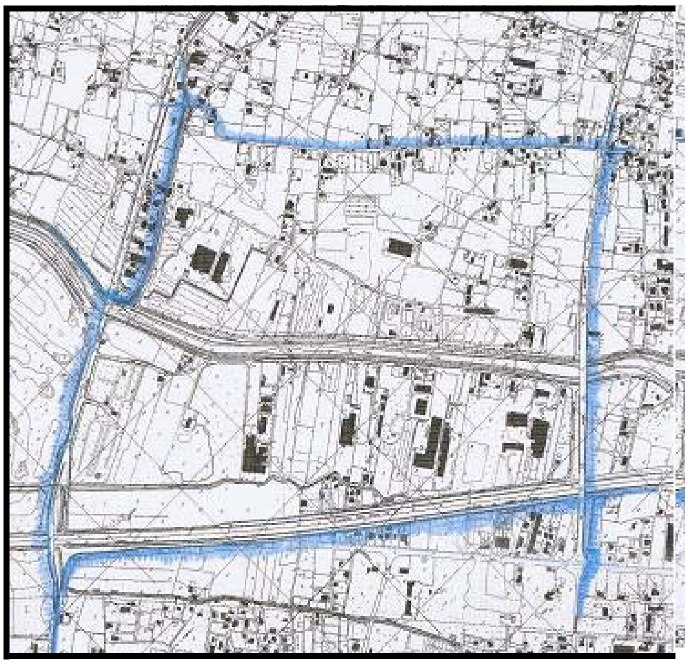
- **SINERIA** (Study centre, co-ordinator of the Plasos project), Spain

➢ ***The following are also involved at the planning and experimental analysis phase, as well as through co-operation to determine methodical rules and a future partnership to carry out specific measures:***

- **ERSU s.p.a.** (publicly owned co-operative organisation – waste recovery and treatment), Italy
- **GAIA s.p.a.** (publicly owned co-operative organisation – water management), Italy

Location of the project

The area studied is the town of Seravezza, on the north-western coast of Tuscany (Italy). The town is practically in the centre of the area known as "historic Versilia", which also includes the towns of Pietrasanta, Forte dei Marmi and Stazzema, and constitutes the meeting point on the northwest border between the provinces of Lucqus and Massa Carrare. Like the rest of Versilia, Seravezza is nowadays characterised by the development of various environmental systems made up of many complex natural, oro-hydrographic and historical/cultural environments. The border of the plain of Versilia is particularly characterised by being a continuous, homogeneous zone, and by a land relief system which, dropping towards the sea, is marked by a dense hydrographic network formed partly by the River Versilia, and partly by a secondary network of surface streams, mostly running perpendicular to the coast.

Figures 1 and 2: View of the whole River Versilia area and the Tuscan coast (left) and details of the preliminary study area (right)

More specifically, the area of interest for study lies either side of the River Versilia and lies in the centre of the open plain environmental system, in an area deeply characterised by the continuity of the watercourse. Even recently, it

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has been subjected to considerable alluvial phenomena and urban transformations connected to the establishment of dispersed production sites. The area partially covers the high-quality environment of the Seravezza region, covered by the local interest protection area of the ancient lake of Porta, which shows a degree of ecological fragility that must be taken into account in the project transformation phases. In addition, the regional setting analysed, near the areas intended for production, is characterised by areas where there are still agricultural operations and where highly residential areas alternate with scattered, craft industry buildings almost always built haphazardly, without a precise plan. Two different territorial settings can be distinguished: the first, between the river and Cugnia Street, where the production sites form a limited area and where agricultural land and residential districts predominate; while, the second area lies between the river and the motorway and is characterised by a denser production network resulting from various diverse, discontinuous developments conditioned by quality and operational standards, particularly with regard to the road network. In fact, the existing road network is characterised by traces of the historic situation linked to recent roads associated with the operation of the various existing production activities.

General information on the studied area

The lay-out of the Ciocche – Puntone production site has been the same since the mid-1970s, in accordance with the first town plan (factory programme) with the insertion of isolated production plots in high-quality environmental surroundings characterised by historic agricultural structures still present today. The planning history that has determined the current position of sites is particularly complex and generally results from a series of changes in planning instruments that have led to the territorial expansion of the industrial estate and exceedingly diverse technical development standards. As the planning history of the manufacturing area meant that serious administrative measures were necessary to rationalise and generally reclassify the site, also associated with water saving issues, the town of Seravezza has undertaken restoration activities carried out as follows:

- Precise determination of the appropriate borders of the production areas in terms of their environmental and territorial situation in order to assess the "limit" of the sustainable load they could stand.
- New census and direct record of manufacturing areas and buildings in order to update the council files on the sector.
- Predisposition of planning changes towards defining guidelines and objectives concerning the study area, with an indication of the measures used to guarantee integrity of resources.
- Restructuring of measures within the construction area in the local council's strategic plan to determine the sustainable quantities admissible under the environmental profile, in accordance with regional planning law.

Under the technical/disciplinary profile, the guidelines submitted to the study planned for the Plasos project are based on specific project strategy elements: the summary documents interpreting planning amendments and data concerning the local production situation.

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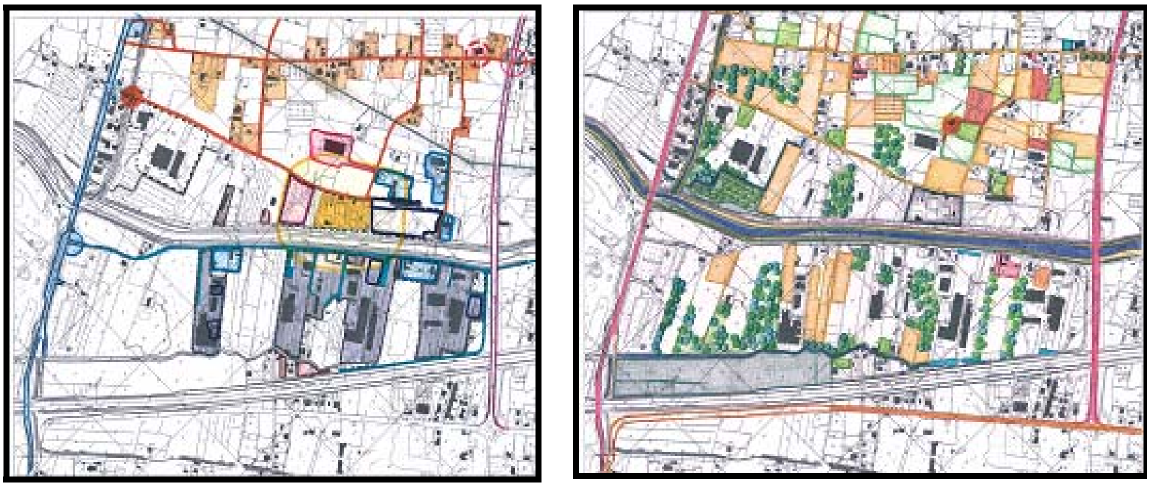
The summary documents (issued with the help of two specific maps) are an excellent setting for defining scheme guidelines and representing the territorial description of the strong and weak points of the site being studied: firstly, they define the resources and important and/or regionally significant elements. Secondly, they involve critical or degradable resources, and all matters that need to be dealt with during the scheme at local level in order to define sustainable choices.



Figures 3 and 4: Maps relating to the "interpretive summaries", "critical and/or degradable" resources (left), "important and/or significant" elements (right).

Meanwhile, concerning quantitative aspects, it is worthwhile reproducing the principal data resulting from surveys and planning reports. The files for production areas show 240 zones (besides the strategic sites) for a total of 253 businesses, which are widely scattered way around the plain region. Planning activity has not been able to rationalise the sites in question. In particular, within the area under study in the Plasos project, there are 40 production buildings, with the following characteristics:

- 24 buildings with a single business (equal to 68% of the total reported), which means the study area is generally characterised by activity with one single business per plot and a single building.
- 7 buildings with two businesses in the same building – a total of 14 businesses.
- 10 unused, deserted or abandoned buildings (either partially or totally): each building and its surroundings are therefore attributed the capacity for housing a single business.
- 49 businesses could potentially be installed (for existing planning locations).
- Various activities characterised by the deposit of materials: 8 facilities, of which 4 are from the stone sector and 3 from the construction sector.

As the manufacturing areas spread very extensively in the urban fabric of the plain, planning strategies aimed at creating an ecologically equipped manufacturing area would be better defined with the Plasos project, with the following objectives:

- The relocation on the industrial estate of activities and facilities now on incompatible sites in the rest of the town's territory.
- The reorganisation and reclassification of road infrastructures and attached developments.

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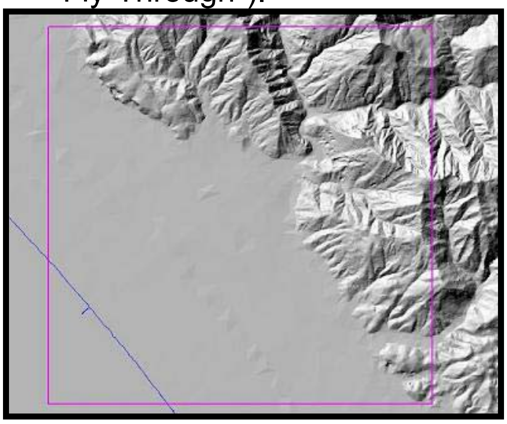
- The implementation and completion of existing general facilities, depending on the services provided to companies.
- Reinforcement of public spaces.
- Identification of work to mitigate risks to water and, more generally, to monitor the water cycle.

Summary of the experience

The project is based on the prior provision of knowledge bases for each individual sector, aimed at covering different disciplines, making it possible to achieve the effectively set objectives. In particular, a knowledge base has been established dedicated to identifying natural resources and components, with particular reference to the geological sector (geology, litho-technical information) and including aspects concerning seismic issues (seismic vulnerability), the hydro-geological sector (water table, hydrology and hydraulic vulnerability) and finally aspects connected to plant and animal ecosystems (vegetation, land use). Studies concerning resources and cultural components complete the knowledge phase: studies concerning the planning of sites, infrastructures, historical-cultural heritage and land occupation in accordance with agricultural activities.
The general supervision work indicated above, judged necessary in order to produce a satisfactory assessment of the project's (environmental and strategic) hypotheses is associated with the detailed bodies of knowledge prepared in order to ensure a proper level of performance by the project in the productive area mentioned below:

1. **Technical and representing the region** (instrumental record and digital plot of the project area, digital modelling of the site, GIS applications and "Fly-Through").




Figures 5 and 6: Digital terrain modelling (DTM) at 10m, vectorial 3D map of the C.T.R. (left), orthophoto with indication of the detailed ortho-rectification items (right).

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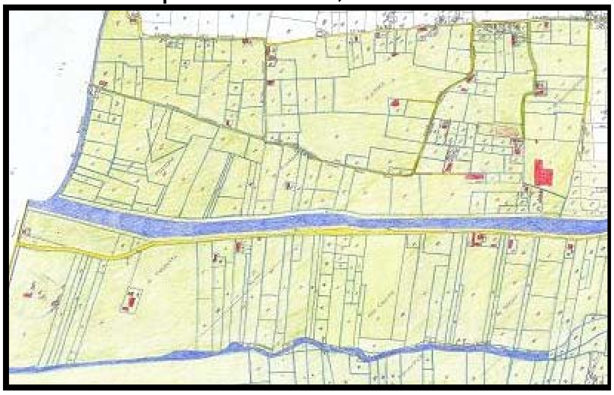
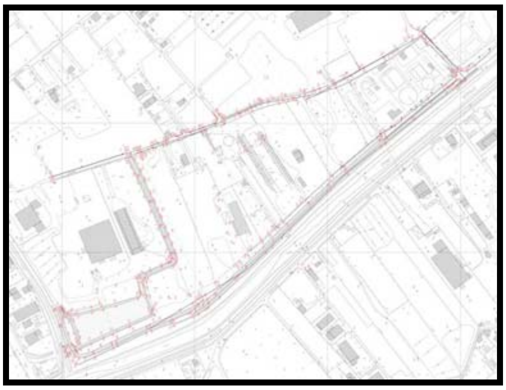
2. **Descriptions of the landscape** (iconography, historical atlases, photographic representations, detailed reports on natural, cultural and landscape elements;

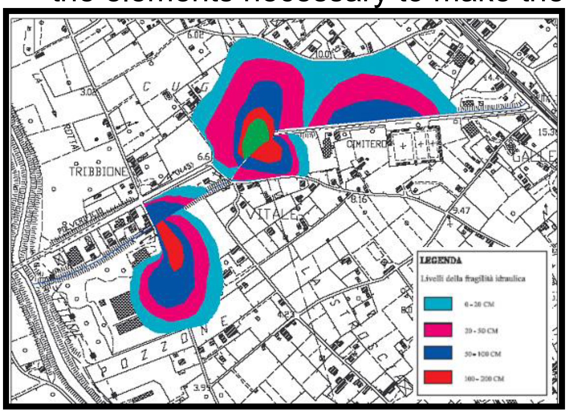



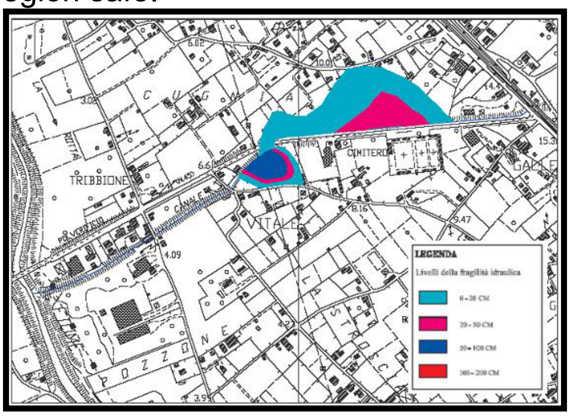
Figures 7 and 8: Maps extract from the Veccio land registry map - 1825 (left), and instrumental land relief records (right)

3. **Materials and technologies for production buildings** (architectural and technical structures and historical and contemporary elements);

Figures 9 and 10: Range of references to technological components and to traditional historical material (left) and contemporary material (right) for production buildings in the Versilia region.

4. **Detailed hydro-geological and hydrological views** and identification of the elements necessary to make the region safe.





Figures 11 and 12: Hydrological/hydraulic model of the Bonazzara torrent with indication of water levels and theoretical flood heights over 200 years (left) and 100 years (right)

In accordance with the aforementioned general objectives and criteria already mentioned, the project takes the form of constituting a knowledge base on the

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basis of the definition of guidelines and regional planning directives, including drawing up preliminary specific plans for collective facilities and services and regulations and prescriptions for establishing production sites that can be summarised as follows:

1) Regional planning guidelines and directives, particularly including:

- Those, in accordance with the adaptation of the collective water treatment sector, for establishing an industrial aqueduct optimising the use and consumption of water resources in the production area.
- Establishing an "ecological platform" where waste can be taken and a station for treating sustainable goods or, as an alternative, the selection and storage of animal-based by-products, with the former oriented towards advanced forms of recycling and the latter towards highly sustainable energy production.
- Establishing a lagooning station for rainwater recovery, optimising the use of water resources and linked to a local rainwater recovery network (at individual site level).
- The completion and integration of technological networks and primary developments, as important elements of the area.
- The reclassification and strengthening of facilities for recovering demolition waste and, more generally, construction waste, with particular attention to the recovery of stone by-products from the marble industry.
- The rationalisation of public spaces and existing infrastructure networks, with the integrated planning of new spaces and infrastructures intended to improve qualitative and operational standards in the production area.

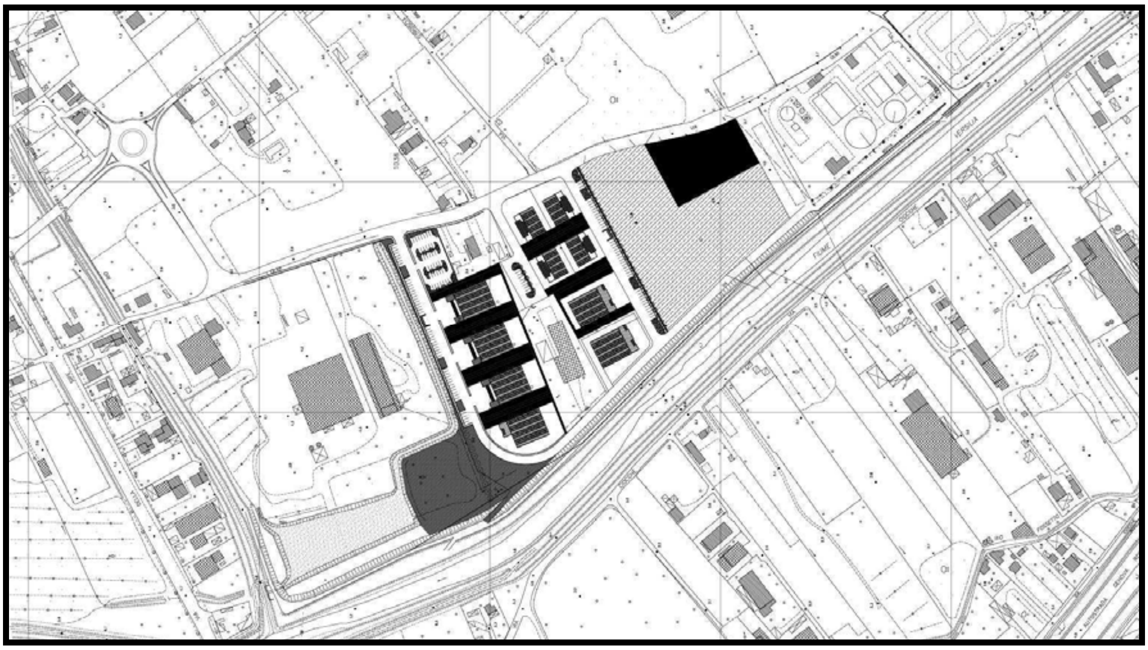

Figure 13: Planning use sketch map and regional planning elements and indications for the ecologically equipped industrial estate (original to 1:500 scale)

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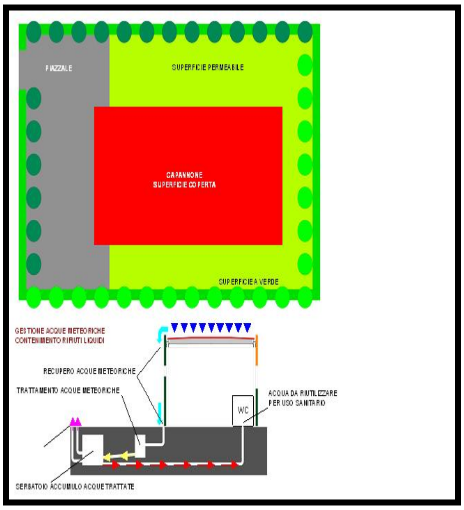

Figure 14 and 15: Sketch of the organisation of the "water cycle" and final lagooning plant (left), typical plan of the external layout of a building plot (right)

2) Prescriptions and rules concerning individual production sites, including, particularly:

- The planning definition of a site and the establishment of buildings with characteristics bringing together the operational conditions required for the proper operation of the aforementioned services and the determination of the architectural type compatible with the elements characterising the production area;
- Indication of the means and techniques of construction ensuring the active operation of the water cycle of the individual facilities and including specific conditions and standards regulating the layout of open areas;
- The definition of quality standards in accordance with specific local conditions, showing that they meet Tuscan regional (bio-architectural and bio-climatic) guidelines on sustainable architecture. Indications and conditions are provided for buildings concerning the use of active and passive solar heating systems, the energy consumption matrix and the collection and entry of waste.

Those planning elements are analytically described and detailed in a suitable synthesis report having the contents and the “guidelines” structure (good practices); those elements are supplied with specific descriptive tables containing maps, diagrams, graphs, perspective views, etc. that provide the major planning contents both in territorial arrangement scale (1) and in single building interventions scale (2).
Moreover, specific views have been reported in order to provide, through an oriented simulation, the landscape-perceptive relationships between planning elements and territorial context.

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Results and impacts of the experience

The elements and the contents of experimentation of the Plasos project find their natural application-declension and are carried out, in the case of Seravezza, in the following editing and approval of one specific "Piano Attuativo" (Realisation Plan) of public initiative (to draw up it to the senses of the article 65 of the L.R. 1/2005).

It is clear that the effectiveness and the efficiency of the planning measures outlined above must be checked on implementation and realisation of the forecasts established in the "Piano Attuativo" (Realisation Plan). In any case, during the execution phase and subsequently at the end of the tasks it is proposed to monitor.

- The effects on the local economic reality, and in particular on the capacity of the area to attract investors and to accept any enterprises willing to move from so-called non-compatible with the territorial and ambient arrangements ambits.

- The effects on both the components and the natural resources and in particular on the cycle of waters and and of effluents, evaluating also the "esternalità" (improving factors) that the project determines with regard to the management of the pool of public companies.

- The effects on the landscape and the historic-cultural resources, verifying in particular the modalities with which the recovery and the use of the particular territorial relationships which are considered meaningful for the community must be warranted.

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EXPERIENCE FILE 11

Name of ECOSIND project: PLASOS **Code: EXP 11 C4**

Title of the experience: Organisation of Urban Areas according to Environmental Standards
Location: Peloponnesus - Greece

Context

The main objective of the PLASOS project is to demonstrate the importance of the environmental evaluation of Industrial Ecology activities in the Mediterranean region in order to integrate the growth of the technological activities in a sustainable way.
There is still no single definition of industrial ecology that is generally accepted. However, most definitions comprise similar attributes with different emphasis, such as the following ones:

- Interactions between industrial and ecological systems.
- The study of material and energy flows and transformations.
- Integration of a multidisciplinary approach into planning schemes.
- Reduction of the impact of industrial systems on the environment.
- Integration of industrial activities into ecological systems.
- Enhancement of more efficient and sustainable industrial systems.
- Integration of eco-industrial guidelines into regional, industrial and research policy framework programmes.

The PLASOS PROJECT adapts the industrial ecology principles to each project, the aim of which is to establish criteria and indicators for analysing and monitoring the sustainability of industrial areas in the Mediterranean area.
The sub-project of the Union of Local Authorities of Arcadia, through the PLASOS project, is focused on the management of natural resources, and especially on the "Steno" aquifer.

Participants in the project

- **CUCD of Cerdanyola del Vallès - Coordinator** *(Consorci Urbanistic del Centre Direccional de Cerdanyola del Vallès),* Spain
- **Seravezza Town Council – Planning management and protection service,** *(commune di Seravezza),* Italy
- **Union of Local Authorities of Arcadia, Prefecture of Arcadia,** Greece

Location of the experience

The area for study and implementation of U.L.A.'s activities is the Mantiniako plateau, which is located in the centre of Arcadia and extends in the wider area

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of Mantinia and specifically the area included within the territory of the Municipalities of Tripoli, Korythio and Tegea.

General information on the studied area

The main characteristics of the project site are defined below:

- It is an area with industries, rural cultivations and settlements with no town planning. There are 13 industries and 442 craft centres and medium-sized Enterprises in the area.
- The aquifer supplies water to the Municipalities of Tripoli, Tegea and Korithio.
- The same aquifer also supplies the local industrial area of Tripoli with water.
- There are a large number of food industries at the specific area.
- Competition in the use of underground water resources between all the users.
- Continuously increasing water pumping.
- Continuously decreasing amounts of water available.
- Degradation of water quality..

Summary of the experience

The Union of Local Authorities of the Prefecture of Arcadia, within the framework of the «PLASOS» project, assigned two studies as parts of a subproject: a Geological – Hydrogeological study and an Environmental study, concerning the aquifer of Steno.
The aquifer is used for irrigation, for the supply of the Industrial Area of Tripolis and for the water supply of two municipalities and settlements of the area.
The aquifer is the most important natural resource for the industrial and urban development since, it is necessary for all kinds of activities and investments.
The main idea for the project came about due to of signs of increased quantities of nitric deposits in the aquifer. At the same time the level of underground water is getting lower.
The scope of the project under these circumstances was initially to evaluate at the condition of the aquifers, to prevent any further pollution, and to show how to reduce pumping.
The water quality in the aquifers is a critical point for the whole area of the Mantiniako plateau, since it is an agricultural area with many food industries and a continuously increasing population.
It is very important to mention that there were no previous studies or any other activities focused on the aquifers' condition and protection except of the environmental studies of the industries. This made the preparation of the studies more difficult and mostly tentative.

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Results and impacts of the experience

The industrial, financial and social development of areas where industry and population are expanding together in a close environment, and especially in agricultural areas such as the Mantiniako Plateau, is absolutely dependent upon natural resources.
The parallel industrial, domestic and agricultural use of water makes the management of the underground water resources extremely difficult. The water quality must be appropriate for all consumers. In this case the quality standards are defined according to the needs for potable water.
An integrated program for the protection of the aquifer of Mantiniako Plateau must include an exact definition of the hydrological basin's characteristics and dimensions, geological mapping, estimation of the hydrological budget, observation and recording of all the parameters that affect its quality, continuous chemical analysis of water from many spots, recording of all the uses of water, recording of all land uses in the area, environmental studies for defining all the possible pollution scenarios and finally a series of the proper protection measures.

➢ ***From an environmental point of view***

Due to the increasing concentration of nitric ions water quality is currently deteriorating, which could make water unfit for consumption in the short to medium term. The concentration of the nitric ions is the result of the excessive use of nitrogenous fertilisers until the last decade, the over-pumping of water, the weather conditions and the geological characteristics of the aquifer.
Under these circumstances, there are two types of suggestions for the management of the aquifer: for the maintenance of quality and for the reduction of consumption.

Suggestions for the maintenance of quality:

- Informing and sensitising all producers, farmers, agronomists and public services about the environmental dangers due to industrial wastes, fertilisers and pesticides.
- Careful and strict evaluation of environmental impacts, especially in high risk areas.
- Reduction of the use of the dangerous pesticides in certain areas.
- Reduction and controlling the use of fertilisers. Implementation of alternative –chemical-free fertilisation.
- Organising and implementing a program for observing and recording of all parameters affecting water quality.

Suggestions for the reduction of consumption:

- Informing and sensitising all the water consumers with regard to the reduction of water consumption.
- Second stage treatment and reuse of the water occurring after the treatment at the Wastewater Treatment Plant, for irrigation or industrial use.
- Alternative ways of irrigation with lower vaporisation.

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- Enriching the aquifer with water from water streams, especially from those which lead water to shallow-holes, with infrastructure constructions, such as interception stages.

➢ ***From an economic point of view***

The industrial and financial development of the area is absolutely dependent upon natural recourses.
This makes the availability and the quality of the water critical for the existence of all industries, and especially the food sector.
The completed plan for the management of water resources includes the implementation of waste-water reuse methods and the utilisation of wastes for producing energy.

➢ ***From an social point of view***

The impacts of all environmental problems are critical for the local societies.
At the same time collaboration with local people is very important for the implementation of the environmental strategy, which must be socially acceptable.
For these reasons, the action plan of the project is based on informing and sensitising all the water consumers with regard to strategies for the reduction of water consumption, and all producers, farmers, agronomists and public services with regard to the environmental dangers of to industrial waste, fertilisers and pesticides.

