Waste Prevention and Minimisation

Final Report

Commissioned by the European Commission, DG XI

Darmstadt
29 July 1999

Öko-Institut e.V

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Contents

Tables

Illustrations

Introduction: Waste Prevention and Minimisation

In its 1996 Communication on the Review of the Community Strategy for Waste Management[1], the EU Commission stresses that prevention of waste and the minimisation of hazardous substances in waste must be the overall targets for a strategy on waste management of the Community.

According to the Fifth Environmental Action Programme for the year 2000, management of waste generated within the Community is a key task of the 1990s. A vital element of the Community Strategy is achieving waste minimisation in terms of both volumes and environmental hazards/damages. The Programme sets the EC waste minimisation target for the year 2000 to be a stabilisation of quantities of waste generated at an EC average of 300 kg/capita on a country by country basis[2].

Waste needs to be prevented and minimised for two major reasons. First, waste is a potential source of pollution. Second, waste consists of high shares of recyclable and reusable materials.

This research examines some of the best waste minimisation practices on both industrial and municipal waste flows. The objectives of the proposed study are to:

a) identify and analyse the measures taken by the various national actors to minimise the quantity and hazardousness of industrial waste;

b) identify and analyse, in the municipal waste sector, the best practices of waste prevention;

c) identify horizontal measures taken with the aim of eliminating hazardous substances from the waste stream;

d) measure and analyse, on several concrete examples, the environmental and economic gains connected to the prevention of waste.

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1 COM 96(399) final, 30.07.1996.

2 See 1993 OJ C 138, Chapter 5.7.

I Belgium

Waste prevention and minimisation only recently became issues of general awareness in the Belgian public and political spheres. In the past, Belgium's policies have favoured waste disposal rather than its prevention.

This delay can be put down on the federal structure in Belgium and to important constitutional reforms from 1980 to 1993. Due to these reforms the administrative competence for environmental matters were mainly attributed to the three Belgium regions – the Walloon, the Flemish and the Brussels Region. Since 1988 these regions theoretically have got the possibility to adopt and enforce environmental law through their own legislation. However, waste minimisation and prevention matters, were not considered as one of their priorities.

In order to further promote waste prevention and minimisation in Belgium this study will describe three cases of good practise from different sectors: waste minimisation within the industrial sector, waste minimisation within the municipality of Dilbeek and household waste minimisation through new legislation in the Walloon Region.

1 Municipal Waste: Taxation of Municipalities

The Walloon Region adopted in July 1998 an enactment with a new and innovative instrument that entered into force 1 January of 1999.

This enactment imposes a specific tax on municipalities if the total amount of household waste[3] collected by the municipalities exceeds the legally allowed amount.

The tax covers household waste that is collected by the municipalities or associations of municipalities. Reusable materials and specific waste that are collected either by the municipalities or by private companies that have been agreed on by the Walloon Government are not subject to the tax.

1.1 Description of the original situation

The large amount of waste currently generated in the municipalities of the Walloon Region is problematic and will likely rise in the following years, if the actual environmental policy is continued:

[3] In this context household waste means general waste produced by households, including organic wastes but excluding reusable material. This is important in order to be able to compare the waste production of the Walloon Region to other European cities where household wastes and organic wastes are collected and calculated separately.

Table I.1 Average waste development in the Walloon Region

	1995	2000 (projected)	2010 (projected)
Household wastes	1,104,110 tonnes	1,240,552 tonnes	1,469,112 tonnes
Household waste/inhabitant/year	381 kg	365 kg	423 kg
Reusable material (addit.)	419,390 tonnes	591,088 tonnes	700,243 tonnes
Reusable material/ inhabitant/year (addit.)	145 kg	175 kg	203 kg
Total Household waste	1,523,500 tonnes	1,831,640 tonnes	2,169,355 tonnes
Total waste/inhabitant/year	526 kg	540 kg	626 kg

Source: Walloon Government 1998

In the Walloon Region, the average production of household waste in 1995 was about 381 kg/inhabitant/year (see Table I.1). In many municipalities it even exceeded the amount of 400 kg/inhabitant/year. Organic waste is estimated to come up to 40 % of the total amount of household waste[4].

Taking into account that reusable materials, as for example bulky waste, inert waste, metal, glasses, papers and cardboard, car oils, plastics, textiles, composite-packaging etc. are not included within the calculation of the household waste, the real amount of waste produced exceeds 520 kg/inhabitant/year.

Not only the amount of produced waste in the Walloon Region is very high, but also the segregation of waste could be improved. Although the facilities for segregation of waste have been established in the Walloon Region, only 480,176 tonnes of waste have been collected through special collections in 1997. This indicates that a main problem in the Walloon region is the lack of general awareness in the public for problems connected with the production of waste.

The Walloon Region therefore decided to enhance a prevention policy by introducing the new tax. This tax shall force the municipalities to improve their waste management systems, to raise the general awareness of waste minimisation among their population and thus to limit as much as possible the quantity of waste produced.