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EXPERIENCE FILE 12

Name of the ECOSIND project: RECIPOLIS **Code: EXP 12 C4**

Title of the experience: Experience of planning for the requalification and the reorganisation of a degraded industrial zone in Viladecans
Location: Catalonia - Spain

Context

In the 1970s, many industrial zones were developed in the urban suburbs in a disorganised manner, free of legal constraints. This development, due to rampant industrialisation, has had important environmental consequences: pollution of the soil, the subterranean and surface waters, and the air.
With the new environmental regulation, important changes will have to be made. But for small companies, these changes will result in costs that are difficult to bear.
It is also difficult for them to keep abreast of the rapidly changing regulations. Thus it is necessary to assist these companies in the process of change.

This is particular true for scrap metal sector, which is made up on the main of traditional family businesses. The impact of this activity is important, in particular with regard to emissions of heavy metals, used oil, and gasoline in the ground.
Help is needed to restructure this activity, which is indispensable for the recycling of the used vehicles at the end of their working lives.

Participants in the project

- **Viladecans Town Council** *(Ajuntament de Viladecans)*, Spain
- **VIMED - Municipal enterprise of Viladecans Town Council** (*Viladecans Mediterrània - empresa municipal de l'ajuntament de Viladecans),* Spain
- **Consorzio Pisa Ricerche,** Italy,

Location of the experience

The project is situated in Viladecans, an inland town of some 60,000 inhabitants, situated 12 kilometres south of Barcelona, 5 kilometres from the port and 1 kilometre from the airport.
Thanks to its geographic position of the city underwent a sudden population increase of the population in the 1960s and 1970s, which led to uncontrolled development in the centre and the suburbs.

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The main activities of Viladecans are agricultural and industrial; however, there are zones, such as the one that concerns this project, which are in precarious conditions which await:

- Being brough in line with standards
- Being used as a model of recovery of the territory.

General information on the studied area

More particularly, the project concerns an industrial zone which contains 42 small and medium-sized firms specialised, for the greater part, in the recycling of vehicles at the end of their working lives and inert materials (in particular, scrap iron). Important quantities of metals are stored in the zone, and this activity there are large gaps with regard to the logistics and the definition of environmental criteria.
This activity began at the beginning of the 1970s, when the municipality of Viladecans accepted the establishment of scrap metal businesses on land situated in the middle of the delta of the river which crosses the municipal zone of Viladecans.

This new activity was the consequence of the urban development of the suburb of Barcelona, which wished to build new residential zones in the area where were the scrap metal businesses had been established.
This new activity gave rise, on one hand, to the abandonment of the pre-existent agricultural activity, and the other hand, to the progressive contamination of the ground and the subterranean waters, as well as the accumulation of old, obsolete vehicles. This new type of activity entailed complementary activities, such as that of the tyre business.

The consequence of all these activities, which are on the whole quite disorganised, has been the increased degradation of the landscape and the environment. The new legal regulations and the European, Spanish and Catalan standards call for rapid measures to be taken to improve the situation.
The responsibility of the operators has not yet been established; nevertheless, it is clear that public intervention is required if the necessary transformations and adaptations are to be carried out.

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Image 4 : aerial view of the industrial zone of Viladecans

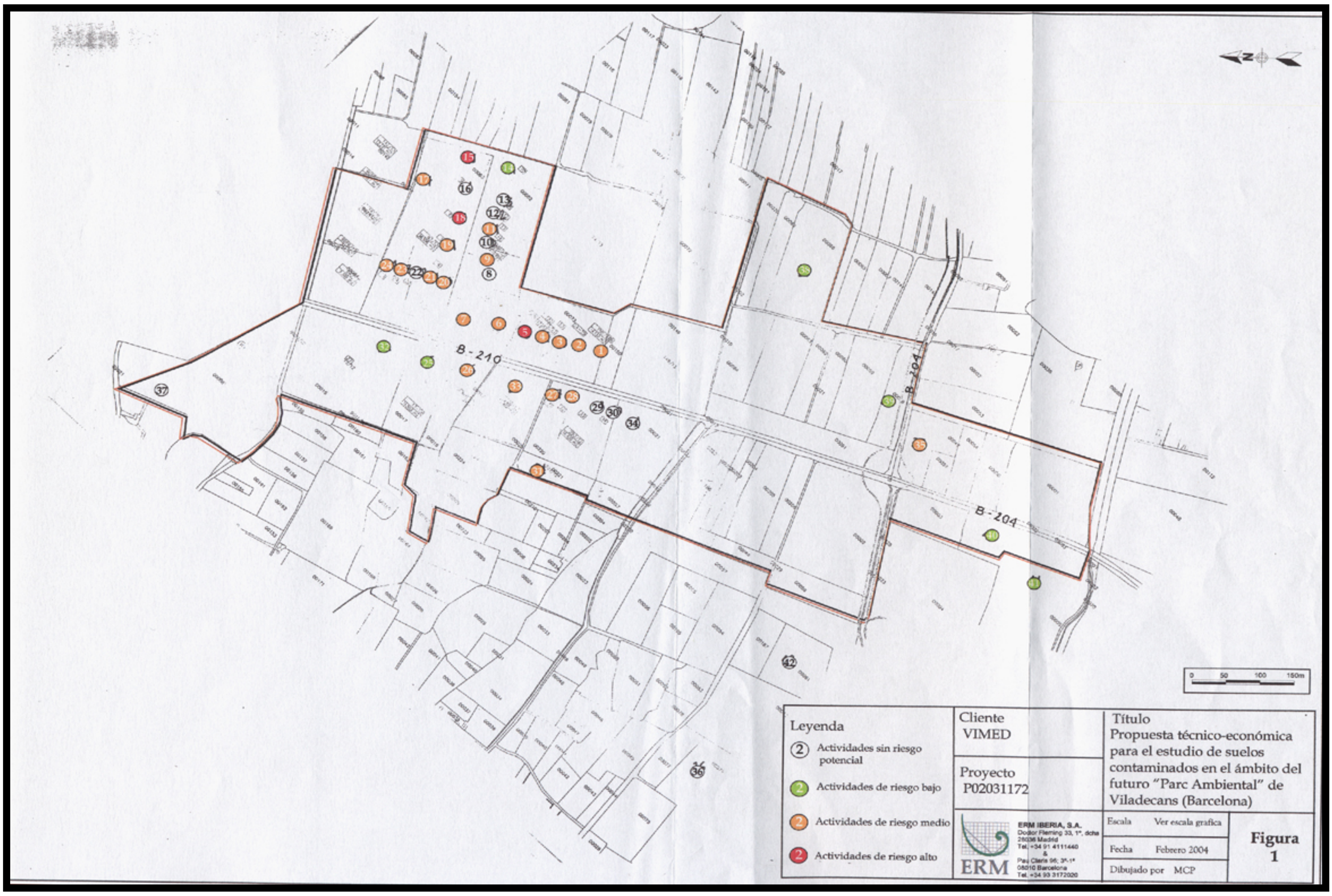

Figure 2: Extract from a study concerning the pollution of the water and the ground (In white, activities with no potential hazard; in green, activities containing a light hazard; in

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orange, activities representing an moderate hazard; in red, activities constituting a high hazard).

Summary of the project

The objective of the project was:

- Draw up a model to relocate the existing activities of recycling in the industrial zone of Viladecans.
- Planning the land use which would permit good landscaping and environmental integration with the aim of establishing an environmental park.

To reach these objectives, several studies were carried out:

- An inventory of the existing activities on the industrial zone.
- A pre-plan for the reorganisation of the land in the industrial zones.
- A hydrological study to verify the degree of contamination of the subsoil and the water,
- A landscape study to permit the integration of the industrial zone into its natural setting,
- A viability study of the relocation of the present companies in the industrial zone.

Results and impacts of the experience

From an environmental point of view

Concerning the pollution of the subsoil and the water, the study revealed less important pollution than expected.

The conclusions of the landscape study defined 2 main conditions for the permanence of the activities on the current zone. It is necessary to have:

- A low density of establishments.
- A very high quality of the zone.

From an economic point of view

The viability study of the company's relocation revealed that, economically, it was more viable to transfer companies to a new industrial zone than to try to reorganise the existing industrial zone.
This is due to:

- The substantial increase in the price of land, in view that Barcelona is growing rapidly and that the industrial zone is in suburb in Barcelona.
- The fact that the parcels of land on which companies are established were initially intended for an agricultural use.
- The fact that it is necessary to clean up the parcels of the zone.
- The conditions established by the landscape study.

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It was thus decided to give the land back to its initial agricultural use after the cleanup and the relocation of the present companies to a new industrial zone.

- ***From a social point of view***

Scrap metal dealers absolutely have to adapt fully to the European standards on the recycling of vehicles at the end of their working life, but now it is hardly feasible in view of the current conditions of the industrial zone of Viladecans. The relocation of companies towards a new industrial zone will probably allow standards to be reached more easily, and thus will provide an improved working space for the workers.

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EXPEXPERIENCE FILE 12A

Name of the ECOSIND project: GPP **Code: EXP 12A C4**

Title of the experience: Guide of Green Procurement in Industries of Arcadia Prefecture
Location: Peloponnesus - Greece

Context

The Project ECOSIND is being carried out within the framework of the European Community Initiative INTERREG IIIC, which aims to promote transregional collaboration in the EU during the period 2000-2006.
The "Green Procurement" sub-project of the Ecosind Project, includes the preparation of Guides, which should be received from the industrial enterprises to implement their "green procurement" processes.

Participants in the project

- **Pescara Town Council** – leader partner, (*Comune di Pesacara),* Italy
- **Union of Local Authorities of Arcadia, Prefecture of Arcadia,** Greece

Location of the experience

The development of the "Guide of Green Procurement in Industries of Arcadia Prefecture" was based on the recording of the existing situation in the I.A. of Tripoli by visiting industries in the region and using questionnaires.

General information on the studied area

Area of study and implementation of the activities that the Chamber of Arcadia has undertaken is the Industrial Zone of Tripoli in Greece. The I.A. was created in 1989, and activities commenced in 1990. It is the 12th legislated industrial area of Greece. It is located 160km away from Athens and 3km from Tripoli. It is the closest industrial area to the capital of Greece, and highly organised. Of the the total area of the I.A., approximately 52% is covered with small and medium-sized scale industries, in diverse and non-homogeneous sectors.

> ***Characteristics***

- Total extent, 1.620.000 m^2
- Industrial plots, 1.054.000 m^2
- Craft-based plots, 222.000 m^2
- Communal area, 90.000 m^2
- Streets, 125.000 m^2

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- Green, 129.000 m^2

➢ ***Infrastructure***

- Internal road network
- Electric lighting network of roads
- Network of water supply
- Drainage network
- Central unit of waste cleaning, in collaboration with the Municipality of Tripoli
- Electrification - medium voltage supply
- Telephone network
- Road connection with national network

➢ ***The characteristics of the region of study can be summarised as follows:***

- Region with small and intermediate scale enterprises.
- Fast growing industrial area.
- Enterprises with small indicator of environmental conscience.

Summary of the experience

The "Guide of Green Procurement in Industries of Arcadia Prefecture" includes those actions that should be received from the industrial enterprises to make their procurement more ecological.

The guide records the existent international experience, identifies important environmental indicators that are connected with green procurement procedures and also identifies the most crucial benefits and challenges that result from the adoption of such strategic procedures.

Information was collected on the inflows and outflows (primary and auxiliary materials, natural resources, energy, materials of packing, products, waste, etc.) of the industrial sectors from the region of study, and the data were subsequently analysed.
Methods of determination of materials/goods/services that are important in the reduction of waste from production are presented, along with materials/goods/services that can be reused or be recycled.

Practical directives on making the processes of supplying industries more ecological are pointed out, aiming at, the ecological awareness of industries, the information and examination of the potentials and the reduction of environmental pollution.
The most important benefits and challenges that arise frown the adoption of strategies of such procedures are defined.

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Results and impacts of the experience

➢ ***From an environmental point of view***

The application of "Green Procurement" substantially reduces environmental impact and incorporates environmental policies into industry activities.
These green processes decrease the environmental impact of industrial activities, and in particular the pollution that is created during the manufacturing of products.
Certain environmental utilities that have been recorded include the following:

- Production using fewer materials, water, energy, etc. and less waste for management.
- Manufacture reliable and durable products requiring less energy or consumables in order to function.
- Increase of availability of resources for products or services by avoiding likely damage in the environment.
- Reduction in the use of natural resources in the manufacturing phase. .
- Reduction in the use of natural resources in at the phase of use.
- Reduction in production of waste at the end of useful life and throughout the life-cycle of the product.
- Decreased content of dangerous materials via the prohibition of substances.
- Continuous improvement of environmental performance of products and services with the growing of green market and the application of new legislations.

➢ ***From an economic point of view***

Green Procurement represents a shift of interest in the reduction of environmental impacts of products and services, not only activities.
The industry faces a series of obstacles in the examination of the environmental demands and legislation that is owed mainly in the perception of environmental aspects as restrictions and expenses, and not as opportunities and commercial profits.
The adoption of the Green Procurement policy has resulted in the growth of the market of green products. If the industry demonstrates the environmental advantages of the products, it will exploit this new, extended market as a pioneer in its sector, it will increase the competitiveness and its share in the market, and it will improve the relations of the customers and the institutions involved.
The legislation places requirements in the environmental characteristics of products (e.g. consumption of energy) in order to improve their quality and the protection of the environment. If the manufacture of products satisfies the requirements, operational costs are reduced and the profits are increased. The measurements and the environmental reports encourage the better management of resources, which leads to lower consumption of energy, water and raw material. The design of more "environmentally sound" products decreases the inflows at all stages of life cycle (e.g. inflows of materials, use of water and energy, waste production) and costs.

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Consequently the supply of green materials may result in higher initial prices for habitual products; however their total cost (use and maintenance included) will generally be lower. When a product is bought its future costs are purchased too. These future costs are related to the consumption of energy, safety, the maintenance of the product, the management of its waste, etc., and are lower for green products.

➢ *From a social point of view*

In recent years, the protection of the environment has been of great importance in all sectors, and consumer awareness has been increased. The global market is constantly pushing for the manufacture of more environmentally friendly products. In an intensely competitive environment, industries should comply with the directives of sustainable development.

The above phenomenon has finally become visible. The social perception of high-quality, environmentally friendly products transfers the pressure from the producer to the supplier in multiple ways, e.g.:

- Businesses select suppliers that have a certified environmental management system such as ISO14001 and EMAS,
- Businesses ask their suppliers to produce their products in an environmentally friendly way.

Beyond the environmental and economic benefits that may acquire from the application of Green Procurement, the industry gains the recognition and support of the society and it improves its profile:

- The production with environmentally friendly criteria improves the perception of the industry in the marketplace, and makes it more competitive.
- The exhortation of innovating thought inside the company leads to increased innovation and facilitates the creation of new opportunities in the market.
- The title and the image of the product are strengthened thanks to the attention to detail on environmental matters and innovating behaviour.
- The improved qualities of the products are appointed by increased resistance and functionality and by ease of repair and recycling.
- Products acquire increased additional value thanks to their improved environmental performance during their whole life circle and are also of better quality.

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EXPERIENCE FILE 13

Name of the project: Geneva **Code: EXP 13 EXT**

Title of the experience: Industrial ecology in Geneva – creation of eco-industrial synergies between the companies of the cantonal territory.
Location: Geneva - Switzerland

Context

The experience carried out in Geneva comes within the framework of the sustainable development policy of the canton of Geneva. This policy is based on the Agenda21 Programme. In Article 12, it is stipulated that the State has to encourage "the consideration of synergies between economic activities to minimise their impact on the environment ".

A workgroup called Ecosite was created to work on the application of this article. It groups together the main services of the State of Geneva. An initial study of industrial metabolism of the Canton was made in 2003-2004, using the MFA (Material Flow Analysis) method.

The study made it possible to draw up an initial global cartography of the main streams and the stocks of materials and energy which structure the functioning of the Canton, and to identify a certain number of actions to be carried out, particularly in the field of the energy, water and construction materials.

At the end of 2004, the Ecosite workgroup decided to go farther and to introduce a dynamic of enclosing the streams of materials, water and energy within the local economic network. The company "Systèmes Durables" was engaged to carry out research into synergies between the industrial companies of the territory.

Participants in the project

- **The State of Geneva** *(Etat de Genève),* Switzerland
- **The Ecosite workgroup**, constituted by the main services of the State:
    - Waste service,
    - Water service
    - Energy Service
    - Industrial Services,
    - Foundation for Industrial Land,
    - Economic development Service
- **ICAST - scientific consultant** (Suren Erkman), Switzerland
- **Systèmes Durables** - technical consultant: (Cyril Adoue), France.

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Location of the experience

The project concerns the whole territory of the Canton of Geneva. This highly urbanised territory covers 245 km^2 and has approximately 440 000 inhabitants.

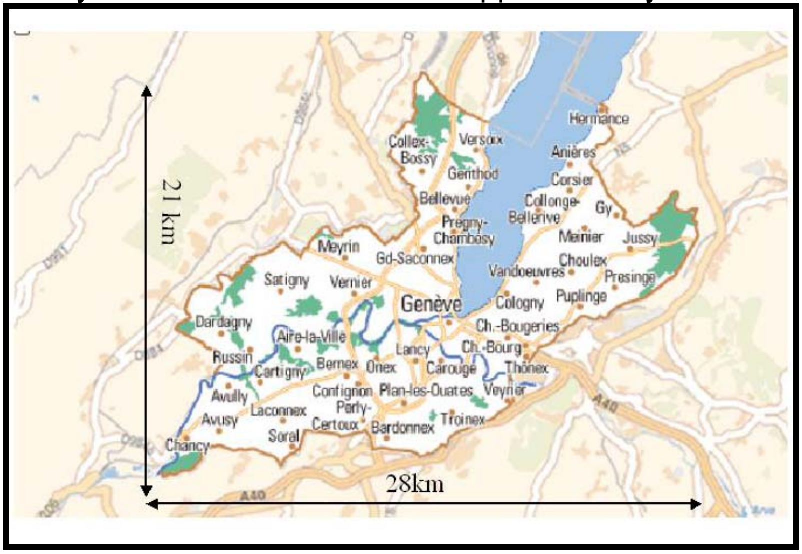

Figure 1: Map of the Canton of Geneva

General information on the studied area

The canton of Geneva is not very industrialised and has only 130 industrial areas with more than 20 employees. Activity is especially dominated by the tertiary sector, with banks and specialised agencies of the United Nations (OMS, WTO, HEARS).

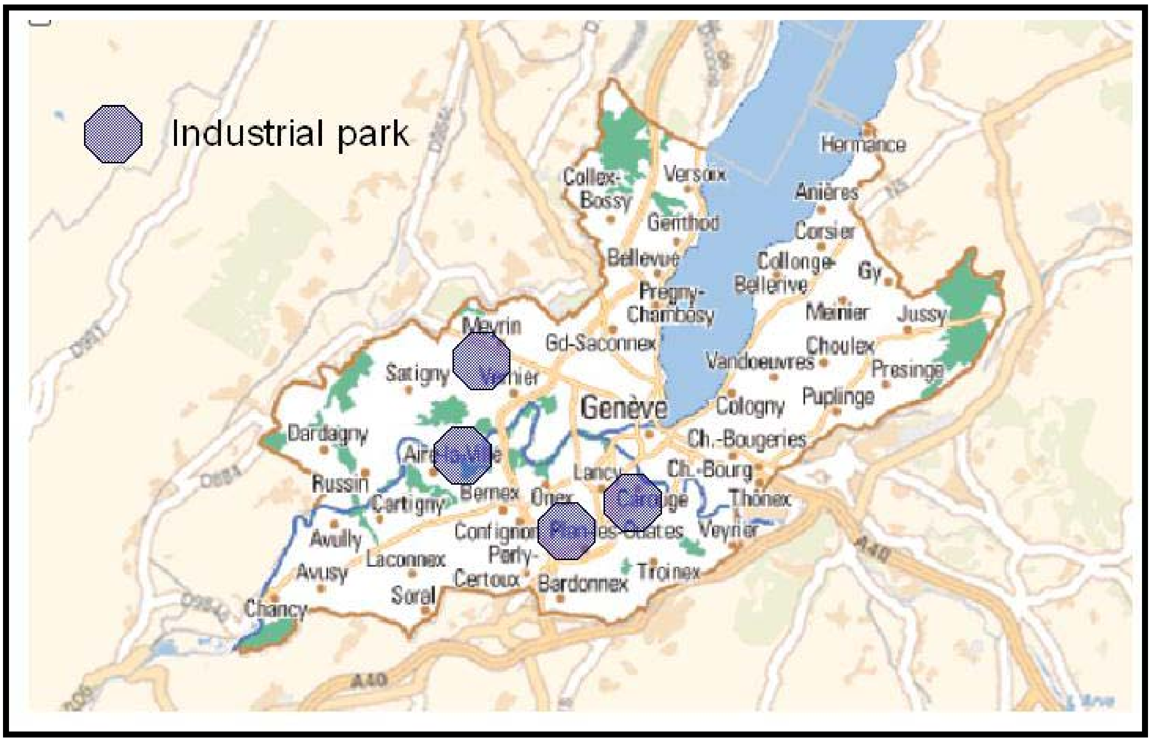

Figure 2: Map of the industrial parks of the Canton of Geneva

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Summary of the experience

The project began in January, 2005. The method used is the one developed by the Dr. Adoue. Forty-three companies were selected and contacted by E-mail; 19 agreed to participate.
They belong to varied sectors: production of industrial machines, printing offices, joiner's workshops, agri-food industries, fine chemistry/pharmacies, production of construction materials and production of household goods, etd.

Two research teams were formed by Systèmes Durables Systems to carry out the studies and the visits to companies. For every company, a detailed balance of input and output streams of water, materials and energy was drawn up. The research began in February, 2005 and ended in July. A total of 800 input and output streams were identified.

The streams have been formatted and stored using the ISIS software program, which was kindly supplied by EDF. Conceived by Dr. Adoue, ISIS is the first research software for synergies developed in French. Other more successful and more ergonomic tools have subsequently been developed, such as, for example, Presteo (file of technology TEC 4 EXT).

Substitution and mutualisation synergies were looked for. The definitions of these two types of synergy are given below:

- ✓ **Substitution Synergy**: *Effluents and waste from production become potential resources for other activities. The streams of energy that are discharged into the environment (surplus vapour, gaseous effluents or warm liquids) become potential sources of energy for nearby companies.*

- ✓ **Mutualisation Synergy**: *When two nearby entities consume an identical product, the pooling of their needs may result in a decrease in supply costs, notably by rationalising the transport links for delivery. In the case of close energy needs in vapour or in compressed air, for example, the mutualisation of production can allow greater efficiency to be reached, resulting in lower costs and reduced environmental impact. The mutualisation of the waste treatment can finally make it possible to reach sufficient quantities to find more effective and economic solutions, such as recovery.*

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Results and impacts of the experience

➢ ***Materials streams***

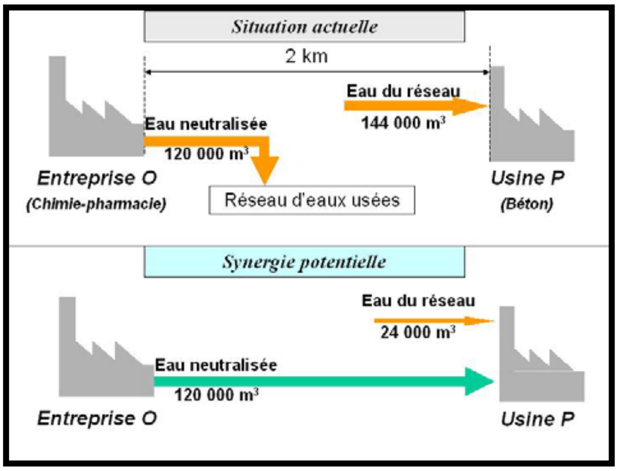
Tracks of synergies between these 19 companies were identified for 16 main types of streams of materials. Below are the materials in question:

- *Deconstruction waste*
- *Cardboard*
- *Organic solvent*
- *Wastes from food*
- *Black water*
- *Acids*
- *Sodium hydroxide*
- *Used inks and pigments*
- *Used materials from wiping*
- *Blankets from printing plants*
- *Fly ash*
- *Wooden pallets*
- *Big-bags*
- *Beams*
- *Steel knives*
- *Polymethylsiloxane hydride*

➢ ***Water streams***

Tracks of synergies were also identified for streams of water with:

- *Exchanges of demineralised water*
- *Industrial wastewater recovery*
- *Creation of water loops inside an enterprise*



The figure on the left illustrates an example synergy track between a chemical-pharmaceutical company and a company producing concrete. The first former discharges 120,000 m^3 of neutralised water and the second consumes 144,000 m^3 of drinking water to produce its concrete.

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➢ ***Energetic streams***

Six synergy tracks were identified for energy streams:

- *Energetic recovery of wooden wastes*
- *Energetic recovery of oil and industrial fats*
- *Recovery of used bricks of aromatic herbs*
- *Mutualisation of compressed air production between nearby companies*
- *Recovery of heat discharged by certain companies*
- *Production of biogas from agri-food wastes*

Tracks of synergies were also identified for the transport of goods and raw materials. Some of the companies visited are in charge of the transport of their input streams of raw materials or of the delivery of their products. The distances can be important, going beyond the borders of the Canton or even of Switzerland. Cars and lorries chartered for the occasion arrive or come back empty. This situation entails additional costs and environmental impacts. The companies concerned are interested in setting up a system of "co-trucking" or "co-transport by wagon" with the other companies.

➢ ***Creation of activities***

The output streams are rarely adapted to the process of recovery. They must be depolluted, repaired, calibrated often even simply collected and grouped together. The creation of synergies between the companies within a region thus generates activities and employment.

Seven activity creation tracks were identified:

- *Solvent regeneration*
- *Setting up of a wiping service*
- *Recovery of cutting oil in black waters*
- *Recovery/repairing of pallets*
- *Crushing/grading of materials from deconstruction*
- *Pulping of recovered cardboard*
- *Production of food for animals*

Further to the study, the Ecosite workgroup asked ICAST to go thoroughly into the study of the feasibility of the identified synergies. No precise indicators have been set up yet.

However, the nature of the main profits that the various actors (community and manufacturers) can except is:

➢ ***From an environmental point of view***, increasing the waste and effluent recovery rate, limiting the saturation of waste treatment capacities in the canton, a more pragmatic use of water and energy resources, the conservation of the local resources in aggregates.

➢ ***From an economic point of view***, the reduction of the cost of waste for the manufacturers and the community, the creation of new activities and the permanence of the existing installations.

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- ***From a social point of view***, the creation of employment and the integration of the industry into an improved Genevan landscape.

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EXPERIENCE FILE 14

Name of the project: ECOPAL **Code: EXP 14 EXT**

Title of the experience: ECOPAL, an alliance of companies engaged in the take up of Industrial Ecology
Location: Dunkirk - France

Context

The mission of ECOPAL is to promote Industrial Ecology in a territory by gathering the businesses interested on the concept, linked with institutional and civil society involvement.
The objective of ECOPAL is to bring together and to federate:

- Companies (from SMEs to large companies),
- Local and territorial communities willing to work on industrial ecology.

The principle is to build dynamics of collaboration between the members of the association in order to implement eco-industrial synergies.

For example, an eco-industrial synergy is the reuse of Coca Cola factory cans in the SOLLAC steel-works . Thus material flows become resources.

The ECOPAL association is the first experiment of industrial ecology in France. Gaz de France initiated the creation of the ECOPAL association using the Kalundborg experience (File EXP 18 EXT) as a model.

Created in February 2001 by industrialists established in Dunkirk, it has become a joint undertaking, carried out by economic and institutional actors of the Dunkirk basin.
Currently with over 80 members, ECOPALI was founded under the impulse of large companies such as Sollac (Arcelor group) and Gaz de France, as well as leaders of SMEs and local communities, in order to take concerted actions in favour of industrial ecology.

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Participants in the project

- **ECOPAL** (*Economie, partenaires dans l'action locale*), France

- This association brings together:
  - **Enterprises**,
  - **The "Nord Pas de Calais" Regional Council,**
  - **The Chamber of Commerce**
  - **The Municipality of Dunkirk.**

Gaz de France has a stimulating role, having invested in launching, running and offering support to ECOPAL. This implication supports its image of innovator and federator of sustainable development initiatives.

Location of the experience

The Dunkirk area is a heavily industrialised area which for a long time has had problems in linking industrial activity with environmental quality.

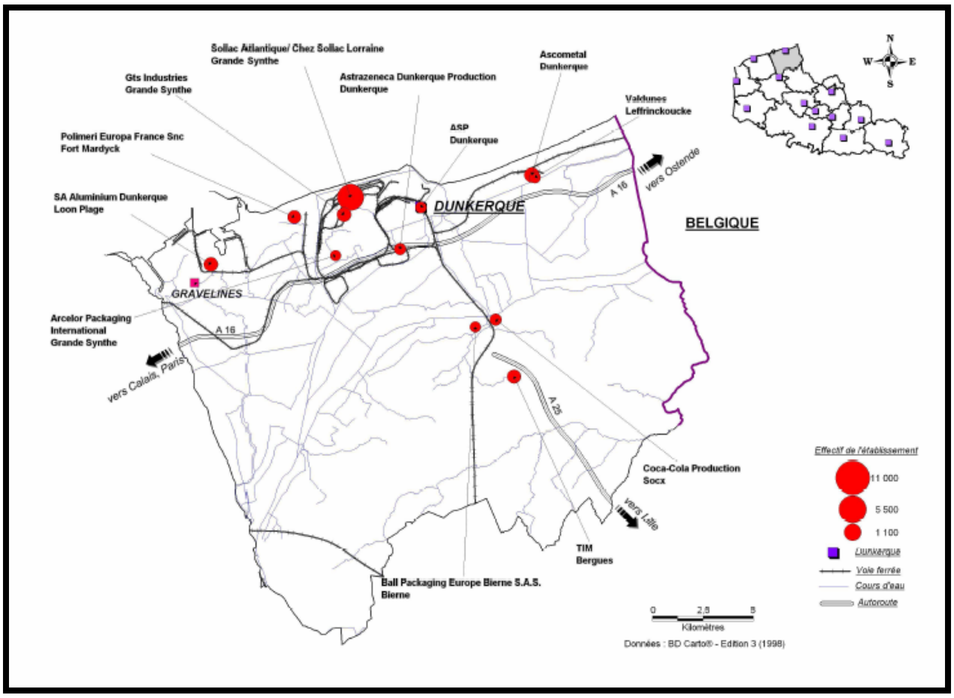

Figure 1: Map of Dunkirk's industrial area

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The following map shows key industrial areas, including the Grande-Synthe industrial zone where ECOPAL is based:

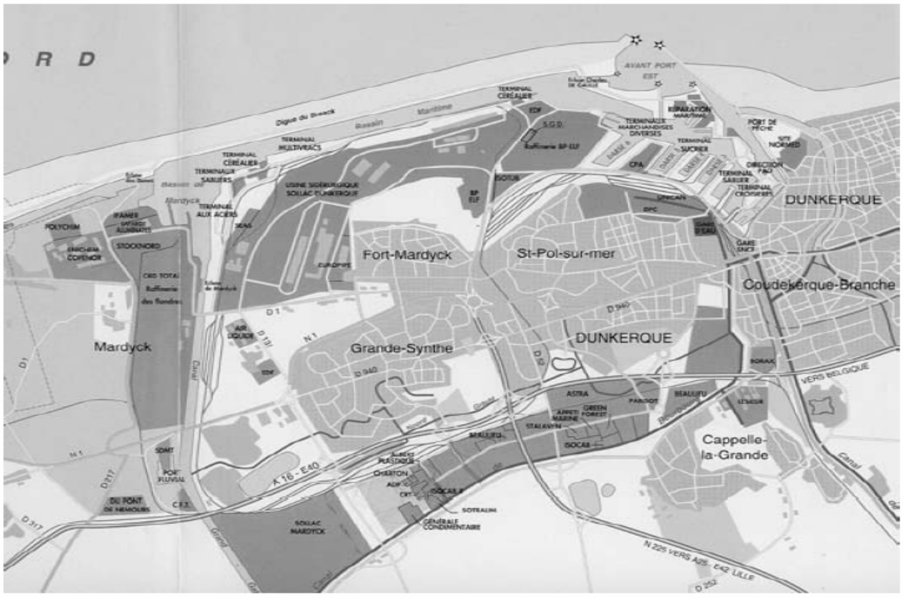

Figure 2: Key industrial zones where ECOPAL is based

General information on the studied area

In September 1999, the city of Grande-Synthe decided to make the industrial zone of Deux-Synthe the first French experimental site of industrial ecology. Gaz de France and Sollac Atlantique were interested in the project, and in February 2001, the ECOPAL association was created.

At the time of launching, in September 1999, a pilot study on the possibility of developing industrial ecology within the framework of the Grande-Synthe activities zone and a research project were carried out with the participation of around 30 businesses from the area. This was to identify the conditions of success of this experiment of industrial ecology. A small group of companies participated in this diagnosis of waste recovery.

Since then, waste recovery has been implemented in numerous ways, such as e.g. transforming plastic packing into wool, or sand slag into raw material for ceramics companies.

Summary of the experience

ECOPAL uses a different approach according to whether the interlocutor:

- Works within large groups established in the agglomeration of Dunkerque (Total, Lafarge, Coca-Cola, EDF, Lyonnaise des Eaux, Dalkia, Air Liquide, among others),
- Is the leader of an SME.

To multiply industrial ecology initiatives at business level, the ECOPAL association was created, grouping together local industries and public administration bodies. The aim is to find specific solutions for recycling industrial waste, regarding both materials and energy flows. One solution that has been

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implemented is that of recycling gases from steel blast furnaces in an electricity power plant.

ECOPAL's mission is:

- To optimise costs, safeguarding the environment and creating jobs.
- To enhance and trigger emerging projects, even modest ones, facilitating an active partnership between economic actors and local authorities.
- To incite companies to get involved in the local development of the territory in which they are established and thus to contribute to territorial conservation.

ECOPAL has designed its industrial ecology activities for two types of groupings of company:

1. Large groups or companies.
2. Small and medium-sized companies or industries.

ECOPAL succeed in creating the dynamics of collaboration between the members companies. It was essential for the success of its missions.

- ***Activities with large companies***

The project "Undertaken Synergy" involves various large companies in Dunkirk:

- *Air liquide,*
- *Ajinomoto,*
- *Euroaspartame,*
- *Aluminium Dunkerque,*
- *Coca-Cola,*
- *EDF / Dalkia,*
- *Europipe,*
- *Gaz de France,*
- *GTS Industries / Lafarge Aluminates,*
- *Lyonnaise des Eaux,*
- *Port Autonome de Dunkerque,*
- *Total Fina Elf,*
- *Sollac Atlantique...*

This has resulted in the creation of the 'Waste club'. The principle is simple: waste from some companies is used as resources for the others, which thus makes it possible to optimise energy flows.

ECOPAL created the "waste club": managers of waste and by-products from big companies can exchange by-products as well as any information regarding the experiments for waste recovery on neutral ground.

The project has resulted in the creation of thematic commissions that respond to the industrial needs, analysing eco-efficient recycling solutions for various materials (wood, soluble oils, paint, gums and tissues, among other materials) .

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In order to implement industrial ecology projects, large companies such as SOLLAC start by a thorough input/output analysis:

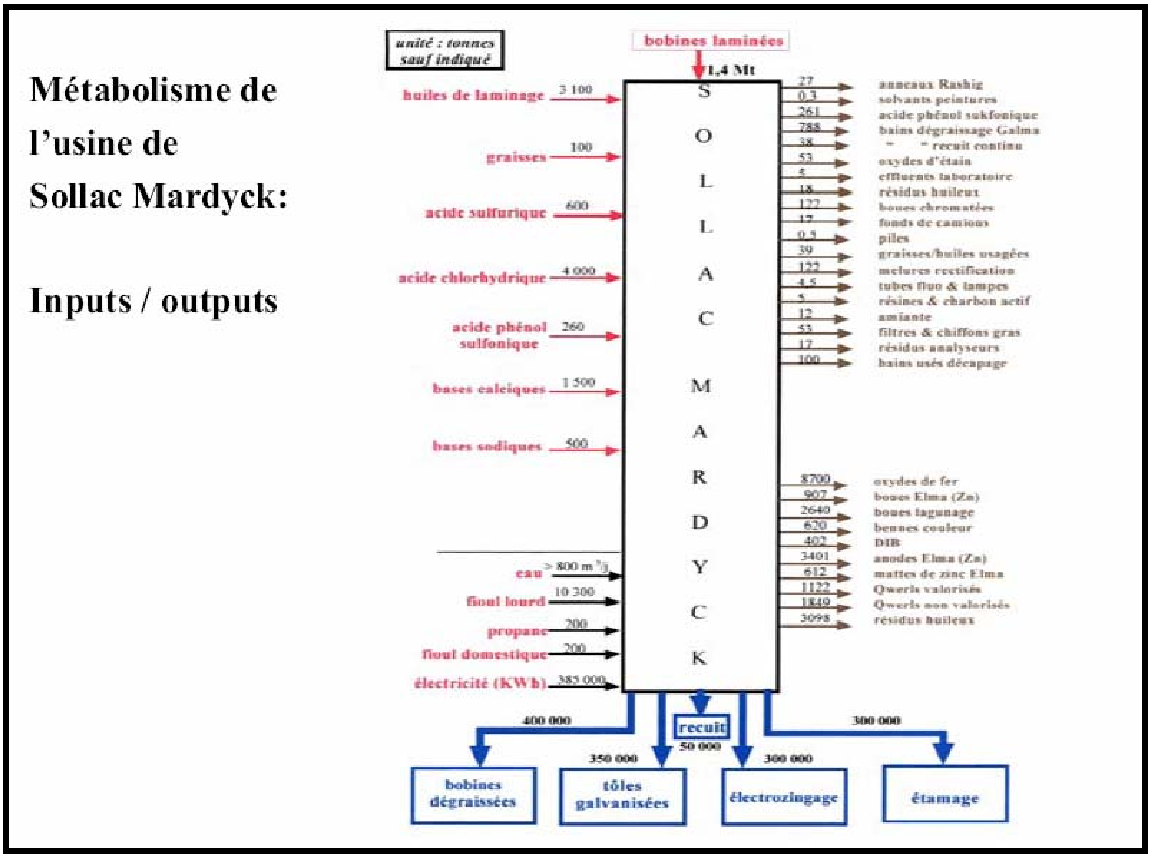

Image 3: Industrial metabolism of the Sollac Mardyck company

- ## *2. Activities with SMEs*

The "Increase the dynamism of the zone" operation, aimed at SMEs in the Dunkirk area, has a less demanding starting point. It starts by evaluating their daily concerns, those which directly improve their processes or their activity.

Furthermore, tests are undertaken to assess the recovery of waste. These tests make it possible to design a flow chart of materials in order to illustrate this experience of industrial ecology. In addition, in partnership with SMEs, ECOPAL encourages the regrouping and the assembly of common actions, such as the mutualisation of services and the improvement of waste management.

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For this territorial analysis ('*Animation Dynamique Territoriale*'), the metabolism concept has been designed and is being implemented:

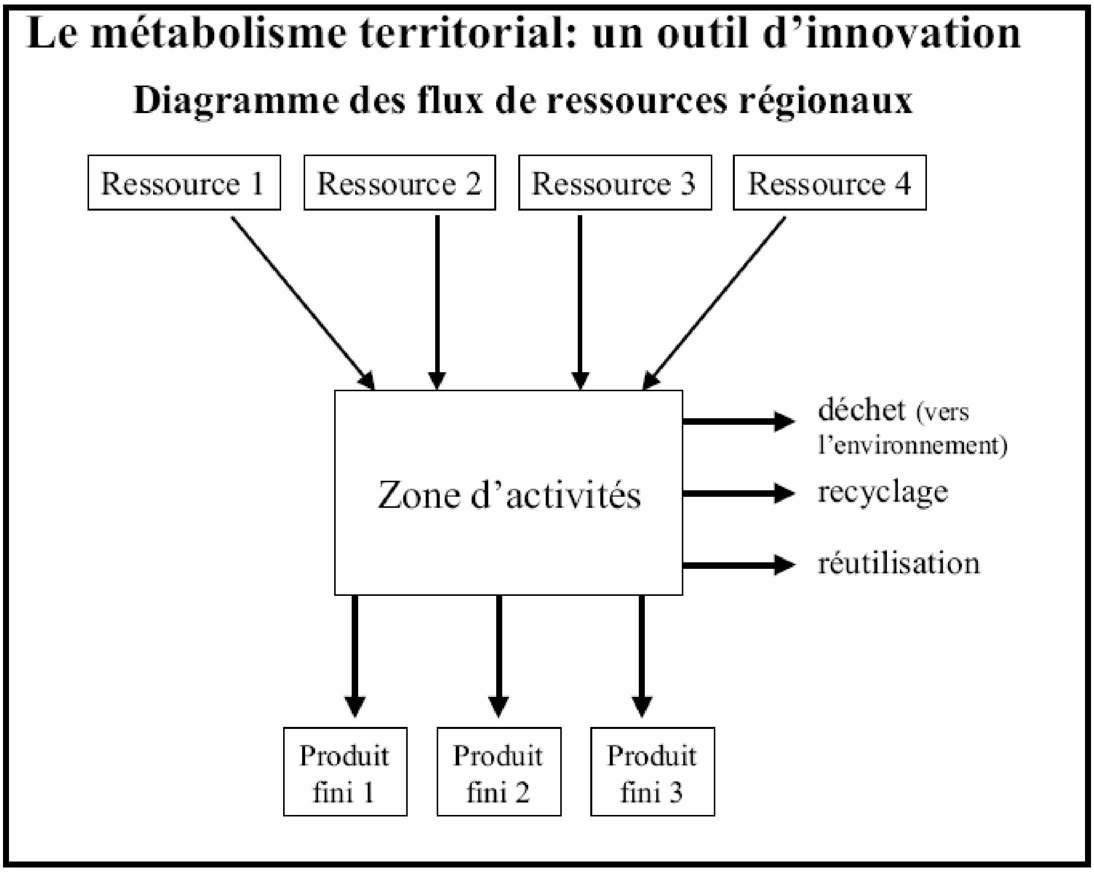

Image 4: Concept of territorial metabolism

Results and impacts of the experience

While ECOPAL, as an association, has no direct economic, ecologic and social indicators on industrial ecology, its work is having a substantial impact on all three levels:

- ***environment***

Examples of business projects fostered by ECOPAL include the retreatment of steel slag for the manufacture of plant-care products, the exchange of products between the steam cracker and chemical companies, an implemented project for recycling gases from steel blast furnaces in an electricity power plant, etc.

- ***economy***

The aim of industrial ecology is to reduce costs, by making use of the circular economy concept. Secondly, ECOPAL has succeeded in creating the dynamics of collaboration between the companies of the territory. It makes the territory more attractive for companies both large and small.

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➢ *society*

Alongside the extensive public participation of various stakeholders, ECOPAL can present a relevant social indicator: a pedagogic information platform has been set up.

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EXPERIENCE FILE 15

Name of the project: EIDC **Code: EXP 15 EXT**

Title of the experience: Network for promoting eco-industrial development in North America.
Location: United States/ Canada

Context

The industrial ecology activities in United States and Canada is about changing industry so it improves the environment rather than degrading it, and designing incentives that make it more cost competitive to fix the problems rather than create them.

Eco-Industrial Development may involve existing or new commercial and industrial development. Urban and rural projects in the United States and Canada include energy-based business parks, resource recovery parks, environmental technologies and other business clusters, green buildings and associated land planning and infrastructure.

In that framework the Eco-Industrial Development Council (EIDC) promotes eco-industrial development as fundamental to business competitiveness, engaging in education, advocacy, technical assistance and research.

Participants in the project

The structure of EIDC professional members is organised into two branches; one is the board of directors, listed below, and the advisory committee.
Both are working together in order to inform, give opinion and advise the members of EIDC as local governments, private companies, academic institutions, research centres, non-profit organisations.

The board of directors came from several environmental technology centres, consultancy, universities and organisations, such as:

- **The Green Institute in Minneapolis**, MN, US
- **Canadian Eco-Industrial Network**, Toronto, Ontario, Canada.
- **Trillium Planning & Development**, Minneapolis, MN, US.
- **Eco-Industrial Solutions Ltd**, Vancouver, BC, US
- **Yale School of Forestry and Environmental Studies**, New Haven, Connecticut, US.
- **Louis Berger Consulting**, Washington DC, US
- **Cape Charles Sustainable Technologies Park Authority**, Cape Charles, Virginia, US
- **ERIN Consulting Ltd**, Regina, Saskatchewan, Canada
- **Triangle J Council of Governments**, Durham, North Carolina, US

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- **Devens Enterprise Commission**, Devens, MA, US
- **University of Texas at Austin**, Texas, US
- **Minnesota Office of Environmental Assistance**, Minneapolis, Minnesota, US.
- **Sustainability Group**, City of Vancouver, Vancouver, BC, Canada
- **McGuireWoods**, Richmond, Virginia, US.

Location of the experience

Canada is the second largest country in the world in terms of land area (9 012 112.20 square kilometres), yet it ranks only 33rd in terms of population. According to Statistics Canada, Canada's population in 2000 was estimated to be 30 750 100. This represents a growth of 3.6% since the 1996 estimate of 29 671 900. Almost all of Canada's population is concentrated in a narrow band along the country's southern edge. The population is also concentrated by province: Ontario and Quebec contain between them 62% of the total population.

As of June 2006, there are an estimated 298,967,801 people in the United States, such a crowded country whose economy is the sum of the actions of more than 250 million people and 3 million profit-making corporations.

In both countries there are numerous projects developing on industrial ecology. The Maplewood Project has been selected to develop the indicators of the project in the EIDC work frame.
The need is for a coherent set of metrics that permits efficient diagnosis of national environmental conditions, and provides help in considering strategies for the future.

General information on the studied area

In the early 1990s a more integrated model of industrial activity[33] had been envisioned, which suggested the need for an industrial ecosystem "with the use of energies and materials is optimised, wastes and pollution are minimised, and there is an economically viable role for every product of a manufacturing process."[1] In the ensuing years, that idea has been taking shape to a reach a situation that shows the importance of the industrial ecology principles in the development of industries. Today, it is reflected by numerous companies, councils, organisations, webs, seminars, symposiums which are specialised in promoting that sustainable activity in the US: one example is EIDC (United States and Canada).

[33] Model described in the article of Robert Frosch and Nicholas Gallopoulos titled "Strategies for Manufacturing". 1989, Sep 01.

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The next figure shows the proportional material fluxes in United States, worthy of note is the great demand of energy and materials of construction. Industrial Ecology principles give knowledge to industries to increase the amount of recycling materials, and that is one of the main goals of EIDC in United States.

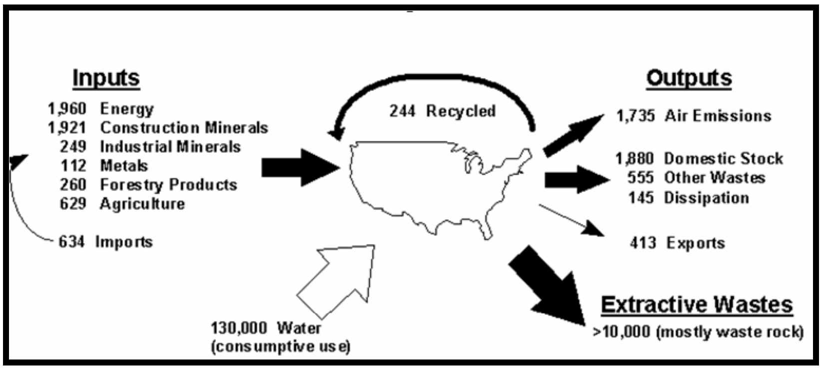

Fig 1: Inputs and outputs of the North American society.

On the other hand, in Canada industrial activities generate waste which is discharged into water bodies, the air or ends up in landfill sites. These wastes are usually processed to some degree. Industrial wastes discharged into the air and water can disrupt ecosystems. For example, waterborne toxic pollutants from industrial sources have been one of the major causes of the degradation of the Great Lakes. Acid precipitation originating from industrial sources and automobiles and has been responsible for acidifying thousands of lakes in North America. An indirect indicator of threats to ecosystems and species is the concentration of major industrial sites that discharge airborne pollutants such as SO_2 and NO_2. Industrial discharge sites are concentrated in southern Ontario and Quebec, on the west coast near Vancouver, and around major cities in British Columbia and the Prairies.

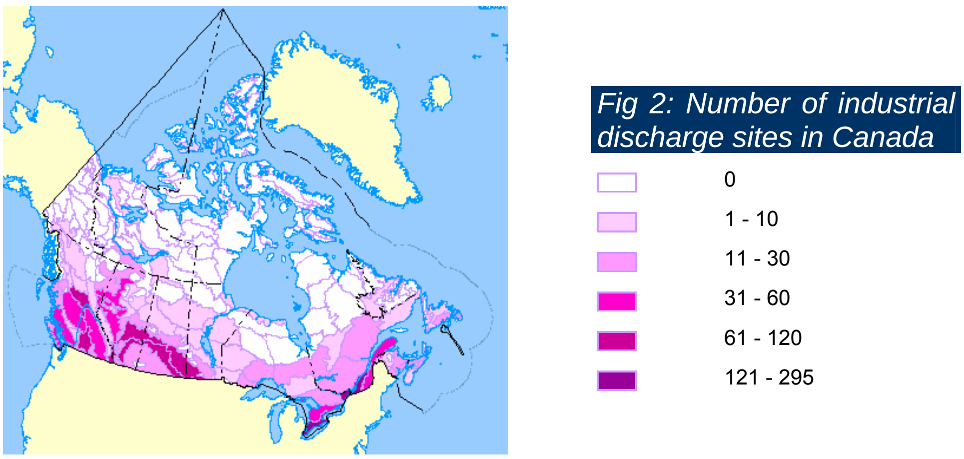

Fig 2: Number of industrial discharge sites in Canada

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Summary of the experience

The main role of EIDC is working as an eco-industrial information network. That activity involves developing new local and regional business relationships between the private sector, government and educational institutions in order to use new and existing energy, material, water, human and infrastructure resources to improve production efficiency, investment competitiveness, community and ecosystem health.

The action lines EIDC carries out are:

- Clearinghouse for project information.
- Arranging workshops and conferences in industrial ecology
- Raising awareness among members as regards financial supports on industrial ecology projects.
- Minimising non-biodegradable wastes into the environment
- Businesses connect to their communities and compatible with mixed land uses.
- Business networks in order to increase efficiencies and new market opportunities.
- Sustainable land use and companies' facilities.
- Achievement of improvements in productivity of human and natural resources

Results and impacts of the experience

The EIDC eco-industrial network is like a chamber of environmental professionals in the industrial ecology field; their work field is to give advice to other eco-industrial projects. An example of a project developed with the help of EIDC is the Devens Community.

Fig 3: Aerial view of Devens.1998.

The Devens Community is set in Central Massachusetts, just 35 miles west of Boston, with a 4,000-acre self-contained community that has transformed a closed military base (without profit) into a sustainable and efficient Community thanks, in part, to the Industrial Ecology Project developed, by the Devens Enterprise Commission (DEC) with the assistance of the EIDC.

The Devens Industrial Ecology Project seeks to improve relationships among companies at the base, improve economic development for the region, and preserve existing natural resources for generations to come. The Devens

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Industrial Ecology Project is comprised of businesses, government agencies, and non profit-making agencies and is dedicated to promoting industrial ecology.

The creation of an eco-industrial park at Devens is working in order to achieve two things:

- Changing the industrial activity into an eco-industrial one, more sustainable with the environment.
- Reaching an industrial activity, which tries to approach the industrial ecosystem model.

From October 1999 through February 2004, a number of surveys were conducted of companies in order to collect data to assess material, energy, and water flows from existing companies on the base and in the surrounding four towns. The results were reported back to the companies and possible synergies identified in order to encourage them.
A solid waste and recycling master plan was created for Devens, which formed the basis of a base-wide recycling contract let in 2005 designed to increase recycling and reuse of materials by firms at Devens and in the region. These data collection results will be published by the Devens Enterprise Commission (DEC).

Currently DEC is has launched the award winning: **"Eco-Star Branding and Environmental Recognition Program"** in Devens. There is a public-private Steering Committee that has developed **25 environmental criteria**. Ten will consitute a core criterion which includes such things as collaboration with other firms for joint purchasing of environmentally products and services, by-product exchanges and/or waste heat recovery. There are a number of incentives in place to encourage existing firms to participate, such as a tax incentive and the use of an environmental logo on your products and services if you become an achiever. So far nineteen firms have joined the program.

➢ *Environment in the Devens Community*

The major material flows currently at Devens are (in approximate order of volume): corrugated cardboard, paper, plastic, metal scrap and chips, wooden palettes, and machine oil. These six types of materials are used, discarded, recycled, consumed, produced or purchased by the companies surveyed. For a full implementation of the principles of industrial ecology, companies at Devens build upon this base and create closed loop material flows for these six major materials. The model eco-industrial park at Devens would reduce waste and water needs of the companies in the eco-industrial Park.

Devens was designed from the outset to have six separate industrial areas: Jackson Technology Park, Robbins Pond Industrial Park, Devens Industrial Park East, Devens Industrial Park West, and the Environmental Business Zone. All areas are connected by well serviced roadways and a greenway network. Within each area (with the exception of the Environmental Business Zone), there is some industrial development already in place. The existing companies are situated is close proximity to one another and in some cases co-located.

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The links made between existing companies could be further extended to energy and water flows. A model eco-industrial park at Devens would use water cascading, a process that allows grey water from one company to be used by another company, and then to be recycled again. This process reduces total water demand for the park. A similar technique is available for energy use, by cascading energy from high quality use to low quality use, thereby eliminating waste and improving efficiency.

Existing industries needed to make modifications to their operations and processes in order to accommodate the industrial symbioses which will be initiated and to create a maximum return on investment for their firm. The planned material, energy, and water flows for Devens must be finalised prior to any retrofitting to ensure the greatest benefit from capital.

➢ *Economy analyses*

Developments since 1996. Since 1996, Devens has attracted a great deal of **economic growth**. There have been some efforts to address the sustainability goal of the base reuse. Some companies are employing the principles of industrial ecology into their practices, using co-location (Gillette), intermodal transportation systems (Guilford Motor Express), materials exchanges (Ryerson), and an extensive recycling program (Comco Graphics). In addition, a International Audubon signature "sustainable" public golf course (Red Tail Golf Club) has been built over previously developed lands, bringing nature back to the Community.

➢ *Society*

Since the Devens Industrial Ecology Project has been implemented in the Community some progress in the labour situation has been detected, it is described in the following data:

- More than 80 companies today employ more than 4.200; 11 have more than 100 workers
- Unemployment rates of Ayer, Harvard & Shirley have fallen from 5.5% in 1994 to 4.6% in 2004 to 4.4% in January 2006, nearly a full point below the Massachusetts rate of 5.3%

That data show the increasing standard of living in the Devens Community and the surroundings.

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EXPERIENCE FILE 16

Name of the project: CTTEI **Code: EXP 16 EXT**

Title of the experience: Technology Transfer Centre on Industrial Ecology (CTTEI) – Creating a value chain for industrial by-products
Location: Sorel-Tracy, Quebec - Canada

Context

Sorel-Tracy defines itself as crossroads for sustainable development. The Technology Transfer Centre on Industrial Ecology (CTTEI) was founded in March 1999 as a follow up of an international conference held in Sorel-Tracy, entitled “Industrial ecology: a development strategy”.

The CTTEI is based in the Canadian city of Sorel-Tracy, close to Montréal, in the province of Quebec. The mission of this industrial ecology technology transfer centre, set up in 1999, is to promote industrial ecology as a primary means to achieve sustainable development. Its objective is to offer R&D services for the development of value-added products by making use of industrial waste.

➢ *Industrial Waste Reclamation Projects*

Associated with Sorel-Tracy CEGEP, CTTEI has been working since 1999 on finding uses for various forms of industrial waste and aims to develop a variety of uses.

To this aim, the Centre works closely together with the local enterprises. In a first step, the enterprises receive guidance on how to better valuate their industrial by-products, in order to foster in a second step any residual material exchanges.

Successful synergies among actors and a comprehensive action plan have resulted into a regional strategy where industrial ecology is slowly but steadily gaining pace.

➢ *Types of Projects*

Applied Research Projects

- Assessment of the technical performance, environmental characteristics and industrial sanitation of the Sorelmix abrasive used for blast cleaning
- Testing the use of slag for water filtration
- Development of inorganic waste characterisation techniques for environmental impact assessments
- Upgrading of quarry fines
- Creation of the Industrial Waste Exchange (Internet site: www.briq.ca)

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Figure 1: From left to right, Hélène Gignac, executive director, Claude Maheux-Picard, research coordinator, Marie-Claude Brouillard, project engineer

Project Management

- Industrial waste characterisation
- Assistance and consulting for businesses organising and controlling waste reclamation projects
- Exploration of the potential uses of primary residue
- Development of new processes and/or technologies for reuse
- Processing and/or treatment of by-products
- Adaptation of an industrial process for residue re-input
- Test bench development
- Support for regulatory compliance

Participants in the project

Alongside the CTTEI staff, the main actors of the current case study are the businesses of the Bas-Richelieu area. Their participation is key to the success of the whole network.

The Centre is associated to a network of **31 other technology transfer centres of the province of Quebec**, affiliated to CEGEPs, each involved in a different field.

The CTTEI is affiliated with the **Sorel-Tracy CÉGEP**[34] which offers post-secondary training on Industrial Hygiene, Environmental Protection and Work Safety, and with **UQAM's Environment Research Centre**, which is specialised on the granulometric and physicochemical analysis of fine and ultra fine particulate matter.

The Centre is partly (about 40%) financed by two **Ministries of the Government of Quebec, the Ministry of Education, Leisure and Sport**, and **the Ministry of Economic development, Innovation and Exportation.** The rest of the budget is covered via governmental contracts and private financing projects from industries.

[34] CÉGEP - *Collège d'enseignement général et professionnel (Techological and Pre-university Institute)*

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Another important actor is the **new Technocentre on industrial ecology**:

Launched in spring 2001 by the Technology Transfer Centre on Industrial Ecology (CTTÉI) and Environment Research Centre affiliated to UQAM/Sorel-Tracy (CREUST), the initial industrial ecology demonstration platform has evolved into an approach to develop a hub for "education, research, and development" in order to meet the new challenges facing organisations of all kinds. This approach will generally serve to strengthen Canada's environment industry, and particularly strengthen, develop, broaden, and disseminate CTTÉI's and CREUST's regional expertise in industrial ecology by **creating a centre for business and research in the environment and sustainable development.** It will also raise the Government of Quebec's awareness of Bas-Richelieu as a pilot region in the field.	

Location of the experience

Located at the riversides of the Saint-Laurent river, the Municipal Regional Council of Bas-Richelieu (51.000 habitants) and its capital, Sorel-Tracy (the fourth biggest city of Quebec), are located in The Montérégie region, almost seventy-five kilometres north of Montreal City.

According to Statistics Canada's *Labour Force Survey*[35], there were 661,566 employed persons in the Montérégie region in 1999-2001, or 19.3 percent of the total number of employed persons in Quebec. The goods-producing sector accounted for 197,233 jobs, or 29.8 percent of jobs in the region, compared with 26.4 percent of jobs in Quebec.

Construction (providing 28.833 jobs) and manufacturing industries (142.633 jobs) alone accounted for close to 87 percent of the jobs in the goods-producing sector. The services sector accounted for 464,333 jobs, or 70.2 percent of total employment, compared with 73.6 percent of total Quebec employment.

The Montérégie's industrial base has a large component of manufacturing industries that provide 142 600 jobs in the region and employ over one person in five. With its high concentration of technology-intensive (as opposed to low-technology) manufacturing industries, the Montérégie region stands out in relation to Quebec overall. In 1998, low-technology industries accounted for 34.9 percent of jobs in the Montérégie, compared with 47.2 percent for Quebec

[35] Rapport de conjoncture 2001.

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overall. Medium-to-high-tech industries (particularly chemical industries) accounted for 17.2 percent and high-tech industries (aerospace and radio and telecommunications equipment) for 11.2 percent of manufacturing jobs in the region. The corresponding Quebec percentages are 15.3 percent and 10.1 percent.

The dominant industry in the municipal area of Le Bas-Richelieu (Sorel-Tracy) is iron, steel and fabricated metal products.

General information on the studied area

Sorel-Tracy is an industrial town in the centre of the province of Quebec at the confluence of the Richelieu River and the St. Lawrence River. Gateway to the Lake Saint-Pierre archipelago of the Lac-Saint-Pierre, recognised by UNESCO as a World Biosphere Reserve in 2000, Sorel-Tracy is closely tied to river navigation:

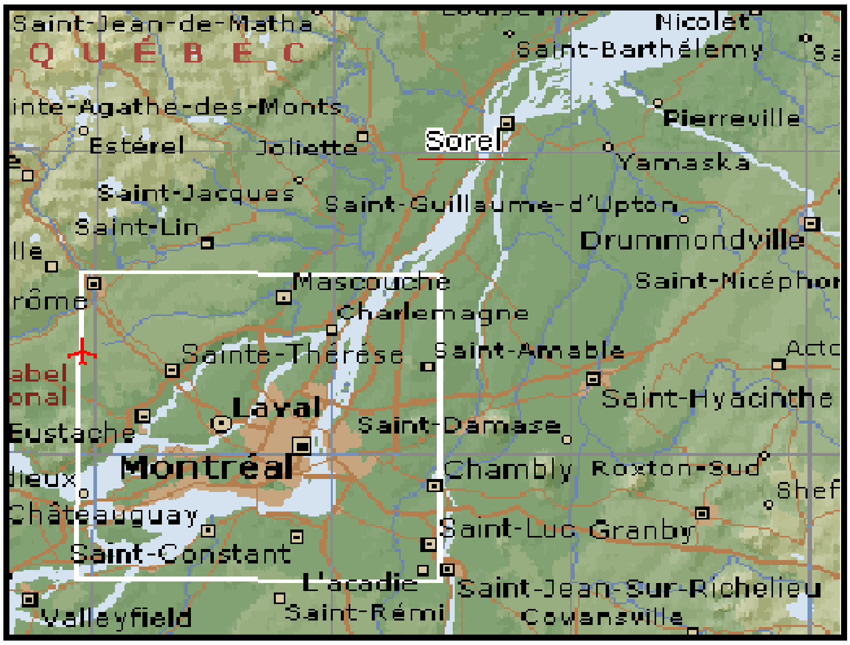

Figure 2: Map of the Sorel Tracy area

Sorel is the fourth oldest city in Canada, founded in 1642. After the visit of Prince William Henry to Sorel in 1787 the town took the name of William-Henry, a name it retained until 1845.
Industrial activity zones are a core element of the urban landscape:

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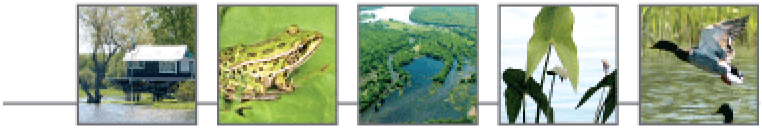
Since the early nineties, Sorel-Tracy has managed to combine sustainable industrial development with the protection of its biodiversity in order to modify its environmental image. The *Centre d'interprétation du patrimoine de Sorel* is a young museum near Regard-sur-le-Fleuve park in Sorel-Tracy. Its permanent exhibition offers a unique and original perspective on the different heritage features of the Lac-Saint-Pierre UNESCO World Biosphere Reserve:



(www.survoldulacsaintpierre.com)

Summary of the experience

At the end of the 1980s, the region of Bas-Richelieu was often criticised for its bad environmental management. Given that industrial development goes hand in hand with sustainable development in the region, industrial ecology became a core element within the environmental strategy.

Since then, various enterprises have obtained environmental awards (Quebec-Iron & Titanium-Rio Tinto, Conporec), others have integrated innovative approaches towards valuating their industrial residues (Excell Materials, QIT-Rio Tinto), and a new urban waste management technology, incorporated by Conporec and Mécatel, has since been transferred to the US and to Europe.

This new waste treatment technology is based on a threefold composting system in which domestic garbage is treated in a semi-continuous and accelerated way. The use of this technology, together with the collection of special residues, has resulted in a waste reduction of 25%. Thanks to important R&D efforts, odours have been reduced and the compost quality has been improved, efforts which have given rise to the exportation of such technology to other countries, such as the US and France.

Excell Materials is successfully recycling metal industry residues, which are reused in road work, as abrasive for high-pressure cleaning and as filtering material in sewage treatment plants.	

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Beyond such entrepreneurial achievements, a regional approach has attained the successful implementation of a series of projects that prove the governmental support for a strategy on industrial ecology, such as the following ones:

- ***1- Industrial Waste of Exchange of Quebec : BRIQ***
  Development of a virtual exchange platform for offers and demands on industrial by-products. Web site: www.briq.ca

- ***2- R&D projects***
  Development of new products obtained via industrial by-products, such as a biodegradable flux that can be used as road de-icer in the winter instead of salt.

- ***3- Recycling of metals***
  As previously indicated, the dominant industry in the region is the metal industry. Hence, special efforts have been undertaken in order to enhance business participation towards recycling their waste.

Results and impacts of the experience

The current project does not monitor its progress via specific indicators. However, various data reveal its achievements and can be considered as informal indicators.

- ***From an environmental point of view***

Thanks to the efforts undertaken so far, more than 2 million tons of industrial residues are being recycled yearly in the area of Sorel-Tracy, which accounts for no less than 80% of the industrial solid waste in the area. This figure places the area far ahead of any other Canadian activity zone.

The project is strongly interlinked with the Local Agenda 21 of the city, as can be deducted from the fact that one of the recently approved challenges within the LA 21 strategy is to enhance more sustainable production and consumption patterns. The CTTEI and the CREUST are mentioned as achievements and key partners.

- ***From an economic point of view***

The activities carried out do not only favour the environment but since their inception they have also created a series of highly-qualified technology businesses.

An example is the creation of the Ferrinov company (http://www.ferrinov.com/), which recycles dust obtained from the steel industry into pigments used in paint and plastics. The production of Ferrinov pigments by the patent pending process does not require the input of raw mineral resources. The reduced energy requirements prevent emissions of greenhouse gases.

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Another potential indicator is the number of enterprises in eco-industrial parks. The eco-industrial park Ludger-Simard in Sorel-Tracy, launched in partnership among enterprises and the local authority, was founded with the aim to enhance an activity zone based on the principle of industrial ecology. The local industrial park development corporation, together with the local port authority, has been commissioned to develop an industrial park that would maximise the valuation of metal waste and other industrial residues, this way consolidating the position of Sorel-Tracy as eco-industrial area:

➢ ***From a societal point of view***

The link between businesses, banks, the government and the research institutes guarantees a broad stakeholder involvement as well as a targeted transfer of know-how.

Mainly via the recycling of waste, employment opportunities have been increasing. In particular, the workshop for the unemployed, called Recyclo-Centre, offers a unique employment opportunity for long-term unemployed people.

The partnership with the CREUST allows for a regular exchange of know-how between researchers, businesses and the CTTEI.

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EXPERIENCE FILE 17

Name of the project: ROI **Code: EXP 17 EXT**

Title of the experience: Enhancing industrial ecology practices in emerging economies: the Resource Optimisation Initiative (ROI), India
Location: India

Context

The Resource Optimisation Initiative (ROI) is registered as a Public Charitable Trust in India, with its registered office in Bangalore, India.
Industrial Ecology promises to be a new exciting platform for development plans for regional development and for businesses. Such plans are built on an understanding of the flow of material and energy in a defined system and not just on the basis of monetary indicators. Such a planning system is particularly relevant in developing countries, where resources are often priced according to the ability of the citizens to pay rather than on the basis of market forces.

Most of the studies ROI develops could potentially be used in the future by planning other projects in the eco-industrial field (see below: General information in the study areas).

Participants in the project

ROI brings together a professional team specialised in the environmental field which offers advice, carries out research and plans eco-industrial activities.

The **Resource Optimisation Initiative** (ROI), headed by Ramesh Ramaswamy, an expert on development and execution of business in the Asia/Pacific region and for profit and loss in a sustainable way, has been set up to introduce planning and tools based on Industrial Ecology to policy makers in governments and businesses of developing countries.

It is intended that the ROI will play a role that complements the activities of the **International Society for Industrial Ecology** (ISIE) and the **Journal of Industrial Ecology** (JIE).

The International Society for Industry Ecology promotes industrial ecology as a way of finding innovative solutions to environmental problems, and facilitates communication between scientists, engineers, policymakers, managers and advocates who are interested in how environmental concerns and economic activities can be better integrated. The mission of the ISIE is to promote the use of industrial ecology in research, education, policy, community development, and industrial practices. The Journal of Industrial Ecology (JIE) is an international quarterly publication with the aim of promoting the understanding and practice in the emerging field of industrial ecology.

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Location of the experience

Under pressure to accelerate economic growth, developing nations tend to disregard environmental concerns.
So far, most of the activities undertaken by ROI have been undertaken in the Southwest and Northwest of India.

However, ROI’s scope of action has focused its activity in the developing countries. Three of the most significant reasons are the following:

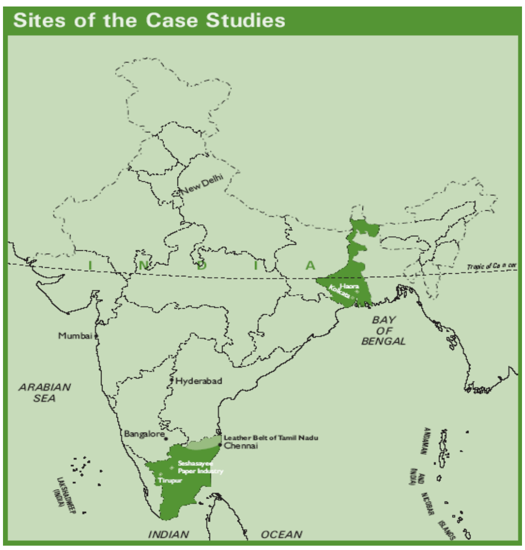
- In developing countries, resources are often scarce and the population density is high, which reflects an impact into the environment.
- Industries are growing quickly and manufacturing activities are one of the most important economic activities in developing the country. And now is a crucial time for influencing the choice of industrial development planning, which would be more sustainable with the environment.
- The majority of the world's population lives in the developing countries.

General information on the studied area

Each corporation involved in industrial ecology activities may see incentives to improve its individual environmental performance. Consideration of the collective performance of an economy is necessarily a public function. A broad view is needed, for example, to encourage waste minimisation as a property of the industrial system, even when it is not completely a property of an individual process, plant, or industry.

A model where a company sets up not one, but a complex of diverse industries, where one industry uses the waste of another, is a viable option for sustainable industrial growth in developing countries.

Furthermore, the experience of industrial development in India shows that there is a high potential for eco-industrial complexes in rural areas that can benefit the local community through efficient use of resources.



Five projects developed in India in the framework of industrial ecology are presented below in summarised figures below. Each of them illustrates in a specific way the relevance and utility of the Industrial Ecology perspective. All the studies were undertaken during the period 1996–1998. Although the data have not been updated, the core issues remain unchanged over the years.Figure 2 indicates the sites of the case studies in various parts of India

Figure 1: sites of the case studies

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Subject	**Material flow analysis**
Researchers	ERKMAN Suren, RAMASWAMY Ramesh
Location	India
Title	Case Study of the Textile Industry in Tirupur
Period of Study	1995
Subject	**Industrial Symbiosis,Substance Flow Analysis**
Researchers	ERKMAN Suren, RAMASWAMY Ramesh
Location	India
Title	Foundries in Haora
Period of Study	1997-98
Subject	**Material Flow Analysis,Regional Metabolism,Policy**
Researchers	ERKMAN Suren, RAMASWAMY Ramesh
Location	India
Title	Case Study of the Leather Industry in Tamil Nadu
Period of Study	1996-97
Subject	**Eco Industrial Parks and Networks,Industrial Symbiosis,Policy**
Researchers	ERKMAN Suren, RAMASWAMY Ramesh
Location	India
Title	Case Study of a Corporate Paper–Sugar Complex
Period of Study	1996
Subject	**Material Flow Analysis,Regional Metabolism,Policy,Teaching**
Researchers	ERKMAN Suren, RAMASWAMY Ramesh
Location	India
Title	Case Study of the Damodar Valley Region
Period of Study	1997

Summary of the experience

The mission of the ROI is to promote the implementation of the concepts and tools of Industrial Ecology in the development and business planning processes in developing countries. With the aim of accomplishing its mission, the aims of the ROI are:

- To increase the awareness of policy makers in government and businesses with regard to the philosophy of Industrial Ecology based planning. This would help them to optimise use of material and energy resources for production and consumption processes in all sectors of the economy.
- To develop and impart skills in using Industrial Ecology based tools for policy-making in government and business.
- To develop and record cases of resource optimisation efforts already in practice in some specific locations and to ensure that the experiences could be shared in different parts of the world.
- To be a repository of case studies and data on resource optimisation experiences in developing countries and of possible technology resources for this purpose.

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- To collaborate with research institutions all over the world to encourage and facilitate research in Industrial Ecology in developing countries
- To offer assistance to user groups such as Governments, International Institutions and Companies in using Industrial Ecology in policy making.

Results and impacts of the experience

From an environmental and economic points of view

The major focus of the ROI activities is on Land, Water and Energy – the three major resources of concern in most developing countries.
ROI uses environmental indicators as well as economic ones, as resources in the developing countries are often only evaluated according to economic aspects, and industrial ecology planning should also include environmental indicators.
Anticipating a world with more industrial activity, India must find ways to make improvements in the totality of industrial interactions with the environment.

From a societal point of view

The target audience of the ROI activities is different depending on the kind of activity, it is summarised in the table below, but the aim is to increase awareness of the eco-industrial activities in the public and private field.

Activity	Target Audience
Awareness to Industrial Ecology	Policy-makers
	Officials from International Institutions
	Government officials and business policy planners in private companies
	Officials from financial institutions
	NGOs
	Academic Planners
Training in Industrial Ecology Tools	Policy-makers
Research, Case Study Development and Data Analysis	
Experience Sharing on the ROI Web Site Audio-Visual Presentation that could serve as an introduction to Industrial Ecology	Policy makers in developing countries.
Assistance to User Groups	

All studies made in ROI could potentially be used by development agencies in planning future eco-industrial systems based on the local availability and exchange of resources

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EXPERIENCE FILE 18

Name of the project: Kalundborg **Code: EXP 18 EXT**

Title of the experience: Assessing the symbiotic material flows on site: the Kalundborg Centre for Industrial Symbiosis
Location: Kalundborg - Denmark

Context

The Kalundborg Industrial Park has been established following the principles of industrial ecology, or more precisely, the principles of industrial symbiosis.
What does industrial symbiosis mean? In short, it is a process whereby a waste product in one industry is turned into a resource for use in one or more other industries. It is the essence of a totally efficient ecosystem.

The context of the project development did not originate from an urban, environmental or energetic planning process; rather it was the result of a gradual cooperative evolution of five neighbouring industries and the Kalundborg municipality. Although it began by chance in order to save raw materials and reuse waste, the project has now developed into a high level of environmental consciousness in which the participants are constantly searching for environmental cooperation.
The explanation of such a complex smooth-functioning Industrial Park could be found in the well known engagement of a variety of disciplines over time: economics, business, policy, environmental management, system engineering, law and planning.

Participants in the project

Industrial symbiosis in the Kalundborg district is based on cooperation between five industrial enterprises and the municipality of Kalundborg, which are the main actors of the Industrial Park.
The enterprises exchange waste as by-products, the waste from one enterprise becoming a raw material for one or several partners. The result is a reduction of both resource consumption and environmental impact.

In connection with the municipality of Kalundborg, the five businesses are as follows:

- Energy E2: Asnaes Power Station
- BPB Gyproc A/S: a plasterboard manufacturer
- Novo Nordisk A/S: a pharmaceutical biotechnology company plant
- Statoil A/S: a oil refinery
- Noveren I/S: a waste company

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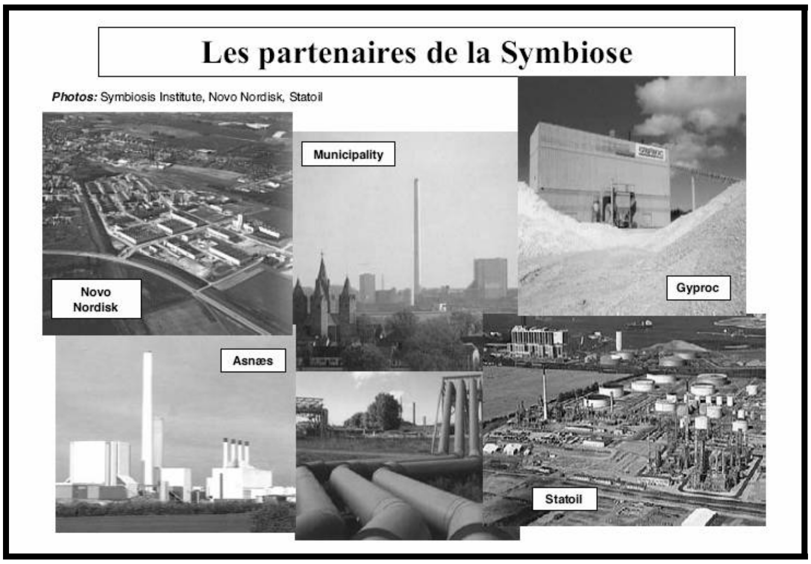

Image 1: Partners in the industrial symbiosis

Location of the experience

Kalundborg municipality is based in West Zealand County on the west coast of the island of Zealand (*Sjælland*), Denmark. The municipality covers an area of 130,20 km², and has a total population of 20.191 (2005). And it is located 100 kilometres west of Copenhagen)

In Kalundborg there is an old harbour town dating back to the 12th century, with farms and fjords on the outskirts that have a landscape value.

Kalundborg, proved to be fertile ground for the prototype eco-industrial park of heavy industry. A partnership evolving over the last 20 years between the five industrial companies has shown very good results in the economic and environmental field, such as saving energy, raw materials and water.

General information on the studied area

- ***History:***

The story of the spontaneous but slow evolution of the "industrial symbiosis" at Kalundborg, Denmark, really begins in 1961, with a project to use surface water from Lake Tissø for a new oil refinery to preserve limited ground water supplies. The city took responsibility for building the pipeline, while the refinery financed it. A number of other collaborative projects were introduced and the number of partners gradually increased up to the 1980s. By the end of the 1980s, the partners realised they had effectively “self-organised” into what is one of the world’s first, and probably one of the best-known eco-industrial parks, an example of a working industrial ecosystem or, to use their term, *industrial*

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symbiosis. The industrial symbiosis in Kalundborg is an example of how strategic material-based planning can earn a handsome payback.

At present, the industrial symbiosis project at Kalundborg, Denmark, is a model of environmental sustainability. It provides a vision of what is possible when taking a symbiotic approach on industrial development. The project has attracted a good deal of international attention, notably by the European Community, and been awarded several environmental prizes, such as *Danish Environmental Prize* in 1991.

➢ ***Key industrial partners:***

The Kalundborg system comprises five partners:

- Energy E2 Asnæs Power Station, Denmark's largest power station, coal-fired, 1,500 megawatts capacity.
- BPB Gyproc A/S, a plasterboard factory, making 14 million square meters of gypsum wallboard annually (roughly enough to build all the houses in 6 towns the size of Kalundborg).
- Novo Nordisk A/S, an international biotechnological company, with annual sales of over $2 billion. The plant at Kalundborg is their largest, and produces pharmaceuticals (including 40% of the world's supply of insulin) and industrial enzymes; and insulin production takes place at this factory either by the fermentation of genetically modified micro-organisms, or by recovery from the pancreatic glands of pigs. Enzymes, glucagon and the haemophilia preparation Factor VIIa are also produced here.
- Statoil A/S Refinery, Denmark's largest, with a capacity of 3.2 million tons/yr (increasing to 4.8 million tons/yr).
- Noveren I/S: the waste company

The City of Kalundborg supplies district heating to the 20,000 nearby residents, as well as water to the homes and industries.

Summary of the experience

Within industrial ecology, the sub-field of “industrial symbiosis” takes as its starting point a vision of industry organised along the lines of an ecosystem. In this way it draws on the concept of biological symbiotic relationships in which unrelated organisms find mutual benefit through the exchange of resources, which are typically wastes. At an industrial park, businesses exist in a symbiotic relationship where products from one company become raw materials for another - the same is true for energy and water between the industries.

Eco-industrial parks are based on industrial ecology concepts - they aim to increase business performance while reducing pollution and waste (Cohen-Rosenthal, 1996). The prototypical EIP is that at Kalundborg in Denmark. There is a network of waste and energy exchanges here between the city, a power plant, a refinery, a fish farm, a pharmaceuticals plant and a plasterboard manufacturer, as explained above. The power company pipes residual steam to

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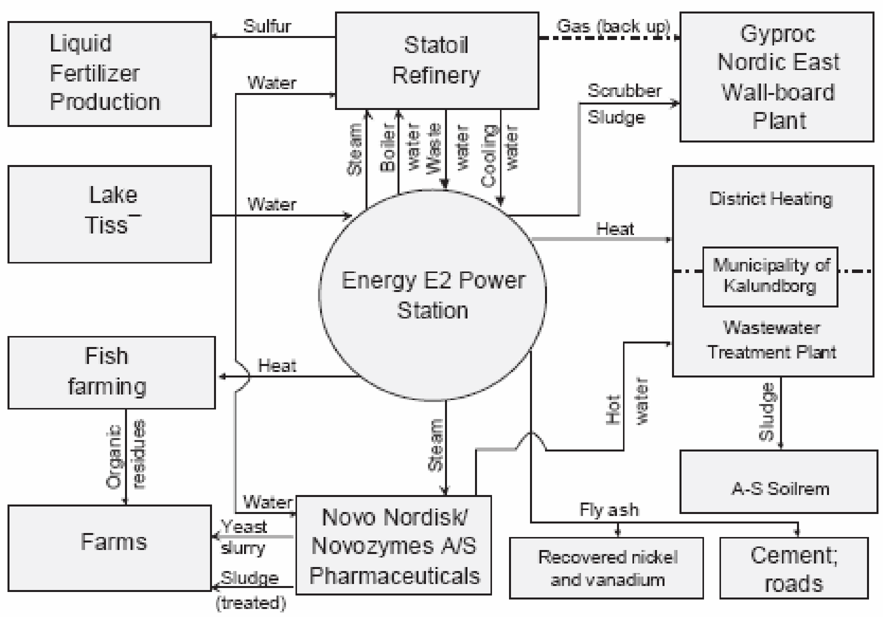
the refinery and, in exchange, receives refinery gas (which used to be flared as waste). The power plant burns the refinery gas to generate electricity and steam and sends excess steam to a fish farm, the city and the pharmaceuticals plant. Sludge from the fish farm and the pharmaceutical processes become fertilisers for nearby farms. A cement company uses fly ash from the power plant, while gypsum produced by the power plant's desulphurisation process goes to a company producing gypsum wallboard (Brand and de Bruijn, 1999).

Company's exchanges of materials:

The enterprises develop synergies and environmental actions between them, such as:

- ***Steam and heat:*** Asnaes Power Station produces heat for the town of Kalundborg and process steam for Statoil and Novo Nordisk.
- ***Water***: water resources in this region are low; hence companies reuse their process water as much as possible. Asnaes has reduced its water consumption by 60 per cent in this way.
- ***Refinery gas:*** an "eternal flare" of surplus gas is part of the safety system of all refineries. At Statoil, the flare has been reduced as far as possible by internal re-use and selling of the surplus to Asnaes which uses the gas as fuel instead of coal and oil. Statoil also supplies butane gas to Gyproc.
- ***Gypsum removal of sulphur*** from the Asnaes Power Station's flue gases produces around 170,000 tonnes of gypsum per year. Part of this is sold to Gyproc, replacing the natural gypsum used initially.



Graph 1: Kalundborg symbiosis

The advantages of the symbiosis system are summarised in the following points:

- Re-use of by-products.
- Reduced consumption of natural resources: water, coal, gypsum, etc.,

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- Reduced environmental impacts, reduced emissions of SO2 and CO2, reduced discharges of liquid waste.
- Better use of energy resources.

Results and impacts of the experience

➢ ***From an environmental point of view***

The direct effects of applying the IEP are the restoration of damaged ecosystems, the reduction of sources of pollution and waste, decreased demand for natural resources, and a demonstration of the principles of sustainable development.

✓ Pollution reduction:
  - CO2: 130,000 tons/yr (3%)
  - SO2: 25,000 tons/yr (58%)

✓ Natural resources savings:
  - Ground water: 1,9 million m3/yr
  - Surface water: 1 million m3/yr
  - Fuel: 20,000 tons/yr
  - Gypsum: 200,000 tons/yr
  - Coal: 30,000 tons/yr
  - Sulphur: 2.8 tons/yr

✓ Saves resources:
  - 30% better utilisation of fuel using combined heat + power than producing separate
  - Reduced oil consumption
  - 3500 less oil-burning heaters in homes
  - Does not drain fresh water supplies. It has been reduced the overall consumption by 25% by recycling the water and by letting it circulate between the Symbiosis partners.

✓ New source of raw materials
  - Gypsum, sulphuric acid, fertiliser, fish farm

✓ Total water consumption:
  - o Reductions of the overall consumption by 25% by recycling the water and by letting it circulate between the individual Symbiosis partners. A total of 1.9 million cubic metres of ground water and 1 million cubic metres of surface water are saved on a yearly basis.

➢ ***From an economical point of view***

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

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The collaborating partners also benefit financially from the co-operation as the individual agreement within the symbiosis is based on commercial principles of sharing costs.

The discovering of a new type of product-exchange between industrial products and its wastes, based on the symbiosis principles in the IP of Kalundborg, brings an economic benefit based on the re-use of the industrial materials.

The economic saving results of the Industrial Park are described in the following data:

- Investments: $75 million in 19 projects developed in the Industrial Park.
- Annual savings: $15 million
- Total savings (1998): $160 million
- Average return on investment period: 5 years

As the data show, there has been an important saving in the Industrial Park of Kalundborg.

Several conclusions can be reported:

- Each contract between industries has resulted from the conclusion by both companies involved that the project would be economically attractive, in a bilateral way.
- Opportunities not within a company's core business, no matter how environmentally attractive have not been acted upon.
- Each partner does its best to ensure that risks are minimised.
- Each company evaluates their own deals independently; there is no system-wide evaluation of performance. Thanks to the industries following the saving principles of industrial ecology the system works well, although it is a difficult matter to achieve

> ***From a societal point of view***

The benefits to society include enhancing economic performance and development, reductions in solid and liquid waste, reductions in demands on municipal infrastructure and budgets.

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http://www.kalundborg.dk
Contact has been established but the case study has not yet been validated

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1 Technical files linked to industrial ecology

- ***From technologies of ECOSIND sub-projects***

File TEC 1 C3 – MEDUSE: Methods and techniques advanced for the environmental analysis in zones with high industrial density by means of optoelectronic probes.

File TEC 2 C3 – MESVAL: Methodology to find the most sustainable synergies on a territory and examples of application in Catalonia.

File TEC 3 C4 – PLASOS: Installation of a centralised trigeneration system (cooling, heating and electricity supply) in a District Heating and Cooling (DHC) network including renewable energy (biomass and solar energy).

- ***From technologies of non-ECOSIND projects***

FRANCE - File TEC 4 EXT - Presteo : Programme of Research of Synergies on a TErritOry.

AUSTRIA - File TEC 5 EXT – Ecoparc Hartberg: Creating an infotainment park based on industrial ecology principles.

AUSTRALIA - File TEC 6 EXT: Capturing Regional Resource Synergies in the Kwinana Industrial Area, Western Australia

BRASIL - File TEC 7 EXT – 3R : Implementation of the 3R strategy

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TECHNICAL FILE 1

Name of the ECOSIND project: MEDUSE **Code: TEC 1 C3**

Title of the file: Methods and techniques advanced for the environmental analysis in zones with high industrial density by means of optoelectronic probes
Location: Tuscany - Italy

Context

Cooperative environmental management

Structures involved

- **IFAC-CNR** (Institute of Applied Physics « N. Carrara » - Researches National council)
- **INOA** (National institute of Applied Optics)
- **CETEMPS** (Excellence Centre for the Forecast of Violent Weather with Remote Sensing and Model)
- **UNI-SI** (Centre for the Study of the Complex Systems - University of Siena)
- **UNI-PI** (University of Pisa - Department of Engineering of Information)
- **UPC** (Polytechnic University of Catalonia)

General description and Technical performances

Zones with high industrial density of the 3 regions involved in the project were studied, more exactly:

- **For Tuscany**, the industrial zone of Macrolotto de Prato (textile sector) and the dump of Case Passerini,

- **For Abruzzo**, the industrial zone of Chieti (textile, paper, packaging and metallurgical sectors),

- **For Catalonia**, in difference of the other regions, it was about the textile sector but distributed in nine local productive systems.

The main objective is the improvement of the air quality of the air and the hydric resource through the determination of an effective environmental analysis applied to industrial zones.

The techniques of remote sensing, based for example on lidar systems and on active probes with laser with compatible diode, have in this respect an important position because they allow continuous and ample controls.

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Other techniques concern the probes which work in situ, based on micro-optical components or optical fibre.

The project especially concentrated on two main subjects:

- "The optoelectronic sensors for the control of waters quality " (WWG),
- "The optoelectronic sensors for the control of air quality" (AWG).

➢ *Optoelectronic sensors for the control of waters quality*

The led work concerned essentially the techniques of follow-up of industrial waste water.
In particular the following points were studied and estimated:

- The characteristics of a network of follow-up (IFAC),
- The examination of the parameters to be measured (IFAC),
- The examination of the optical methodologies (IFAC UNI-PI),
- Comparison and development of methodologies for the measure of the CDO (Chemical Demand in Oxygen) (IFAC UNI-PI).

The use of electrooptic systems, by basing itself on spectroscopic processes of absorption and\or fluorescence, allowed the measure of significant parameters in equivalence with those asked by the regulations in force, as for example:

- ✓ *Suspended solids,*
- ✓ *Turbidity,*
- ✓ *Organic matter,*
- ✓ *TOC eq*. COD eq.* BOD eq.*,*
- ✓ *Organic matter (Benzene, Xylene, Toluene, Naphtalene, Nitrobenzene, Phenol),*
- ✓ *Nitrates,*
- ✓ *H2S,*
- ✓ *HS,*
- ✓ *Chlorophyll,*
- ✓ *Cyanobacteria,*
- ✓ *CDOM*,*
- ✓ *Hydrocarbons,*
- ✓ *O2 disolved.*

**TOC eq.: Total Organic Carbon Equivalent*
**COD eq.: Chimical Oxygen Demand Equivalent*
**BOD eq.: Biochemical Oxygen Demand Equivalent*
**CDOM: Color Dissolved Organic Matter*

Furthermore, techniques and methods for the measure of some of these parameters were implemented, like the coefficient of enfeeblement of waters and COD as well as measures relative to surfactants.

➢ *Optoelectronic sensors for the control of air quality*

The led work essentially concerned the techniques of follow-up of atmospheric emissions. In particular the following points were studied and estimated:

- The exam of the characteristics of emissions in the industrial zone (UPC).
- The exam of the parameters and the measurable atmospheric pollutants with lidar (CETEMPS)

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- The analysis of models and optical sensors for atmospheric parameters (INOA CSSC)
- The analysis of a method (models and optical sensors) for atmospheric parameters (INOA CSSC).

The measurable parameters with optoelectronic sensors based on spectroscopy with differential absorption or elastic backscattering are:

- ✓ *benzene,*
- ✓ *toluene,*
- ✓ *xylene,*
- ✓ *ozone,*
- ✓ *sulfur dioxide,*
- ✓ *nitrogen bioxide,*
- ✓ *PM10,*
- ✓ *aerosol,*
- ✓ *Water vapour,*
- ✓ *temperature*.

Thanks to these sensors, it is possible to realize a 3D follow-up on vast zones, localizable from the geographic point of view and especially in real-time.
The development of an integrated system is at present in a phase of advanced study in order to be able to foresee and estimate emissions and the dispersal of the atmospheric indicators.
At present, the activity is concentrated on:

- The system of measurement of the concentrations thanks to a spectrometer with diode-laser for measures in opened fields with retroreflector;
- The mathematical model of forecast of the dispersal of the atmospheric indicators.

The chosen case of study was that of the dump Case Passerini and the considered pollutant was the methane (CH4), which is a pollutant and, even more important thing, a very good indicator of process.
Instruments of diffusional model were applied to a sensor expressly conceived and placed in the Scientific Centre (Polo Scientifico) of Sesto Fiorentino, (distance of the source: on approximately 1200 m).

- **Air quality modelisation**

The meteorological data which are supplied by the operational system of weather forecast of the Abruzzo region are administered by CETEMPS. At present the model which is capable of foreseeing all the major polluting and particles, has a resolution of 50km and will arrive until 100km on the specific regions;

- **Implementation of a Raman lidar for the characterization of sprayers**

The lidar uses a laser of 355 nm and produces a Raman signal between 374 and 378 nm for the oxygen and the other one in 387 nm for the nitrogen. Thanks to this system, the profile of the sprayer can be built without resorting to particular hypotheses.

- **Implementation of a LiF detector (**Fluorine of Lithium**) for the NO2 which also makes measures of HNO3 (**nitric acid**), RO2NO2 (**Alkylperoxynitrates**) and RONO2 (**organic nitrates**).**

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Indicators and/or benefits

- ***From an environmental point of view***

Methods and innovative techniques were implemented for the real-time control of zones with high industrial density.

- ***From an economic point of view***

The discoveries of this project can be used by industries which work in the optoelectronic and communication fields, that will allow to give an impulse to the economic development in this domain.

- ***From a social point of view***

The discoveries of this project can be also used for the analysis and the control of the urban areas or areas with a important traffic and susceptible afterward to improve the environmental quality.

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TECHNICAL FILE 2

Name of the ECOSIND project: MESVAL **Code: TEC 2 C3**

Title of the file: Methodology to find the most sustainable synergies on a territory and examples of application in Catalonia.

Context

One of the goals of industrial ecology is to set up an industrial symbiosis. To reach it, it is necessary to create multiple synergies to close at the most the cycle of the material.
It is thus imperative to find effective methods for revealing possible synergies and for carrying out viability viability studies. As every synergy is very specific, it requires for each case to study carefully the economic, environmental and social viability.
This file explains the general methodology established by the MESVAL partners and shows 2 synergies of the 7 synergies detected thanks to this methodology during the development of MESVAL.

Structure (s) involved

➢ ***Catalonia:***

- **CTM-UPC** (Technological centre of the Technical University of Catalonia, Manresa) – coordinator
- **AIICA** (Research Association of the Leather Industries and Annexes, Igualada),
- **CETEMMSA** (Centre for technological Innovation and Enterprise Development, Mataró)
- **CIMNE** (International Centre for Numerical Methods in Engineering, Barcelona)
- **IUCT** (Institute of Science and Technology, Mollet)
- **CU** (UNESCO Chair in sustainability, UPC, Terrassa)

➢ ***Tuscany:***

- **DCCI** (Department of Chemistry and Industrial Chemistry, University of Pisa)
- **Ecosistemi** (Environmental consultancy)

➢ ***Peloponnesus:***

MCCI (Messinian Chamber of Commerce and Industry, Kalamata)

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General description of the methodology

To identify synergies 3 main steps have been defined by the MESAVL partners:

- ✓ 1. Establishment of qualitative and quantitative flow diagrams analysis (Raw materials and waste) of each of the considered industrial sectors,
- ✓ 2. Laboratory assays (practical valuation initiatives),
- ✓ 3. Implementation of a set of sustainable development indicators to the different valuation options in order to choose the most sustainable one.

✓ *1. Flow diagram analysis*

The first step to lead in order to find options for waste valorisations is the establishment of material flows analysis of each of the considered sectors.
An exhaustive research of the flows diagrams has to be delivered in order to identify possibilities of valorisation of wastes generated.
The normalisation of the flow diagrams is necessary to permit to work on a defined calculation base (reference value) for each sector. This fact allows the integration of flows diagrams and the identification of possible material exchanges between different industrial sectors to create an eco-industrial network.
The flow diagrams and the flows diagram integration constitute very powerful tools to choice useful processes. The analysis of processes performed with this approach is essential also for further development of industrial ecology projects.

✓ *2. Laboratory assays*

The second step of this methodology consists in carrying out the valuation initiatives for wastes at a laboratory scale. This permits to study the various technical options available for the valorisation.

✓ *3. Set of indicators*

The MESVAL project permits to develop a set of sustainability indicators including social, economic and environmental indicators.
The application of this set of indicators gives a guide to decide, for the same valuation assay, which is the most sustainable method.

The design of this set of indicators has a twofold objective:

- To provide enterprises with an assessment tool for choosing among alternative projects;
- To provide local and regional decision makers with guidance and support in the selection of industrial ecology strategies and projects to be pursued.

Below are the indicators defined by the MESVAL partners:

➢ *Environmental indicators*

Global objectives: closure of material cycles		
Topics: water recovery, reuse & recycling, waste production, material balance		
Indicators :	Use of recovered water	m^3/unit
	Reusable/recoverable components of final product at end of the product's life	% of weight
	Recycled or reused material components of product	% of weight

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	Quantity of residuals used as raw material	% of total raw material used
	Reduction in production of hazardous waste	kg/unit
	Reduction in production of non-hazardous waste	kg/unit
	Quantity of material input/quantity of material output	% of unit
Global objectives: reduction in material and natural resource use		
Topic: water consumption, consumption of fossil fuels		
Indicators:	Reduction in consumption of water	m3/unit
	Reduction in consumption of fossil fuel	t/unit
Global objectives: reduction in energy use and/or in the use of energy from non-renewable sources		
Topic: energy consumption, use of non-renewable energy sources, use of renewable sources		
Indicators:	Reduction in electricity consumption	kWh/unit
	Reduction in use of non-renewable energy resources	%
	Increase in use of renewable energy sources (%)	%
Global objectives: reduction in air emissions		
Topic: greenhouse gas, CO, NOx and VOC emissions		
Indicators:	Reduction in CO_2 equivalent emissions *(includes emissions after waste treatment)*	kg/unit
	Reduction in CO emissions	$\mu g/m^3$
	Reduction in NOx emissions	$\mu g/m^3$
	Reduction in VOC emissions	kg/unit
Global objectives: protection of water quality		
Topic: water emissions		
Indicators:	Change in BOD	%
	Change in COD	%
	Reduction in other water emissions	kg/unit
Global objectives: reduction in the use of hazardous substances		
Topic: use of chemicals		
Indicators:	Reduction in the use of chemicals	kg/unit

- ***Economic indicators***

Global objectives: reduction of environmental costs		
Topic: waste management, water use, pollutants abatement, energy use, raw material use		
Indicators:	Change in waste management costs after industrial ecology application (IEA)	%
	Change in water fees after IEA	%
	Change in pollutant abatement costs after IEA	%
	Change in electricity costs after IEA	%
	Change in gas costs after IEA	%
	Change in raw material costs after IEA	%

- ***Social indicators***

Global objectives: creation of new jobs or higher quality jobs		
Topic: capacity to create new jobs		
Indicators:	Increase of new jobs after industrial ecology application (IEA)	%

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	Increase of workers' wages after IEA	
Global objectives: increase of social responsibility of the enterprise		
Topic: application of social measures		
Indicators:	New social measures applied in the enterprise after IEA	number
Global objectives: upgrading decentralised technology		
Topic: promotion of adequate local/regional/country R&D activities		
Indicators:	Increase in number of new technology used in the enterprise's town/region/country	%
	Increase in number of new activities/projects started	%
Global objectives: increased local social capital		
Topic: social cohesion, creation of jobs, enterprise relations		
Indicators:	Increase of number of productive relations of the enterprises after IEA	%
	New jobs created in the enterprise's town/region/country after IEA	number
	Increase in number of new stakeholders after IEA	%

Applying this set of indicators to each of the available valuation options will permit to know what is the most sustainable option to implement the considered synergy.

Application of the methodology

The synergies to be presented, result from a material flow analysis of the possible synergies between 4 different industrial sectors: tanneries, textile, surface treatment and olive oil production.
From the flows diagram integration of this study, several synergies were highlighted but only some were selected for a feasibility study. These ones are represented in the diagram below.

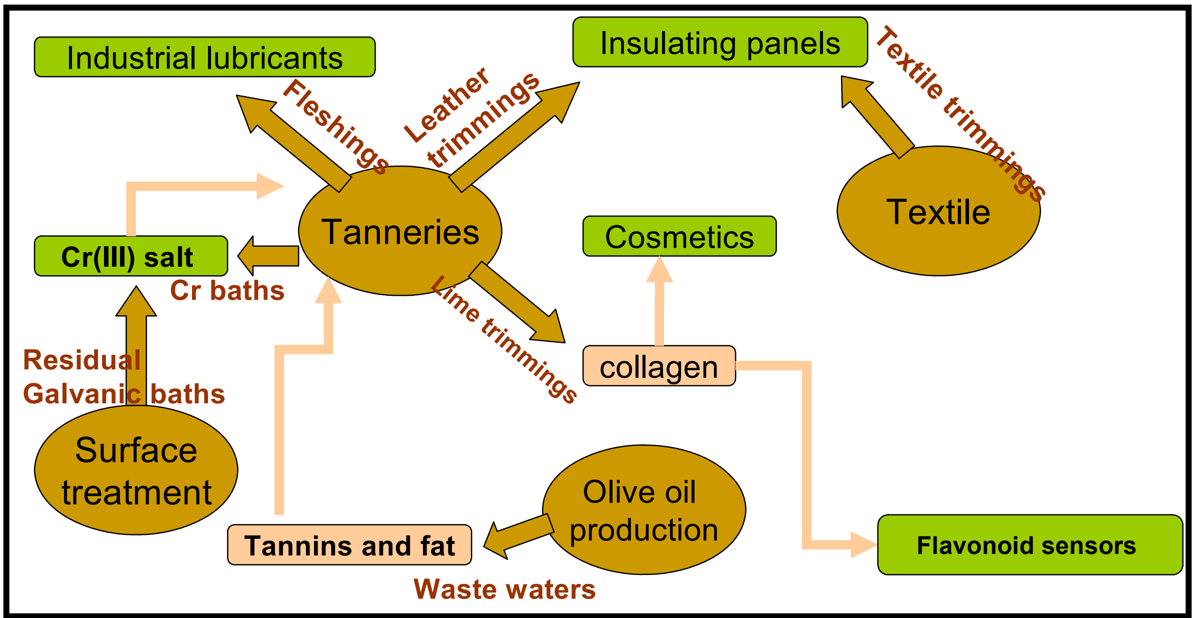

Diagram 1: Representation of possible synergies

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Possible substances for setting up synergies include the following:

- **Residual galvanic baths** from surface treatment industries and **residual chromium baths** from tanneries as a source of Cr(III) salts,
- **Fleshing** as a source of fat and protein,
- **Lime from fleshing** as a source of hydrolyzed protein,
- **Textile and leather finished trimmings** to produce insulating panels,
- **Wastewaters** from **olive oil production** as a source of tannin and oil,
- **Collagen from tanneries** as a captor to test flavonoids in food and natural products,
- **Collagen from tanneries** to produce cosmetics.

The 2 synergies that are explained in this file concern the residual galvanic baths containing chromium VI and finished textile and leather finished trimmings.

✓ *Utilisation of residual galvanic baths of chromium VI*

This synergy consists of recovering the chromium VI, originating from the rinsing waters of parts entering galvanic baths for chrome plating (used to carry out surface treatments) for use during the operation of leather tanning.
The treatment of rinsing waters of chrome-plated parts represents an important financial cost, as important quantities need to be treated every day.
In comparison, the galvanic baths contain an even more important concentration of chromium but the bath is only changed on a monthly basis, so the question is less problematic.
The initial composition of rinsing waters is given below:

	pH	[Cu] ppm	[Zn] ppm	[Pb] ppm	[Ni] ppm	[Cd] ppm	[Sn] ppm	[Sr] ppm	[Ba] ppm	[Fe] ppm	[Cr] ppm
Studied sample	1-2	153.7	72.6	4	9.9	0.1	2.3	1.86	1.34	404	13400

This analysis shows that the chromium is not pure, it is mixed with a certain quantity of other types of metals. It was thus necessary to find a technique for separating the chromium from the other elements.
Furthermore, given that rinsing waters contain a large quantity of chromium VI and the tanning operation requires chromium III, it was also necessary to integrate an operation to reduce the chromium VI to chromium III.

For the separation of the chromium, two techniques were feasible:

✓ The precipitation with Mgo or Na2CO3
✓ The trapping in a resin

Photo 1 and 2: Precipitation of Chromium VI (on the left) and trapping of chromium in the resin (on the right)

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Once the chromium VI has been separated, it must be reduced to chromium III so that it can be used for the tanning process.

- Technical performances and feasibility

This synergy is very interesting in view of the current stakes around the chromium VI: European Directive 2000/53/EC, requests the replacement of chromium VI used in vehicles.

This constitutes a strong constraint for the surface treatment sector as:

- From a technical point of view, chromium VI is an ingredient in the best anti-corrosion protection solutions.
- The specifications of corrosion resistance will not be abated in the automotive domain, on the contrary.
- From an economic point of view, the technical solutions which make it possible to tackle its replacement are more complex and thus may adversely affect costs.

This synergy could allow the treatment surface industries to continue to use chromium VI, as its transformation into chromium III counteracts the hazardousness of the product.

To choose the best option of valorisation, the set of indicators has been used. The comparison has been made between 3 different options:

- A = the separation of Cr(VI) by means of MgO precipitation,
- B = the separation of Cr(VI) by means of Na2CO3 precipitation,
- C = the separation of Cr(VI) by means of ionic exchange (trapping in a resin).

Below, the table indicate the best option (A, B or C) in function of the used indicator:

❖ **From an environmental point of view**

Name of indicator	Best performing option
Water consumption	A = B
Electricity consumption	Not applicable
NOx emissions	A = B = C
Water emissions	A
Use of chemicals	A

❖ **From an economical point of view**

Name of indicator	Best performing option
Wastewater treatment costs	Not applicable
Raw material costs	A

❖ **From a social point of view**

Name of indicator	Best performing option
New jobs that could be created (number)	A = B = C
Number of new activities/projects that could be started	A = B

From those indicators, it is possible to conclude that:

- For the environmental performance, options A and B are better
- For the economical performance, option A is better

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- For the social performance, options A, B and C are equal.

The conclusion is then that the option A (separation of Cr(VI) by means of MgO precipitation) is the best option for the sustainability.

✓ *Use of textile and leather finished trimmings*

The second synergy of this file concerns the manufacturing of insulating panels from finished leather trimmings from tanneries (photo on the left).
These finished leather trimmings are obtained after the operation of tanning. Generally, they are eliminated or undergo a heat treatment due to their high concentrations of chemicals that are hazardous to the environment (heavy metals, varnish).

Photo 4: Leather finished trimmings from tanneries

The method employed to make these insulated panels was to mix some gelatine or plaster with the ground finished trimmings.

The finished trimmings come from two different processes:

- Mineral tanning (the most used) which uses chromium III salts .
- Vegetal tanning which uses different tannins (quebracho, mimosa, sumac.)

Both processes give rise to two different types of production residues of with relatively different compositions:

General analysis of finished trimmings from mineral and vegetal tanning		
Analysis	**Results (%) – Mineral tanning**	**Results (%) – Vegetal tanning**
Volatile matter	45	14
Water-soluble matter		
Water-soluble organic matter	0.3	12.5-11.5
Water-soluble inorganic matter	3.5	2.5-2
Sulphated total ash	7	3.5
Chromic oxide	4	0
Nitrogen	15	9.3
Hide substance (collagen)	84	52.3
pH value, difference figure, aqueous extract		
pH	3.7	3.8
Difference figure	0.6	0.3
Chloride	1.5	
Sulphide	0.7	

Table 1: General analysis of finished trimmings from mineral and vegetal tanning

Before the insulating panels are manufactured, finished trimmings must be ground into small particles to homogenise the sample. Leather with vegetable

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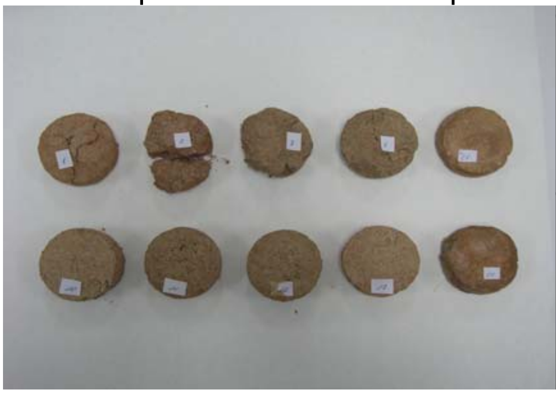
ground grains or chromed ground grains is thus obtained.

Two types of tests were carried out:

- One by mixing some gelatine with leather with vegetable ground grains (Option A)
- The other by mixing some plaster with leather with chromed ground grains (Option B).

Both samples are shown in the photos below:




Photos 5 and 6: Results of the tests - on the left with the gelatine and on the right with plaster

- Technical performances and feasibility

Concerning Test A (with gelatine), the material obtained with the adequate proportions seems to be fairly resistant and could prove useful for the construction of insulating panels. It is interesting to specify that gelatine is also obtained from the extraction of the collagen (protein) contained in the skin, bones, cartilage and ligaments of bovines or pigs.

Concerning Test B (with plaster), the material obtained may prove useful for the construction of insulating panels if it is compressed with a suitable machine in order to obtain homogeneous panels. In this case, it can be used for suspended ceilings.

On the whole, the results obtained show good properties. The implementation of this synergy supposes a significant reduction in waste resulting from the tannery industry, as well as a reduction in the use of raw materials and natural resources.

The valuation of the most sustainable option (A or B) with the set of environmental, economical and social indicators gave those results:

- **From the environmental point of view**, Option A is the best, due to the technical performance, which, in several cases, is better than for B.

- **From the economic point of view,** Option B is the best option in view of the lower cost of raw materials (plaster).

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- **From the social point of view**, A is a better option, due to the fact that there are more companies which have this type of waste, as well as the possibility of generating new jobs being higher.

Option A (gelatine + leather with vegetal ground grains) thus seems to be the best option from the point of view of durability.

Conclusions

The development of the methodology set up by all the MESVAL partners permitted in particular to develop:

- A multidisciplinary approach,
- The assessment of new processes for industrial wastes valorisation,
- The promotion of saving of raw materials,
- The new use of wastes as raw material after valuation,
- The improvement of knowledge about main regional industrial processes.

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TECHNICAL FILE 3

Name of the ECOSIND project: PLASOS **Code: TEC 3 C4**

Title of the file: Installation of a centralised trigeneration system (cooling, heating and electricity supply) in a District Heating and Cooling (DHC) network including renewable energy (biomass and solar energy).
Location: Catalonia - Spain

Context

The implementation of a system of trigeneration from biomass arises from several problems:

- At present, energy is transported over extremely long distances, and the greater the distance the more the loss of energy increases. It is thus necessary to reduce at least the distance between the source of the energy and the place where it is used.
- Furthermore, in the light of falling stocks of non-renewable energies, the evolution of their cost and their impact on the environment, these energies need to be gradually replaced with renewable, local, and easy-to-use energies. Nevertheless, consideration must be given to the logistic, economic, energy and environmental viability.

In the South of Europe, the use of District Heating and Cooling (DHC) is still not very widespread. It is thus absolutely necessary to develop technologies and innovative systems which allow real applications to be set up in these industrial zones.

Structures involved

- **CUCD** *(Consorci Urbanístic del Centre Direccional de Cerdanyola del Vallès)*
- **Universitat Rovira i Virgili** - CREVER
- **ICAEN -** Catalan Institute for Energy (*Institut Catalán d'Energia)*
- **DMAH –** Department of the Environment and Housing of the Government of Catalonia *(Departament de Medi Ambient de la Generalitat de Catalunya)*
- **ICTA – UAB** *(Institut de Ciència i Tecnologia Ambientals de la Universitat Autònoma de Barcelona))*
- **CTFC** – Forest Technology Centre of Catalonia *(Centre Tecnològic Forestal de Catalunya)*

General description

The objective of this trigeneration system is to supply electricity, heating and cooling in a residential and industrial area through the use of partially renewable

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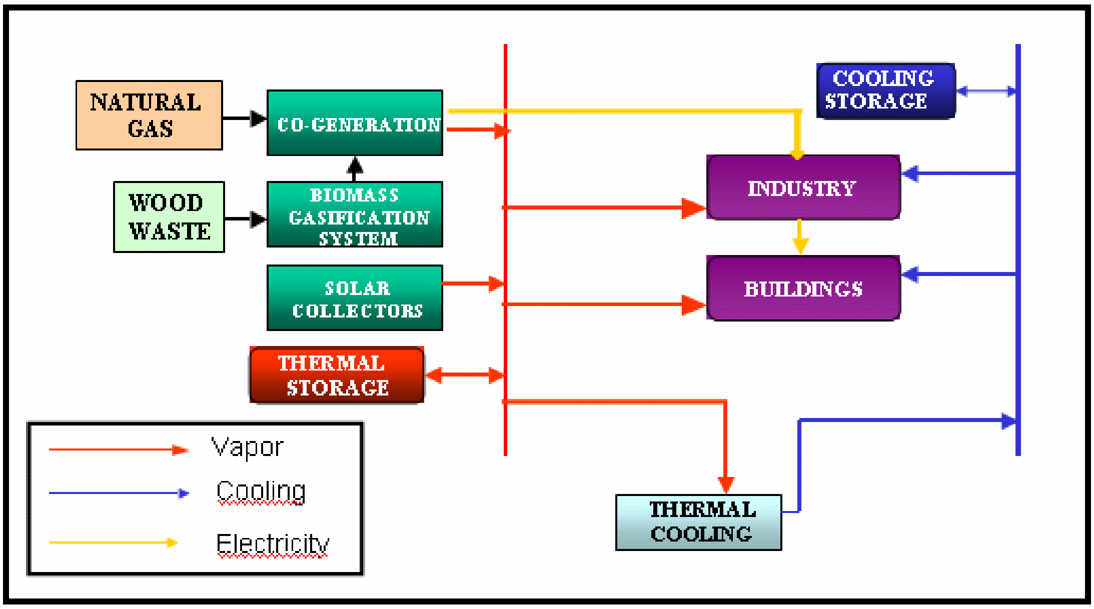
energies. This trigeneration system is fed by previously gasified biomass and natural gas.

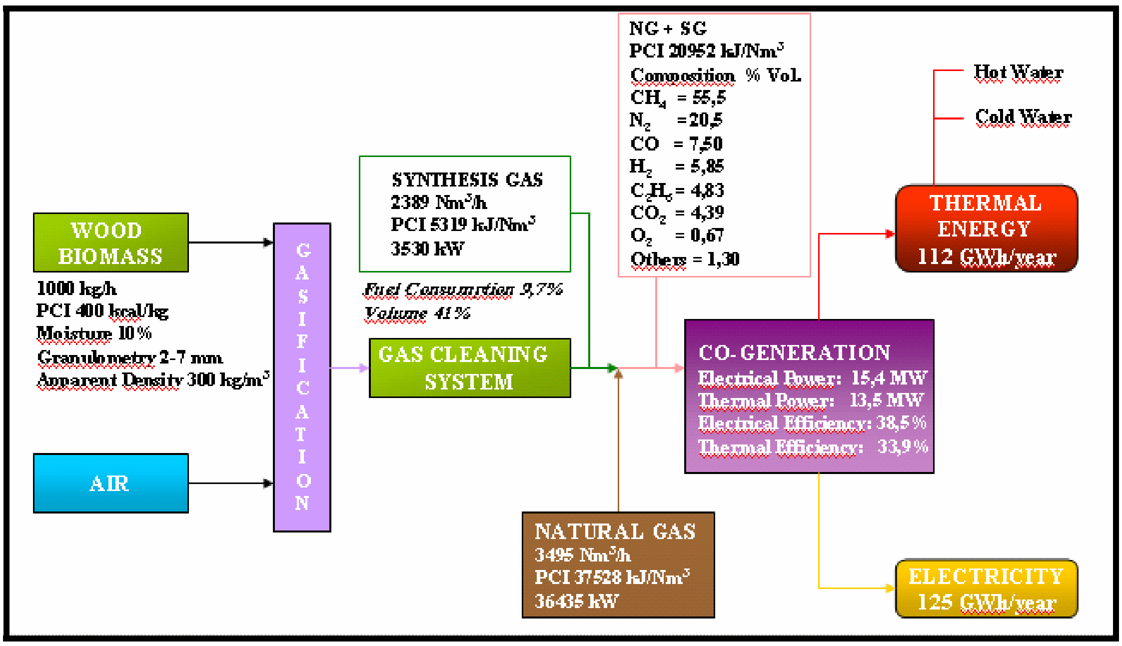
The supply of heating and cooling can be supplemented with the use of sun panels.

The plan shows the trigeneration system supplied with solar energy, biomass and natural gas:



Plan 1: General diagram of the energy supply

Below, the process of natural gas cogeneration and biomass gasification of the Cerdanyola plant according to the results of URV/CREVER (Polycity project) is given in greater detail:



Plan 2: Diagram of the biomass gasification process

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The gasification of the biomass is a very delicate stage, as it is a technology that is still not totally understood. The composition, quality, size and rate of humidity constitute parameters which have a very strong influence on the gasification reaction.
Furthermore, thanks to a preliminary study carried out by the ICTA of the Autonomous University of Barcelona and the IMA of the University of Gerona it has been possible to verify the part of the energy needed for the preparation and the transport of the biomass compared to the total energy obtained by gasification, and according to various types of biomass. The results are as follows:

	Energy expenditure for transport (distance of 50 km)	Energy expenditure for preparation of the biomass	Total energy of cogeneration (electric and thermal)
Wood waste coming from drop-off centres	1%	3 %	96 %
Wood waste from bulky waste	2 %	4 %	94 %
Wood waste from forestry	1 %	14%	85%

Table 1: Comparison of the energy balances for various types of biomass concerning the transport, the preparation and the energy produced by cogeneration.

From the perspective of energy, the most efficient solution would thus be to use the biomass resulting from drop-off centres; thus it is important to study the composition of this option in order to gauge the size of the system.

Technical performances

The expected annual energy performance which the system can supply is given in the table below:

Type of energy	Quantity (MWh/year)
Electrical cogeneration engines	115,715
Electrical biomass plant	-
Electrical integrated biomass gasification	9,184
Total electrical production (42 %)	124,899
Thermal cogeneration engines	101,94
Thermal integrated biomass gasification	8,071
Thermal biomass plant	-
Thermal solar	2,084
Boiler	
Total thermal production (36 %)	112,095
Absorption (SE)	52,809
Absorption (DE)	4,015
Adsorption	1,313
Compression	9,176
Total cooling production (22 %)	67,312

Table 2: Annual energy performance of the system

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Costs

The table below gives an idea of the cost of the implementation of such an installation:

Investment Costs (k€) - Polygeneration (proposal)	
Cogeneration engines	9069
Biomass	1683
Solar	1100
Absorption Chiller (SE)	1439
Absorption Chiller (DE)	202
Adsorption Chiller	102
Compression chiller	375
Cooling Tower	166
District heating network	1122
Total investments cost (k€)	14136
Lineal pay back (years)	5.4

Table 3: Investments costs of the system

Indicators and/or benefits

An installation of this type can make it possible to significantly reduce energy expenditure in comparison to a conventional energy supply that is fed with heat from a boiler and with electricity from the national grid.

- ***Environmental benefits***

Primary energy consumption (MWh/year)	148,089
Primary energy saving (%)	53%
Primary energy from RES (MWh/year)	33,007
Biomass (MWh/year)	30,923
Solar (MWh/year)	2,084
% RES in consumption	18%
CO2 emissions (t/year)	35,962
% CO2 emissions reduction	29%

Renewable energy (MWh/year)	
Total electrical production	124,899
Biomass electrical production	9,184
% Renewable electrical production	7.40%
Total thermal production	101,94
Biomass thermal production	8,071
Solar thermal production	2,084
% renewable thermal production	10%

Table 4: Energy savings with the new system

The results of the implementation of this innovative system can be very positive. With regard to a traditional supply, it can result in savings of up to 53 % of primary energy and to decreases of up to 29 % the CO^2 emissions.

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This result is due, on the one hand, to the high efficiency of cogeneration systems, and on the other, to the use of renewable energies.

➢ *Economic viability*

The table below shows that the implementation of a cogeneration system with biomass is profitable and does not require an excessive return on investment period.

			Biomass plant lineal payback		Comparison with conventional case		
Biomass type	**Biomass price €/MWh biomass**	**Biomass cost k€/year**	**subsidy**	**without subsidy**	**Operational annual difference Conventional-Biomass k€**	**L. payback years (with subsidy)**	**L. payback years (without subsidy)**
Forest residues (1)	9,40	291	3,2	3,9	147	5,1	6,9
Forest residues (2) Mechanised withdrawal Max distance: 10 km	15,00	464	5,3	6,4	-26	-	-
Forest residues (2) Manual withdrawal Max distance: 30 km	25,00	773	-	-	-335	-	-
Industrial residues (2) Large crushing machine	0,67	20,7	2,0	2,4	417	1,8	2,4
Industrial residues (2) Small crushing machine	5,51	170	2,5	3,0	268	2,8	3,8
Conventional case investment cost (all cases):			664				
Sold energy (power + thermal) k€/year			728				
Natural gas cost k€/year (all cases):			438				
Biomass plant cost k€ (all cases):			1.684				
Biomass plant extra cost k€ (all cases):			1.020				
(1) IDAE Promotional paper nº 2 June 2002							
(2) "Cogeneración con biomasa, los hechos en cifras", Besel S.A. May 2001							

Table 5: Return on investment

Conclusions

The implementation of such an installation can bring real profits, in particular concerning the reduction in the consumption of non-renewable energy, and hence greenhouse gas emissions.
Nevertheless, the choice and the dimension of the technology in accordance with the needs of the zone are essential elements for guaranteeing the success of its setting-up.

Contact(s)

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TECHNICAL FILE 4

Name of the project: PRESTEO **Code: TEC 4 EXT**

Title of the file: PRESTEO© (Programme of Research of Synergies on a TErritOry.
Location: France

Context

Presteo is the product of 5 years of research and development led by Dr. C. Adoue within the University of Technology of Troyes (France) and the enterprise company "Systèmes Durables". The conception and the development of Presteo are based on the results of Dr.Adoue's doctoral thesis (ADOUE C., Methodology of identification of practicable eco-industrial synergies between companies on the French territory, doctoral thesis, University of Technology of Troyes, 2004, 224p).
From a practical point of view, the results are based on two specific experiences carried out in the *département* of Aube (France) and the canton of Geneva (Switzerland).

Presteo has been marketed since January, 2005. It was developed in response to the needs of these territories, which had introduced a step of industrial ecology.
This need, identified by the company "Systèmes Durables", is that of a software for research into eco-industrial synergies:

- Ergonomic,
- Useful at any time and in the duration,
- Allowing up–to-date data to be maintained on streams of companies (new processes, new companies).

Structure(s) involved

Conception:
SARL Systèmes Durables: Advice, studies, computer products for industrial ecology, LCA and eco-conception

Development:
LGCD: Advice and development of computer products
Web site: http://lg-conceptiondeploiement.com/

General description

Presteo is a client/server tool composed of a MySQL database and a Php interface. It is accessible from a simple internet connection for every user. It can be used by:

- Experts (consultants, researchers),
- The facilitator of a step of industrial ecology (territory, association),
- The industrialists participating in a step of industrial ecology.

The data on streams of companies concerned with a long-lasting step of industrial ecology or with a simple punctual study must be collected and keyed in the tool Presteo©. This concern input and output streams of water, materials, manufactured objects and energy. This information can be collected by an expert or by the industrialists themselves.

From these data, Presteo© allows its users to look for the potential synergies of substitution and mutualisation between companies participating in a step of industrial ecology.

- ✓ **Definition of a synergy of substitution: Production***effluents and waste become potential resources for other activities. The streams of energy that are given off into the environment (surplus vapour, gaseous effluents or warm liquids) become potential sources of energy for nearby companies.*

- ✓ **Definition of a synergy of mutualisation:** *When two nearby entities consume an identical product, the pooling of their requirements can make it possible to decrease the costs of supply, notably by rationalising the transport link to the delivery. In case of close energy needs in vapour or in compressed air for example, the mutualisation of production can result in greater efficiency and thus to a decrease in costs and environmental impact. The mutualisation of waste treatment can finally enable sufficient quantities to be obtained, to find more effective and more economic solutions, such as recovery.*

Presteo© uses a wordlist of streams of more than 1400 components. It is based on a rigorous methodology of identification and formalisation of streams in which its users must be trained.
This method allows the users of Presteo© to describe two streams that have the same chemical nature in the same way. For example, two companies using

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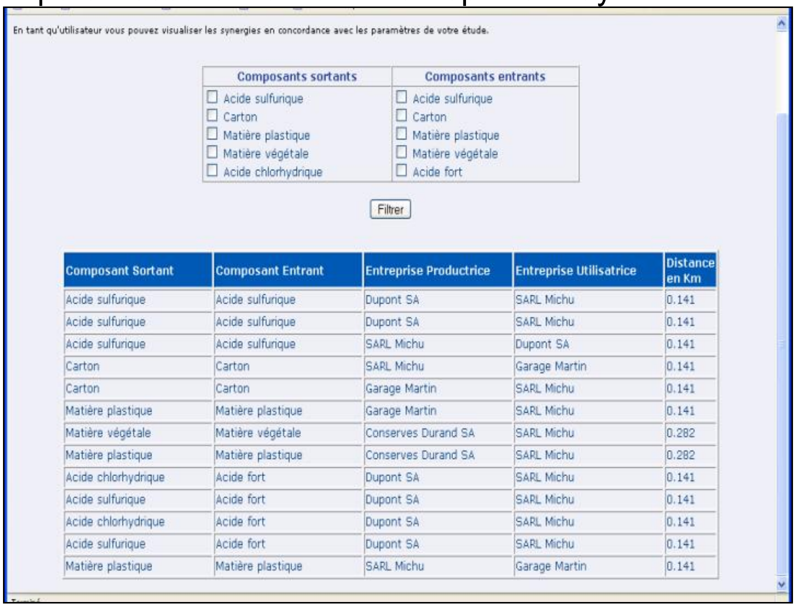
Hydrochloric acid must identify it key it in as "Hydrochloric acid" and not as "HCl" or "Muriated Acid".
A homogeneous and rigorous description shared by all users enables the synergies computer research to work in an optimal way.


En tant qu'utilisateur vous pouvez visualiser les synergies en concordance avec les paramètres de votre étude.

Composants sortants	Composants entrants
☐ Acide sulfurique	☐ Acide sulfurique
☐ Carton	☐ Carton
☐ Matière plastique	☐ Matière plastique
☐ Matière végétale	☐ Matière végétale
☐ Acide chlorhydrique	☐ Acide fort

Filtrer

Composant Sortant	Composant Entrant	Entreprise Productrice	Entreprise Utilisatrice	Distance en Km
Acide sulfurique	Acide sulfurique	Dupont SA	SARL Michu	0.141
Acide sulfurique	Acide sulfurique	Dupont SA	SARL Michu	0.141
Acide sulfurique	Acide sulfurique	SARL Michu	Dupont SA	0.141
Carton	Carton	SARL Michu	Garage Martin	0.141
Carton	Carton	Garage Martin	SARL Michu	0.141
Matière plastique	Matière plastique	Garage Martin	SARL Michu	0.141
Matière végétale	Matière végétale	Conserves Durand SA	SARL Michu	0.282
Matière plastique	Matière plastique	Conserves Durand SA	SARL Michu	0.282
Acide chlorhydrique	Acide fort	Dupont SA	SARL Michu	0.141
Acide sulfurique	Acide fort	Dupont SA	SARL Michu	0.141
Acide chlorhydrique	Acide fort	Dupont SA	SARL Michu	0.141
Acide sulfurique	Acide fort	Dupont SA	SARL Michu	0.141
Matière plastique	Matière plastique	SARL Michu	Garage Martin	0.141

Thanks to its ergonomics and to this method of collection and formalisation of the data, Presteo© also allows the data on streams to be kept up to date when:

- A new company adheres to the step.
- A new process is used by an already participating company, with new streams.

Technical performances

Presteo© V1 is currently only available in French; an English version will be marketed for V2, which is planned for 2007.
Presteo© takes into account the geographic coordinates of companies (X, Y).

It can be thus connected to a Geographical Information System (GIS) to improve the graphic representation of the synergies and facilitate the feasibility study. On a test study of 20 companies the methodology enabled the identification of more than 800 types of streams of water, materials and energy.

Once keyed into Presteo© V1, these streams generated more than 5000 tracks of synergies. There are filters (distance, chemical nature) for refining the researches and concentrating on the relevant tracks.

Presteo© V1 does not enable direct prospecting by identifying the companies which could be synergic with those already implemented or in the course of establishment on the territory. However, using certain methodological tricks it is possible to identify the synergic activities to be attracted from a study carried out on a sample of companies already in the territory.

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Costs

- License of permanent use,
- Hosting of the tool on a remote server for a period of one year,
- 3 months of corrective maintenance,
- 1 on-site training course for future users in:
    - Data collection and formalisation methods ,
    - The use of Presteo©
    - The analysis of the feasibility of synergies,
- User training documents
- Manuals

Price: between €12 000 and €15 000, according to the location of the training.

Indicators and/or benefits

➢ *Environmental benefits*

The eco-industrial synergies generally allow non-renewable resources and diverse emissions in the environment to be saved. However, it is important to verify this for every case. Presteo© does not calculate the environmental profits of the various synergies directly. A specific method inspired by the Life Cycle Analysis (LCA) [36] was developed to this end. .

➢ *Economical viability*

Presteo© V1 does not directly calculate the economic viability of a synergy. This information generally results from an analysis of the other factors of feasibility: geography, quality of streams, available technology, regulation, etc. The software contains, however, a good deal of information which aids in calculating this economic viability: size of streams, distances between companies, etc.

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[36] *[ADOUE C., Methodology of identification of practicable eco-industrial synergies between companies on the French territory, doctoral thesis, University of technology of Troyes, 2004, 224p]*

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Conclusions

Presteo© is an original tool conceived to help in the construction of steps of industrial ecology over time. It is built on solid methodological bases established by theoretical reflections and using empirical results. These rules contain the entire step of industrial ecology on a territory, from the collection of the data on streams to the evaluation of the feasibility of synergies.

They allow the use of Presteo© by all the participants in the step, as well as continuous updating of the data on the streams.

The commercial version finally permits a real transfer of technology and skills, made possible thanks to the training which deals with the various stages of the use of the tool and the search for synergies.

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TECHNICAL FILE 5

Name of the project: OKOPARK HARTBERG **Code: TEC 5 EXT**

Title of the file: Creating an infotainment park based on industrial ecology principles.
Location: Hartberg - Austria

Context

The "Ökopark Hartberg" brings together in a singular environment a business-, trades-, research- and experience park built on the area of a former brick factory. The innovative idea comes from the director of the Hartberg public utility. The Ökopark has become a unique business area perceived as "holiday farm", on which you cannot see where the milk comes from, but where you can see, for example, the whole production chain of a prefabricated eco-house.

Hartberg Ecopark in the Austrian region of Steiermark is a business park which combines on its premises a wide range of ecologically conscious businesses and industries, scientific research institutions, and a permanent public exhibition on environmental protection technology and the natural environment.

The aim is to provide scientific, structural economic and marketing support to ecological businesses by facilitating cooperation and interaction and by presenting the environmental problem to the general public in an attractive and imaginative manner.

The main innovative technology to be highlighted is the idea of a self-sufficient supply and disposal system at park level, linked to the dissemination of environmental management technologies and to technological research facilities.

The Ökopark Hartberg is a unique infotainment park which has become - through the connection of ecology, economics and experience - a lasting experience for the visitor as well as an attractive location for those companies that wishing to cooperate on cycle economy practices and innovation.

Structure(s) involved

The Park was created by the city's utility company and offers the following innovative core services to any business that decides to allocate facilities at the Park:

- **Environmental management and industrial ecology**
- **Innovative technologies and clean production processes**
- **Support in international contacts and alliances**
- **Research experts and contacts**
- **Outsourcing of development units**

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- **Training, guided tours, school visits, others**

Thanks to the more than 20 environmental technology enterprises and the research facilities, the Ökopark offers a unique environment for demonstrating the impact of eco-industrial management.

Visits to the enterprises are permitted: The heating and cooling supply with its most different procedures and a number of further alternative forms of energy can be seen at this “Energie-Schau-Platz”.

Special exhibitions in the solar showroom change annually. Additional stations (such as a water park, climbing foil, swampland shank, sound park, forest paths, and the Imax cinema with its 400 m² screen) offer all visitors a day full of new impressions and experiences on how ecology and businesses can work synergetically.

General description

Hartberg is a small town of 6,000 inhabitants in the Austrian 'Land' of Steiermark, located between Vienna and Graz. As part of a popular tourist region, Hartberg has many cultural and recreational attractions.

The Ökopark Hartberg, located in the Styria region, brings together in 15 hectares approximately 20 enterprises and research establishments, permanent exhibitions (bionics, energy demonstration road, etc), as well as a large format cinema, thus assuring the experience park concept.

The concept chosen for Hartberg Ecopark is based on three interconnected fields of activity:

- **First**, an ecological business park.
- **Second,** an explorative exhibition and recreational park. An integral part of Hartberg Ecopark, permanent exhibitions on major subjects such as water, energy, waste, ecology are addressed to the general public consisting of adults as well as (school) children.
- **Third**, a centre for applied research. Continuous scientific and conceptual guidance is provided by a research centre to be established in Hartberg Ecopark.

The underlying thought is to point out the way from scientific research to development and, thus, to help technical innovations along the path to their practical application. To facilitate this, renowned research institutes are invited to open laboratories in Hartberg Ecopark. Thus, many technical innovations can

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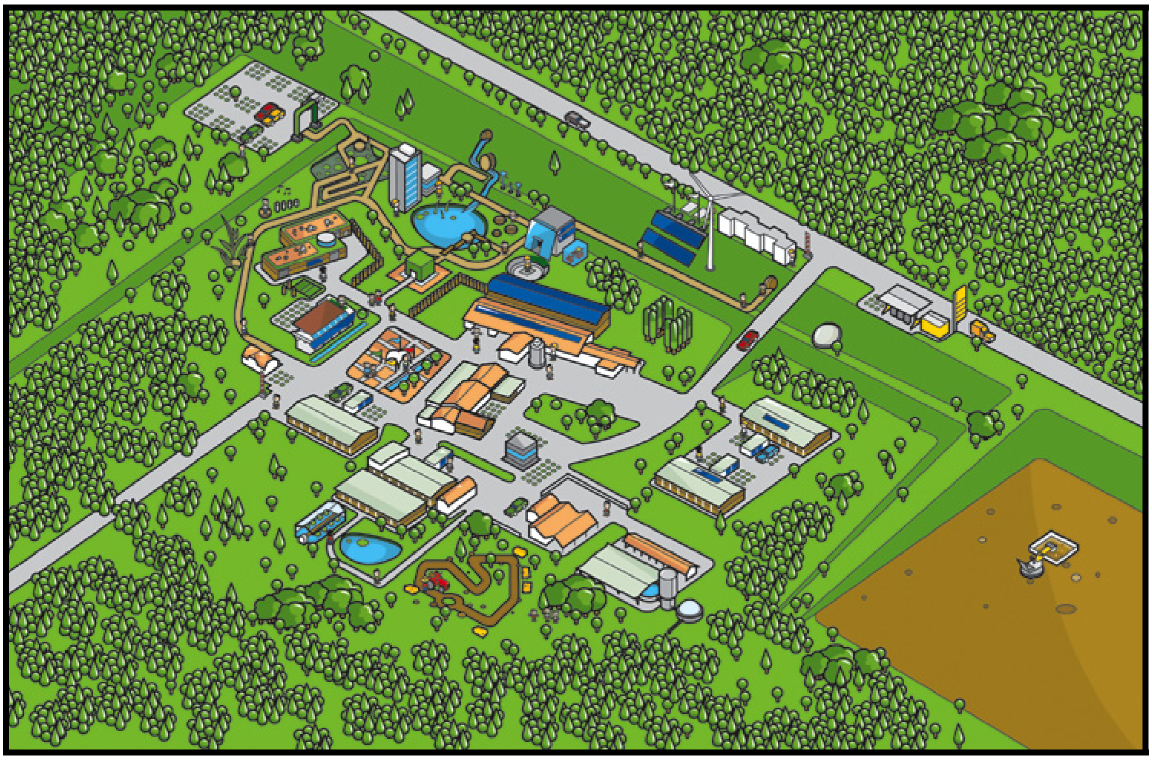
be directly put to use in supplying the Ecopark with utility services and/or they can be integrated as part of the various exhibitions.

The enterprises that have been set up in the Park premises are either ecological service providers, ecological producers or ecological research enterprises. They enjoy special promotions on the part of the municipality, the region, the country and the European Union.

Through the eco-park it is intended to meet economic development needs in a sustainable way. The Park has an area of 15 hectares:



Enterprises that wish to settle at the Ökopark Hartberg, have to support the overall objectives of the Park:

- Improve access to information
- Improve environmental efficiency
- Increase public awareness
- Increase use of clean technology
- Increase use of ecological building materials
- Increase use of renewable resources
- Reduce resource consumption
- Waste recycling

Technical performances

The Ecopark has as mission to become energetically self-sufficient and control all material flows as far as possible. All such processes are being monitored and demonstrated to the general public in specific facilities and under the supervision of technical staff.

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The technical performance can be measured for three key resources:

1. **Energy**
2. **Water**
3. **Material flow (by-products and/or waste)**

1. Energy

To fulfil the country's CO_2 reduction targets, Austria has developed regional strategies in which local and regional public stakeholders are actively involved.

In the district of Hartberg, the use of renewable energies has a share of 26% (source: Case study Energy-Cités, 2002). To attain this high share, several technologies are being used:

- Solar cells for hot water and heat
- Photovoltaic power
- Wood pellets
- Hydro-power
- Biomass plants
- Geothermal energy
- Biogas

The energy is distributed via district heating networks but also via the general grid. Public transport uses bio-diesel for its vehicles.

The Hartberg Park aims to become an energy-independent area. The Park's energy management unit includes a demonstration and trial area for energy efficiency measures, including the following ones:

• Wood chip unit with Stirling motor	ca. 800 kW heat and power
• Wood gasification plant	ca. 100 kWheat
• Biogas CHP	ca. 430 kW heat and power
• Fuel cell	ca. 20 kW heat and power
• Photovoltaik power	ca. 40 kW power
• Adsorption-type refrigeration system	ca. 200 kW cold (produced from recovered heat)

Hence, most of energy consumed at the Park premises comes from renewable resources, and the Ökopark even supplies 'green energy' to nearby districts. The Ökopark uses an ecological heating system and its power comes from renewable energy sources.

The 1st International energy road of Europe (which starts at Oststeiermark and reaches Slovenia) offering the only possibility of visiting all topics of renewable energy and solar power in the world.

One of the Park's demonstration highlights is the Research house, which is used for seminars and conferences as well as office infrastructure. It is a building with two floors (each about 140 m^2) with a glass facade in the south (in the lower part there are 11 vacuum tube collectors.

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The building uses "desiccative and evaporative cooling" (DEC) system as technology for the air-conditioning, which includes a heat storage facility for 2000 litres of water for cooling and heating (the heat comes from the installed solar collectors and the mobile pellet heating system).

The experience shows that the adiabatic air conditioning is sufficient for 50 to 70 % of summer days, and only on days with higher humidity is heat required for the sorption-based air conditioning.

Furthermore, the park offers innovative technologies for improving the energy efficiency of buildings. One of the businesses located in the Park has created a thermal and noise insulating material based on recycled cellulose.

The circular economy concept is put into practice in the energy consumption scheme of the Park: not only does the Park use renewable energy but a research project is evaluating the potentials of extensive vegetable oil production with innovative utilisation potential. Know-how in the composition of mixed crops (cultivation of energy crops and synchronous cultivation of qualitative cereals and accordingly other plants) is passed on to Styrian agriculturists.

A solar train makes the different sections of the ecopark accessible to the visitor.

- ***2. Water management***

The Ökopark actively promotes the sustainable use of water. The Park uses the facilities of the municipal service (principal shareholder of the Park) for the supply of drinking water. The water labyrinth project consists of a nature trail with information on how to save water. The main goals are to show to students in an interactive way the value of biodiversity, nature protection, water management and water consumption. As a result, a labyrinth was built, with various ecosystems,

- ***3. Material flow analysis***

With the idea of natural cycles in mind, preferences in selecting businesses to move in is given to those which can and wish to enter into cooperation and symbiosis with neighbouring firms. For instance, a waste paper recycler provides the resources for a firm producing insulation materials, which in turn can be utilised by an ecological building company. From this cooperation, positive side effects are expected for the environment as well as the individual company's balance sheet. Furthermore, customers have a chance to be informed in an integrated and comprehensive manner.

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Different research projects in the sense of the cycle economy such as the NAWAROS (regenerating raw materials) concept are the scientific pillars of the Ökopark Hartberg, and assure the continuous improvement of the environmental performance of the Park and its businesses.

Costs

To give Hartberg Ecopark a firm financial and organisational base, early in 1997 a development corporation was established which operates under the auspices of Ökoplan, the environmental planning branch of the Stadtwerke Hartberg. It is a partnership consisting of the Stadtwerke Hartberg and two (in future, possibly three) banks. This corporation coordinates and finances construction needs, rents out the sites on Hartberg Ecopark to interested businesses and coordinates contacts with the research institutions and other parties.

The greater part of the financial needs for the construction phase of Hartberg Ecopark have been met by Stadtwerke Hartberg as the owner of the property and main partner of the development corporation. Another important contributor are the banks involved in the corporation. In addition, the project is subsidised by public funding made available from national and regional development funds. Financial support from European Union regional development funds may be acquired for the future.

Once the Ecopark has been opened to the public, maintenance costs should be covered in the main by income from rents and leases and entrance fees to the exhibitions.

Indicators and/or benefits

➢ ***Environmental benefits***

Hartberg Ecopark is a remarkable example of sustainable development for several reasons:

- it explores innovative ways of conveying information to consumers on environmental problems and possible solutions.
- it raises public awareness of environmental issues in a comprehensive manner.
- it promotes applied research on environmental techniques and industrial symbiosis.
- it responds to the economic needs of the region.

While there is not yet any monitoring scheme in place for evaluating the ‘ecological footprint’ of the Park, the environmental benefits are being displayed and shown to the public via regular exhibitions and tours.

➢ ***Economic feasibility***

Alongside each company’s own responsibility for its economic performance, the Park offers advisory services for the creation of new businesses, the integration of innovative production processes as well as the economic feasibility of innovative ideas.

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In addition to this advice for potential clients, the Park offers support on feasibility studies as regards the integration of new technologies and ideas for the improved environmental performance of the Park, such as the construction of a pilot plant in order to evaluate the feasibility of using grass as an energy resource.

The economic feasibility of the Park in terms of its operating costs versus its revenue sources has not been disclosed for this case study.

Conclusions

The ecopark has managed to put business development and research under the umbrella of industrial ecology, linking it to information, participation and training.

The example shows that through integration of innovative technologies, research facilities, training schemes and businesses, industrial ecology becomes a reality and is being implemented day by day.

Beyond economic and environmental strategies, social aspects are key to the overall Park concept: the aim is to explain in an imaginative and interactive way the diverse aspects of environmental problems and to indicate practical ways to solve them. Included in the exhibition is a walk-in dung heap and explorative installations focused on the topics of energy or human cognition. For recreation, woods, a biotope and other natural areas have been designed. Moreover, following a policy of 'open doors', businesses are open to visitors. Thus, basic technical processes as well as their ecological contexts and impacts can be made transparent.

Such business parks are incubators of innovative technologies and processes that often attract further investments and have an added value for the regional economy.

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TECHNICAL FILE 6

Name of the project: KWINANA **Code: TEC 6 EXT**

Title of the file: Capturing Regional Resource Synergies in the Kwinana Industrial Area, Western Australia
Location: Kwinana - Australia

Context

Regional resource synergies are one of the practical applications of *industrial ecology*, which refers to the fostering of mutually beneficial coexistence between industrial production and consumption. Exchanges of natural resource flows between different businesses or with other sectors aim to attain a more efficient use of the materials, energy or water consumed on a site.

The Kwinana Industrial Area is Western Australia's premier industrial area. The area is home to a diverse industry base, comprising several large-scale mineral processing plants, chemical and fertiliser operations, oil refinery, power and waste water treatment plants and cement plant, as well as a group of service industries. The existing synergies in Kwinana Area are quite diverse, but seem to fall into three principal categories (Bossilkov, van Berkel et al. 2005; van Beers 2006), i.e.:

- ***By-product Synergies:*** these involve the use of a previously disposed by-product (as solid, liquid, or gas) from one facility by another facility to produce a valuable by-product.
- ***Utility Synergies:*** these involve the shared use of utility infrastructure, and mainly evolve around water and energy (e.g. water recovery and cogeneration).
- ***Supply Synergies:*** featuring local manufacturer and dedicated supplier of principal reagents for core process industries (e.g. production of ammonia and chlorine for industrial use).

Traditional supply chain synergies are not addressed in this article as such supply synergies are business-as-usual, where a business benefits from co-location with its main customers, a phenomenon well-known as agglomeration economy (Desrochers 2004). Therefore, these supply synergies do not meet the criterion of 'resource exchange between traditionally separate industries' as the distinctive feature of industrial symbiosis (Chertow 2000).

In close consultation with Kwinana Industries Council (KIC), its members and other industry bodies, Curtin University of Technology designed an integrated research strategy to support the realisation of further by-product and utility synergies in Kwinana as well as in other heavy industrial areas (e.g. Gladstone in Queensland, and Rustenburg in South Africa). This research is now being implemented in collaboration with the University of Queensland. The research in Kwinana comprises of the following elements (illustrated in Figure 1):

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➢ ***Kwinana Case-Study:*** The Kwinana Synergies Project provides practical support for the identification and evaluation of synergy opportunities in heavy industrial areas, and is funded by the Centre for Sustainable Resource Processing. The research work includes collection and assessment of material, energy, water and other resource input and output data by company, generation and screening of synergies, and development of business cases for the implementation of techno-economically feasible synergies.

➢ ***Research on Engineering Tools and Technologies:*** The Centre for Sustainable Resource Processing (CSRP) supports this research component. It is aimed at developing an engineering and technology platform for the identification, evaluation and implementation of synergy projects through the development of a regional eco-efficiency opportunity assessment method, and the assessment of technological needs for regional synergy projects, and their subsequent application in Kwinana and other resource processing intensive areas.

➢ ***Research on Enabling Mechanisms:*** This research is supported by the Australian Research Council (through its Linkage Program), KIC, Alcoa, BP, and CSBP. It addresses the organisational challenges faced for the greater realisation of regional synergies in heavy industrial areas by creating the right incentives and mechanisms for industries to start to collaborate and find ways to better share the risks and benefits associated with the development of synergy opportunities.

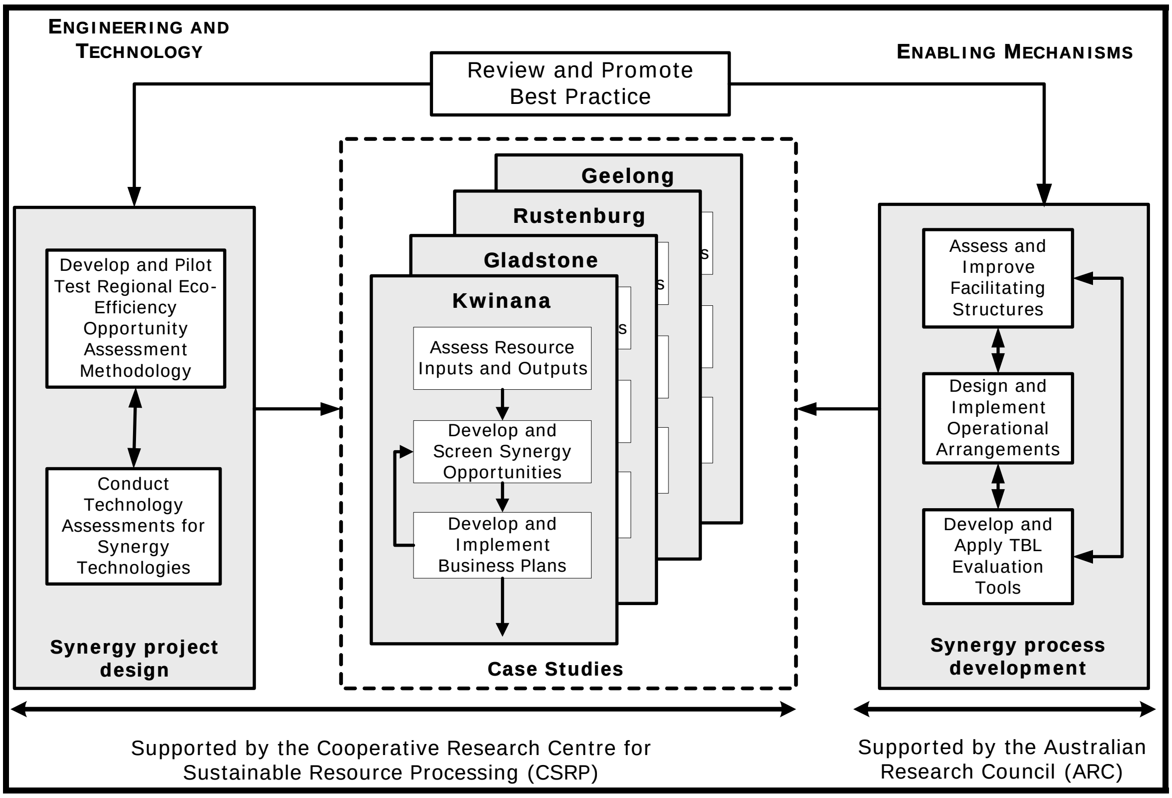

Fig 1: Applied Regional Synergies Research Strategy

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Structure(s) involved

The integrated research strategy on regional synergies development in Kwinana is a joint effort among the following institutions:

- Centre for Sustainable Resource Processing (CSRP)
- Centre of Excellence in Cleaner Production (CECP)
- Kwinana Industries Council (KIC) and its members

The CSRP (www.csrp.com.au) is established and supported under the Australian Commonwealth Cooperative Research Centres Program. The CSRP aims to find technological solutions for eliminating waste and emissions and for reducing energy and water consumption in the minerals mining and manufacturing cycle while enhancing business performance and meeting community expectations. The centre, which is based in Perth, is a government- and industry-funded research initiative to develop greater levels of sustainability in mineral production and processing. CSRP has 9 core participants: Alcoa World Alumina, ANSTO, BHP Billiton, CSIRO Minerals, Curtin University of Technology, Newmont Australia, Rio Tinto, University of Queensland, and Xstrata Queensland. In addition, there are also 12 supporting participants in the CSRP (including the Kwinana Industries Council). Sustainability themes are woven throughout the CSRP's four programs:

- Strategic Analysis and Methodologies
- Eco-efficiency of Existing Operations
- Regional and Supply Chain Synergies
- Breakthrough Enabling Technologies

Curtin University of Technology is one of the research providers to the CSRP. Curtin's Centre of Excellence in Cleaner Production (http://www.c4cs.curtin.edu.au/) was established in 1999, and provides education, applied research, and consultancy services in the fields of eco-efficiency, industrial ecology, sustainable technology, and sustainability management.

The Kwinana Industries Council (www.kic.org.au) is an incorporated business association with membership drawn from all the major industries and many of the smaller businesses in the Kwinana Industrial Area. To assist Kwinana industries address the sustainability of the KIA in a cohesive and coordinated manner, the KIC was formed in 1991, with the aim of fostering positive interaction between member companies and with its major stakeholders. Fourteen major industries are currently full members of the Council, and 27 other industries (predominantly medium sized operations and service providers) are associate members. The aims of the KIC are to:

- Co-ordinate the activities of Kwinana industries on a range of common issues.
- Provide effective liaison with the local community.
- Promote a positive image of Kwinana industries.
- Highlight contributions to the community by Kwinana industries.
- Work towards the long-term viability of the Kwinana Industrial Area.

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General description

The Kwinana Industrial Area (KIA) is located 30 km south of the capital city of Perth on the shores of the Cockburn Sound, a sensitive marine environment. Kwinana's many features make it a world-class industrial area and the Kwinana Industrial Area is Western Australia's primary area of industrial development. The area was established in the 1950s to accommodate the development of resource processing and other heavy industries. There is now a coexistence of diverse and non-competing processing industries in the Kwinana area. The Kwinana Industrial Area is home to a diverse range of industries ranging from fabrication and construction facilities through to high technology chemical plants and large resource processing industries, such as titanium dioxide pigment production and alumina, nickel and oil refineries. A map with the location of the main process industries in the KIA is provided in Figure 2.

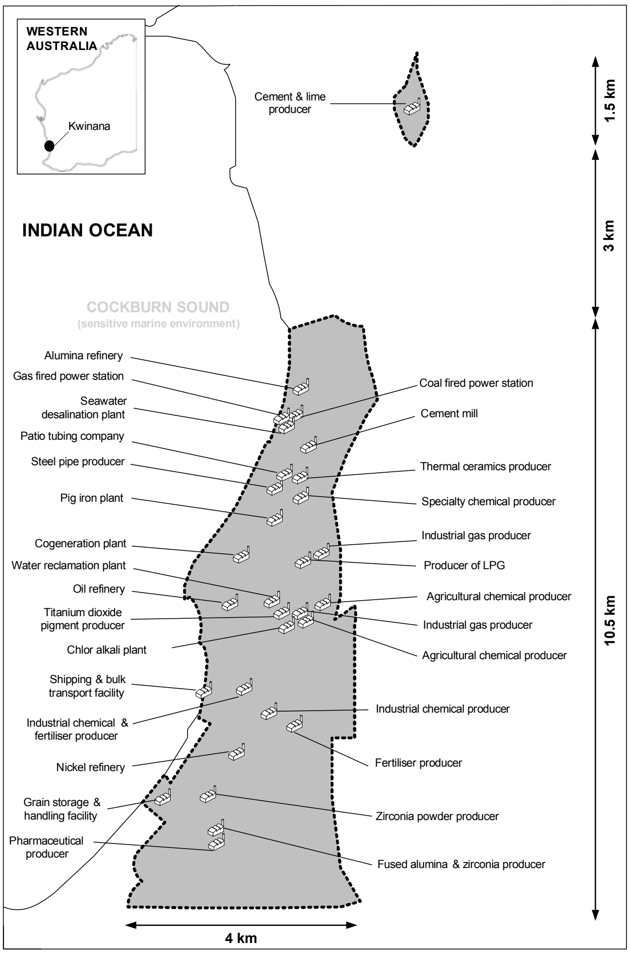

Figure 2: Location of Main Process Industries in the Kwinana Industrial Area (van Beers 2006)

The heavy and supporting industries of the KIA have added enormous value to the resources of the state, and have provided direct and indirect employment opportunities for tens of thousands of Australians. The companies in the KIA (SKM 2002):

- Generate a combined annual output valued at $8.7 billion per annum.
- Have direct sales of $4.34 billion.
- Directly employ approximately 4,000 people (70 % live locally).
- Provide indirect employment to approximately another 24,000 people.
- Commit hundreds of millions of dollars to capital expenditure every year;
- Provide a wide range of employee services.
- Actively fund and contribute time and talent to community activities.
- Sponsor independent research to validate their own high standards and strict code of self-regulation on health, safety and environmental issues.

The total number of current regional synergies (or industrial symbiosis) projects already in place in Kwinana is 47 with 32 being by-product synergies (Figure 3) and 15 pertaining to the shared use of utility infrastructure (Figure 4). Many of these resulted from businesses pursuing opportunities to enhance their efficiencies, reduce costs and increase reliability of access to scarce resources

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for running their operations. The existing regional synergy projects in Kwinana are more diverse and significant than reported for other heavy industrial areas (Bossilkov, van Berkel et al. 2005). This positions Kwinana among the international leading edge examples of regional synergy development. The evolution and maturity of industry collaboration in Kwinana provide testimony for the contribution regional synergies (industrial symbiosis) can make to sustainable development.

The key project that initiated much of the more recent work on regional synergy development in Kwinana was the *Kwinana Industrial Area Economic Impact Study* in April 2002 (SKM 2002). This project was supported by the Kwinana Industries Council, Chamber of Commerce and Industry Western Australia, Western Australian Planning Commission, Landcorp, Department of Mineral and Petroleum Resources and Environment Australia. The study showed that the environmental performance, and in particular cleaner production, energy efficiency and water conservation efforts of Kwinana companies have substantially reduced waste generation and increased resource efficiency.

Figure 5: Aerial picture of Kwinana Industrial Area

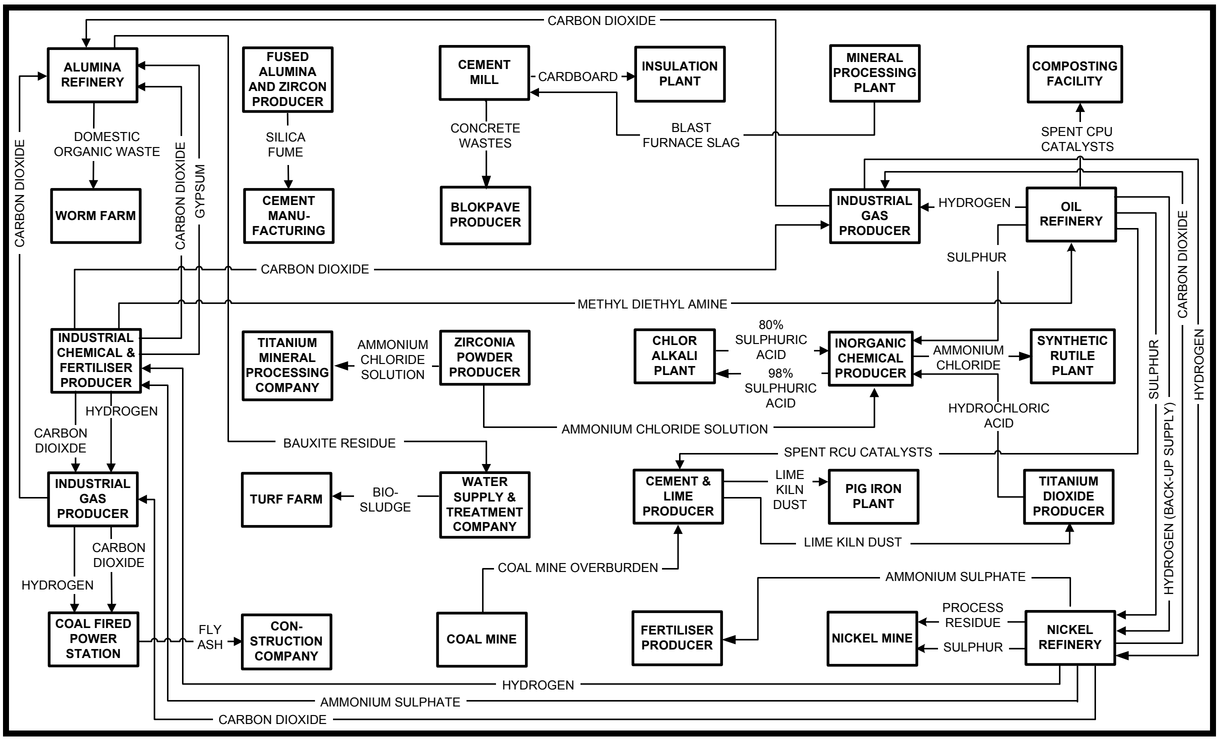

Figure 3: Existing By-Product Synergies in the Kwinana Industrial Area (van Beers 2006)

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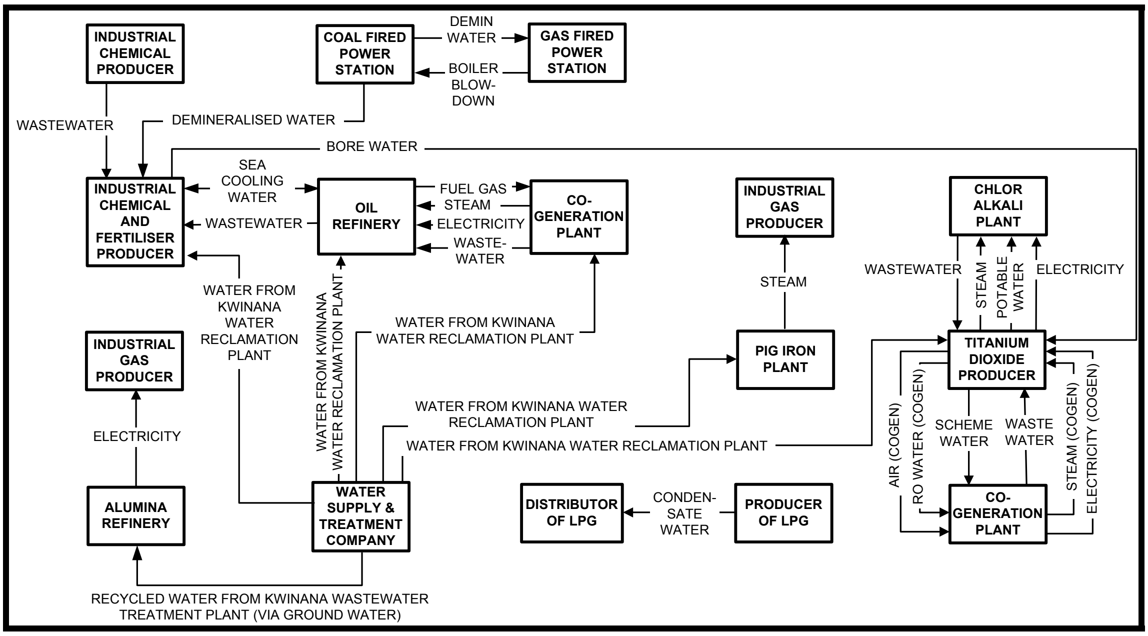

Figure 4: Existing Utility Synergies in the Kwinana Industrial Area (van Beers 2006)

Technical performances

Regional Synergies is a collective approach to environmental management and resource efficiency among industries in close geographic proximity. Technology is a key enabler for regional resource synergies. As shown in Figure 1, the supportive regional synergy research involves the development of engineering tools and technologies and enabling mechanisms.

In order to assess the role of technology in the realisation of regional resource synergies, an analytical framework was proposed that breaks down any synergy project into three components: capture, recovery/ management and utilisation (see Figure 6):

- ***Capture*** refers to how the material/heat/water is taken from the 'source' production process.
- ***Recovery*** refers to the technology used when the resource stream (water/heat/material) is recovered, separated into valuable components, transformed or mixed with another resource to form a usable by-product.
- ***Utilisation*** then refers to the technology involved when the by-product stream is used in a 'sink' production process.

The initial review (Harris, Corder et al. 2006) provided an overview of the technology needs in order to enable synergies in the three key areas of water, heat, and material. These three areas are subjected to in-depth technology assessments.

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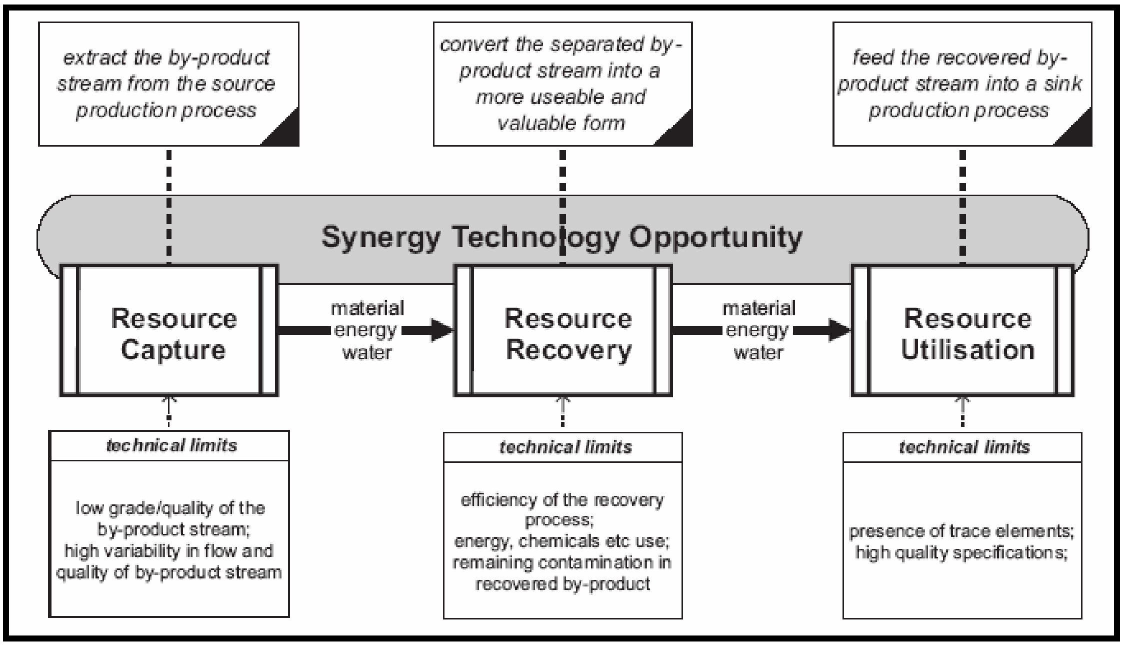

Figure 6: Synergy technology opportunity (Harris, Corder et al. 2006)

As part of the CSRP research on synergy enabling tools and technologies, a prototype for a Regional Eco-efficiency Opportunity Assessment Toolkit has been developed. This toolkit guides a targeted and less resource intensive way to identify feasible synergy opportunities in heavy industrial areas, using a using a three-phase process (see Figure 7). In its final version it will represent a step-by-step routine with instructions on "how to" at each stage.

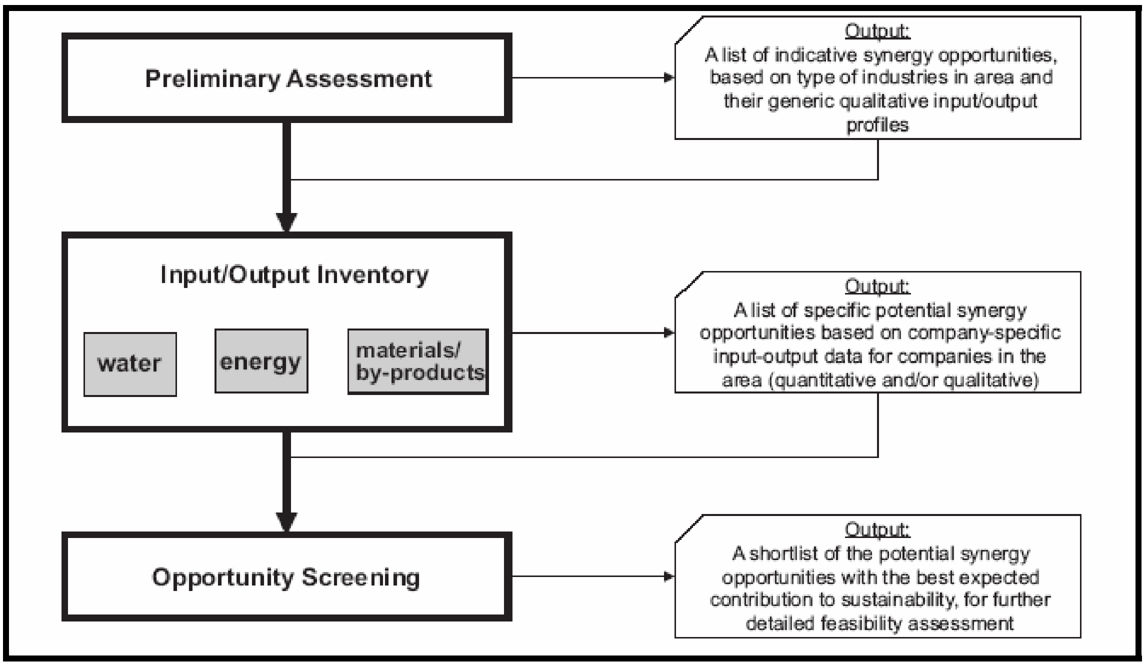

Figure 7: Overview of the regional synergy opportunity assessment methodology (Bossilkov and van Berkel 2005)

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Costs

The Centre for Sustainable Resource Processing (CSRP) supports the research on Synergy Engineering Tools and Technologies, and the Kwinana Regional Synergies Project. The research on synergy-enabling mechanisms is supported by the Australian Research Council (through its Linkage Program), KIC, Alcoa, BP, and CSBP.

While detailed information on the annual or total costs for the regional synergies research in Kwinana is not (yet) available in the public domain, members of the KIC have started to recognise and value the benefits of regional synergies in terms of economic returns, business efficiencies and reduced costs and liabilities from waste disposal, leading to the continuation of the support towards the further development and realisation of synergy opportunities through the KIC. Companies and their employees have seen business opportunities to reduce costs, and increase revenue and/or reduce resource vulnerability by engaging in resource exchanges with their neighbours.

Indicators and/or benefits

For a regional synergy to be successful, all involved parties must benefit in one way or another. In fact, it is unlikely that a synergy would be implemented unless all involved parties at least perceived some business benefit (direct or indirect). For all synergies implemented in Kwinana there are both tangible operating benefits as well as less tangible ones, such as reputation, environment or community benefits. To illustrate this, Table 1 presents a summary of the commercial, environmental, and community benefits for a set of existing synergies in Kwinana.

Synergy	Commercial benefits	Environmental and community benefits
CSBP gypsum re-use at Alcoa residue area	▪ Reduced costs to manage gypsum stockpile (long-term) ▪ Lower cost gypsum source for alumina refinery	▪ Reduction of stockpiled gypsum onsite at chemical plant ▪ Increased soil stability and plant growth at Alcoa residue area
Air Liquide utilising by-product CO_2 from Kwinana industries	▪ Cost savings for industrial gas company to produce food grade CO_2 from otherwise emitted CO_2 emissions	▪ Proportion of CO_2 emissions from industries are no longer emitted to the atmosphere ▪ Avoidance of energy use that would otherwise be required to produce CO_2 from air
2 Cogeneration facilities (BP, Tiwest)	▪ Increased energy efficiency ▪ Reliable source of electricity and superheated steam ▪ Sales of electricity and steam from cogeneration plant	▪ Reduced greenhouse gas emissions ▪ Increased energy efficiency ▪ Employment

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Synergy	Commercial benefits	Environmental and community benefits
Kwinana Water Reclamation Plant (KWRP)*	▪ Water security for industry users ▪ Availability of high-grade water for industry	▪ Scheme water conservation ▪ Redirection of discharges of treated industrial effluent from coastal zone into deep ocean ▪ Water quality improvement in sensitive coastal zone

* A more comprehensive assessment of the triple bottom line impacts of these regional synergies is available from (Kurup, Altham et al. 2005).

Table 1: Illustrative Benefits of Regional Synergies in Kwinana (Corder, Van Beers et al. 2006)

As illustrated in Table 1, the types of benefits can vary greatly, and often go well beyond the conventional business case benefits. Security of water and energy supply, increased energy efficiency, lower operational costs for energy use, and reduced storage costs for the inorganic by-products are key benefits from the Kwinana synergies presented here. In addition, all of these synergies had environmental and community benefits. These case studies exemplify that the benefits from regional synergies are not just commercial but also strategic, leading to reduced exposure to risk and better reputation with key stakeholders. The critical factor in initiating a regional synergy is for all the involved parties to appreciate fully the range of benefits, both direct and indirect, that will result from its implementation (Corder, Van Beers et al. 2006).

The benefits of regional synergies have typically been documented only in environmental and/or financial terms for the project partners involved. This however does not consider the broader sustainability benefits, including economic, social, and environmental opportunities for the exchange partners, the neighbouring communities, and industries. A more comprehensive and inclusive approach is required to account for the full economic, social and ecological benefits over the entire life cycle of a synergy opportunity. As part of the ARC research on synergy enabling mechanisms, a novel approach on Triple Bottom Line Accounting is being developed and trialled in Kwinana (and Gladstone, Queensland) to help build a more comprehensive business and societal case for material and energy exchanges, leading to improved regional sustainability (Kurup, Altham et al. 2005).

There are 47 industrial synergies now in place in Kwinana – 32 by-product synergies, involving the reuse of solids, liquids or gasses, and 15 involving the shared use of utility infrastructure. Most of the existing synergies in Kwinana are documented in the Global Synergies database of the Centre for Sustainable Resource Processing (http://www.csrp.com.au/database/index.html). The purpose of this database is to provide a publicly available database of synergy examples from around the world, which can be easily searched and accessed to aid in the development of synergies worldwide.

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Conclusions[37]

The regional synergy research confirmed the tight collaboration and integration already existing in the Kwinana Industrial Area, which has historically evolved in response to perceived business opportunities and environmental and resource efficiency considerations. The number of existing regional synergy projects (47 in total) in Kwinana in place go well and truly beyond business as usual, as they involve either exchange of by-products or shared use of water and/or energy infrastructure and utilities. These current synergy projects are more diverse and more significant than those reported for other heavy industrial areas. This in turn positions Kwinana well among the leading edge examples of regional synergy development in heavy industrial areas (Bossilkov, van Berkel et al. 2005).

There is widespread enthusiasm and commitment from the industries operating in the Kwinana Industrial Area to achieve greater regional synergies and thereby make a contribution to sustainable development in the area. This is most profound among the members of the Kwinana Industries Council, but extends to several other companies that have significant operations in the area. This commitment is reflected in the willingness to participate in the Kwinana Synergies Project, the disclosure of input and output data for operations and participation in synergy development workshops.

Many diverse regional synergy opportunities appear still to exist, as evidenced by the Kwinana Synergies Project being able to identify over 90 new potential synergies, mostly in three broad areas: water, energy, and industrial inorganic by-products. Current development efforts focus on nine promising one-on-one company synergies with regard to water and by-products.

Over the past few years significant progress have been made by the industries, research team, and the Kwinana Industries Council to develop regional synergies in the Kwinana Industrial Area. The substantial economic, environmental, and social benefits of these synergies need to be effectively communicated to key stakeholders (e.g. government, community, and other industries) so that existing barriers can be removed and appropriate policies can be put in place to enable further development of regional synergies in Kwinana.

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[37] Conclusions taken from van Beers, D. (2006). Status Report on Regional Synergies in the Kwinana Industrial Area. Perth, Western Australia, Centre for Sustainable Resource Processing (CSRP): 100.

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TECHNICAL FILE 7

Name of the project: 3R strategy **Code: TEC 7 EXT**

Title of the file: Implementation of the 3R strategy
Location: Brazil

Context

The Ministry of Environment of Brazil, with the cooperation of the Ministry of Cities, the Ministry of Health and NGOs dealing with garbage pickers, promoted, last year, 10 Regional Seminars on Solid Waste Management in order to inspire the municipalities to ensure the environmentally sound management of solid wastes and to encourage the participation of garbage pickers in the process.

The initiative started with the Ministerial Conference on the 3Rs in April 2005, organised by the United Nations Environment Programme (UNEP).

The Seminars were aimed at mayors, municipal technicians, academic staff, and non-governmental organisations.

Brazil drafted a bill that is being submitted to the National Congress regarding a proposal for the National Solid Waste Policy that includes basic concepts of no generation, 3R, integrated solid waste management, formal inclusion of garbage picker's organisations and logistics reversal.

The proposal also includes the principles and foundations of sustainable development, the participation of civil society in plans and programs, the integration of garbage pickers into programmes with actions regarding solid waste flow, the environmentally sound disposal of the residues, and differences between solid wastes and residues.

The most important aspect of the proposal is to bring about the adoption of the 3R concepts as a common procedure; this is the working mission of the "*Compromisso Empresarial para Reciclagem*", (CEMPRE), which in English means Business Commitment to Recycling.

Structure(s) involved

CEMPRE is a non-profit association dedicated to promoting integrated management of solid municipal waste and post-consumption recycling, disseminating environmental education based on the "3Rs", and attempting to increase the social awareness of recycling, and wastes in general, through publications, technical research, seminars and data banks.

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Established in 1992, CEMPRE is maintained by a body of 22 private companies from various sectors, listed below:

- ✓ Alcoa
- ✓ Aleris Latasa
- ✓ AmBev
- ✓ Beiersdorf/Nivea
- ✓ Coca-Cola
- ✓ Carrefour
- ✓ Daimler Chysler
- ✓ Kraft Foods
- ✓ Klabin
- ✓ Natura
- ✓ Nestlé
- ✓ Paraibuna Embalagens
- ✓ Pepsico
- ✓ Philips
- ✓ Procter & Gamble
- ✓ Souza Cruz
- ✓ Suzano Papel e Celulose
- ✓ Tetra Pak
- ✓ Unilever Brasil
- ✓ Gerdau
- ✓ Sadia
- ✓ Wal-Mart

The main grounds of activity of CEMPRE could be described as the following:

- To promote the concept of Integrated Management of the Municipal Solid Waste
- To promote post-consumption recycling
- To disseminate environmental education with a focus on the three Rs theory: reduce, reuse & recycle

In line with the mission of CEMPRE, the 3R proposals in Brazil include the participation of waste collection cooperatives in the integrated management of urban waste, in addition to promoting the concept of shared responsibility, involving public authorities and industry, cooperation among different stakeholders, distribution and the community.

General description

A 3R policy typically calls for an increase in the ratio of recyclable materials, the further reuse of raw materials and manufacturing wastes, and an overall reduction in resources and energy used.
These ideas are applied to the entire lifecycles of products and services – from design and extraction of raw materials to transport, manufacture, use, dismantling/reuse and disposal - and range from rotting vegetable matter and foodstuffs to more valuable metal, plastic, glass, and paper.

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The material cycles are shown in the following diagram.

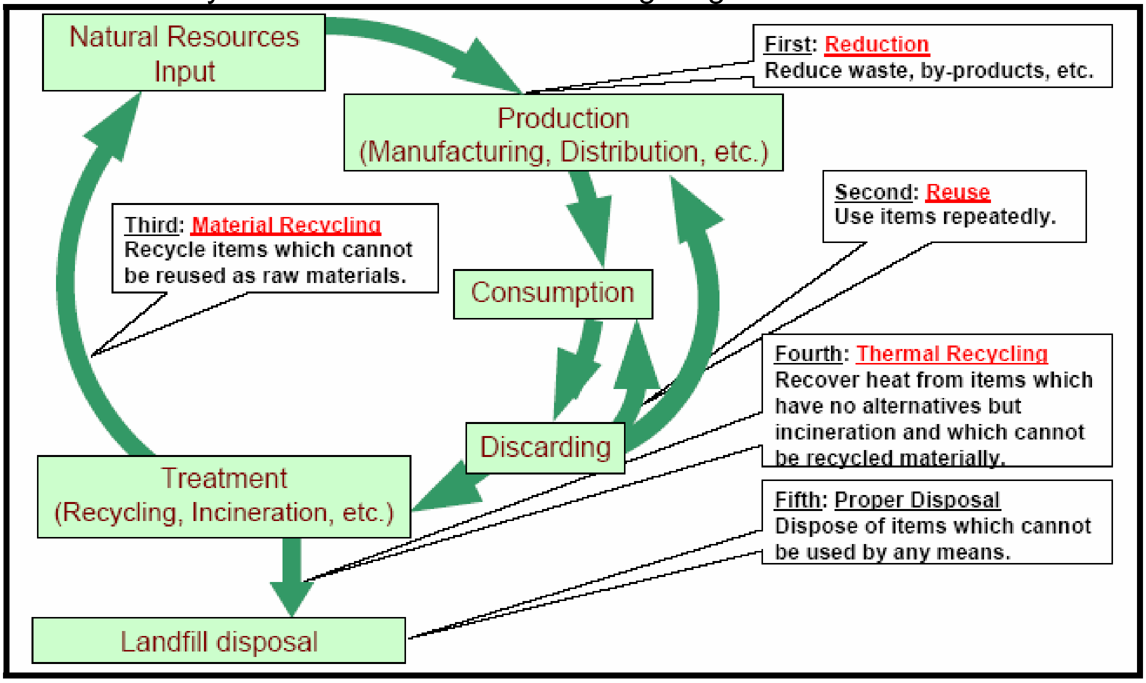

Fig 1: Waste cycles with the application of Recycling, Reusing and Reduction steps.

Then, the 3R facility will divert waste away from landfill by separating out these valuable products, converting the organic component of the waste into compost and fertiliser products, and giving the inorganic materials another use.

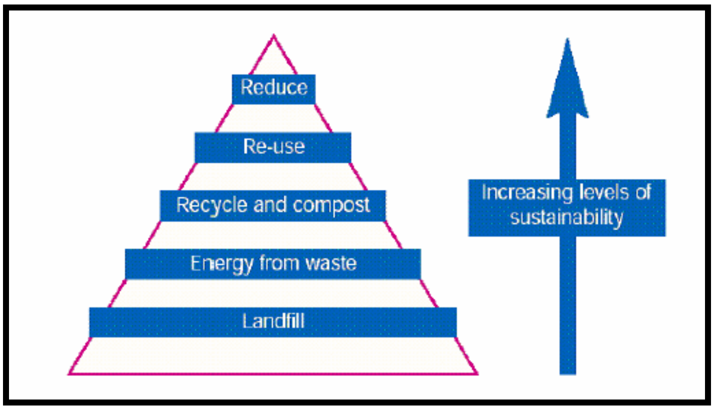

Fig 3: The 3R technology changes the trend of waste accumulation.

Technical performances

The aforementioned 3R approach, focusing on the **reduction, reuse, and recycling of resources and products** essentially aims to set up a sound material cycle society within the concept of a life-cycle economy, where consumption of natural resources is minimised and the environmental load is reduced as much as possible.

The model of industrial economy that was adopted during the 20th Century was based on the exploitation of natural resources, manufacturing them into an amount of waste accumulated in the environment.

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The 3R facility will divert waste away from landfill by separating out these valuable products and converting the organic component of the waste into compost and fertiliser products. The 3R technology tracks a circular economy model, which is shown in the following diagram:

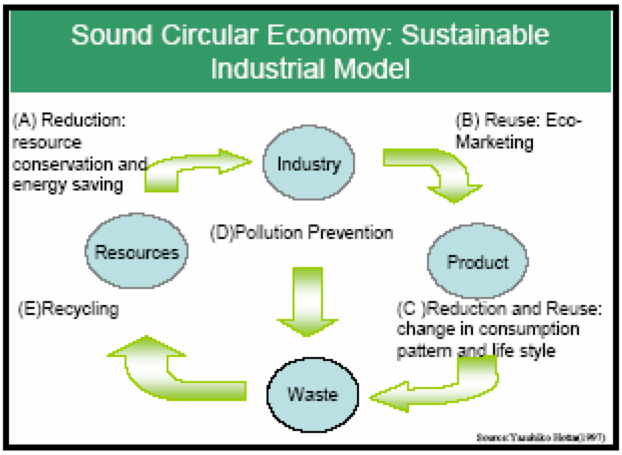

***Fig 2**: Circular Economy.*

By way of technology, CEMPRE provides people with the following exclusive services:

- Virtual library comprising books, documents, CDs catalogues of equipment suppliers, campaign materials, folders of events and courses.
- Database of the country's recycling companies, scrap dealers and cooperatives.
- Database of the recycling market: prices of recycling materials depending on the city in Brazil and the kind of material.
- A scrap buyer searcher for people who want to sell their materials recycling.
- Giving the possibility of subscription on its webpage in order to receive information on recycling, seminars, good practices, environmental education, etc.
- General information and current data on the recycling process, such as aluminium cans, urban compost, corrugated, office paper, glass, hard plastic, plastic film, PET, tetra pack, urban compost and used lubricant oil.

All these services facilitate the accessibility of information in order to be able to generate new solutions to a problem facing businesses and community associations that promote recycling: the discharge of material separated from waste disposal.

Costs

The Brazilian Government and the municipality gave a grant of 1.5 million American Dollars for projects that take the responsibility for the collection, separation and sale of recyclable material. This has increased the number of employees in the business, and has also resulted in social gains, with the generation of jobs and increased income for workers in the recycling sector.

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Indicators and/or benefits

Environmental benefits

The environmental benefits of adopting the concept of 3R are less waste for local government and community to manage and a better environment for citizens, which would significantly:

- Reduce greenhouse gas production. Preventing pollution generation and promote recycling and reuse.
- Decrease the use of landfills
- Promote the use of sustainable resources with reductions in the consumption of natural resources. To conserve energy and materials.
- Reduce the use of toxic constituents/release of priority chemicals

The following data collected from CEMPRE database 2004 shows the types of recycling materials and the existing recycling market in Brazil.

MATERIAL	% of the National production recycled 2003-2004
Aluminium cans	95.7
Corrugated cardboard	79
Glass	47
Rigid/Film plastic	16.5
Office paper	33
PET	48
Steel cans	49
Tyres	57
Tetra pack Packages	22
Urban compost production	1.5
Used Lubricating Oil	30

Economic feasibility

There are different points of view for analysing the economic feasibility:

- For the National Economy, 3R technology offers a harmonisation of environmental and economic concerns in the framework of circular economy.
- For industry, 3R technology increases resource productivity and thus competitiveness in the industrialist business, with reduction in materials investments.

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- Being essential for the efficiency of the Brazilian model, the 3R concept also leads to the creation of thousands of jobs and ensures the generation of income for the country with an increasable standard of life.

Conclusions

Implementing 3R technology in the circular economy has the following results:

- Reduction of illegal activities and transformation of the informal sector of recycling material market into another more recognised one.
- Promotion of technological development and exchange
- Mitigation of negative impacts on human health and the environment
- Reduction of barriers to the international flow of recyclable materials

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3 Projects linked with the ECOSIND network

3.1. CLOSED

The closed cycle management systems in manufacturing districts- *http://www.arpat.toscana.it/progetti/pr_closed.html*

"Sponsored by ARPAT and Ecosistemi, and co-financed within the context of the European Union's LIFE Program, this was a biennial project that was launched in November 1999. Its goal was to reconcile economic growth and environmental protection, creating communities in which businesses, local agencies and citizens work together to manage the environment and available resources in a manner that is compatible with the economic criteria of closed cycles. The production chains involved in the project were: paper manufacturing in Lucca, plant-flower growing in Pistoia and textile manufacturing in Prato according to the methods outlined in the Project guide. The Project participants were small and medium-sized enterprises in Prato, Lucca and Pistoia and the industrial associations in each district."

3.2. ECOLAND

An Ecological Approach for the Next Decades - *http://www.ecolandproject.com/*

"The Interreg IIIc project "**EcoLAND**: an **Ecolo**gical **A**pproach for the **N**ext **D**ecades" - runs for the period 2003-2006 and was approved in the first consideration of proposals for Interreg IIIc's eastern region on 9th January 2003.

The project concerns the creation of a European relationship network of partners who have similar experiences, in order to be able to identify an effective model for the planning and management of Eco-Industrial Estates. This model has to be compliant with European Community directives and at the same time adaptable to the laws and the regulations of the local Governments. The project was conceived in an effort to seek synergies within economic

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development, the local communities and the natural environment (resources, landscape etc.).

Sustainable development is the key word for this new integrated approach; it requires local actions to ensure that development leads to a future where both economic development and environmental respect are compatible."

3.3. NISP

National Industrial Symbiosis Programme - *http://www.nisp.org.uk/*

"NISP is a free business opportunity programme that delivers bottom line, environmental and social benefits and is the first industrial symbiosis initiative in the world to be launched on a national scale.

NISP is a national programme that is delivered at regional level across the United Kingdom. Each of the eleven regions has a team of dedicated IS (Industrial Symbiosis) practitioners working closely with businesses in the area to raise the profile of IS and to recruit members to the programme.

NISP works directly with businesses of all sizes and from all sectors. A programme advisory group, consisting of key industry representatives, assists each of the regional IS teams to ensure the programme is driven by genuine business requirements, and that the strategic direction is relevant for each region.

NISP is part funded by Defra through its Business Resource Efficiency and Waste (BREW) Programme. Some of the regional programmes also receive additional funding from their respective regional development agencies and other organisations."

3.4. SIAM

SIAM – Sustainable Industrial Area Model - *http://www.siamproject.it/*

"SIAM is a project that arose in 2004 from an ENEA (Italian National Agency for the New Technologies, Energy and Environment) proposal within the European Community and subsequently funded through the "LIFE - environment" instrument. It is carried out with the collaboration of twenty Italian partners from diverse sectors.
The aim of SIAM is to build up a knowledge base that will allow us to specifically modify – orienting ourselves towards a reduction of the environmental impact as a whole such that, in relation to the parameters considered validating from the partners, it exactly turns out to be *sustainable* - the setting of existing and future industrial areas.

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The environmental impact of an industrial area - in the case of SIAM project - is related to the concept of "local system", in which is subdivided into "economic system", "social system" and "environmental system". In order to be *sustainable*, it will have to be sustainable for all parts of the "local system".

The SIAM project is involved in the integration policy of different community instruments (both mandatory and voluntary) to allow their innovative use in territorial planning and managing. During its development, the identification and implementation of a new mannner of applying sustainable development principles were identified, encouraging the integration of environmental and socio-economic policies, by means of a process that involves local authorities, industry and the general public. The results of the project will make it possible to solidify a Sustainable Industrial Area Model that can then be replicated elsewhere in the EU, and outside the Community territory. Suitable **software** will be developed over the course of the project in order to monitor the development of the area management correctly. “

3.5. IMEDES

IMEDES - Instituto Mediterraneo Para El Desarrolllo Sostenible - *http://www.ctv.es/USERS/imedes/imedesprogramas.htm*

3.6. UWE

UWE – Union Wallonne des Entreprises - *http://www.uwe.be/*

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