1.2 Description of the implemented measure

The measure taken by the Walloon Region for exerting political pressure on the municipalities is as impressive as simple. With the new taxation of July 1988 on municipalities for household waste production, municipalities are expected to reduce the amount of generated household waste. Every tonne of waste that exceeds the allowed level will be charged with a special tax that has to be paid by the municipalities to the Walloon Region. The new enactment forces municipalities to take responsibility for awareness-rising of the population concerning problems connected

[4] Recently, several pilot programmes were set up by the regional administrations in order to enhance the segregated collection of organic waste and the introduction of waste composting - see the case of Dilbeek.

to the production of waste. The final target is that every inhabitant will be conscious of waste prevention in order to limit as far as possible the quantity of waste produced.

The basis of assessment

The basis of assessment for the application of the taxation is the total quantity of household waste collected within one year. The allowed tax-free quantity of household waste in 1999 is 270 kg/inhabitant. After 1999 this amount shall constantly decrease every year by 10 kilos and will end in 2002 by 240 kg/inhabitant.

Table I.2 Schedule for the basis of assessment

Year	Allowed tax-free household waste production
1999	270 kg/inhabitant.
2000	260 kg/inhabitant.
2001	250 kg/inhabitant.
2002	240 kg/inhabitant.

Source: Enactment of the Ministry of the Walloon Region of 16 July 1998

Nevertheless, some kinds of wastes are not taken into account when calculating the yearly allowed amount of wastes:

As already mentioned above, the reusable wastes, like paper or glass, etc. that are collected through specific collections are not at all subject to the tax, in order to support waste recycling.

Additionally, the collection of household waste by the municipalities covered by the tax has one essential exception: Any material that still could be eliminated, segregated, or recycled from the household waste after the collection is not taken into account. In this context recycling is also understood to include thermal waste reuse. At this point a loophole of the implemented measure has to be stated: In the Walloon Region thermical reuse already starts with a calorific value of waste of 2,000 KJ[5]. This has the effect that lots of waste can be understood to be thermally reusable. Therefore one has to state that the calculation of the tax most probably will only refer to waste that has to be disposed or removed to incineration plants.

The tax

The tax that has to be paid by the municipalities will vary during the next four years. In 1999 each tonne of waste exceeding the allowed amount will generally cost the municipality about 27 EURO. Every year the costs will increase by almost 2.5 EURO up to 35 EURO in 2002.

[5] In Germany the calorific value of waste has to be 11,000 KJ in order to speak of thermal reuse.

Table I.3 Schedule for the tax

Year	Costs
1999	27.27 EURO
2000	29.74 EURO
2001	32.23 EURO
2002	34.71 EURO

Source: Enactment of the Ministry of the Walloon Region of 16 July 1998

1.3 Results

It is too early to see the practical results of such a tax measure. The very special aspect of this tax is that it only refers indirectly to the polluter-pays principle, since the inhabitants who are producing the waste are not directly covered by the tax.

Indeed, the municipality itself will be submitted to the tax, but it has the possibility to rise the level of municipal waste taxes. However, the municipalities are encouraged to develop new activities for segregation and prevention of waste.

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2 Municipal Waste: The Dilbeek Experience

The municipality of Dilbeek, situated in the Flemish Region at the doors of Brussels, is a very old city and one of the richest municipalities of Belgium. Dilbeek has a surface area of 4,117 ha, with approximately 38,000 inhabitants, forming about 15,000 households. Dilbeek is composed of many green areas and woodlands as well as agricultural areas. It is indeed the place to live in for wealthy Flemish people working in Brussels.

It was foreseen in 1990 that the average production of waste in the Flemish Region would reach, according to the worst scenarios, 2,700,000 tonnes in 2010. However, in 1995 the production of waste already exceeded 2,800,000 tonnes. Therefore the municipality of Dilbeek decided in 1993 to carry out a pilot project, based on a voluntary participatory action, involving all the inhabitants and institutions of the municipality. At the same time a new financing system for the waste management was introduced. The final target of this pilot project was to decrease the total amount of waste collected by the municipality.

2.1 Description of the original situation

Before starting with the waste prevention action, Dilbeek produced in 1995 a total amount of 495 kg of waste/inhabitant[6].

The treatment of municipal waste was very cost intensive for Dilbeek. In 1995, for example, waste incineration or disposal cost 1,770,000 EURO which meant between 2 and 2.5 million EURO for 1997 if no diminution of waste would have been achieved.

Inhabitants of Dilbeek used to pay a general tax for the collection of their household wastes that did not correspond to the individual amount of waste produced by each household. Within the new charging system this tax was given up and the prices are now calculated on basis of the polluter-pays principle.

2.2 Description of the implemented measure - The participatory community action

The process started in 1993, when representatives of a specific neighbourhood initiative conducted a big survey among the population about the rate of packaging consumption and about the contents of private dustbins. At the same time, growing awareness of the local population about waste prevention was created by information campaigns, by mail, etc. The awareness campaign focused on four core groups: families, public services, schools and shopkeepers.

Initiators of the waste campaign in Dilbeek were very concerned with equally involving different local actors in their potential actions. Therefore, different actors such as citizens, politicians, environmentalists, experts and representatives of various community groups participated in a voluntary action that finally resulted in a process of communicative planning. In order to support this action, a steering committee and two major working groups, one dealing with technical issues and the other with public awareness, were established.

One problem within the whole process was the interest level of the broader public debate and even on the global debate on environmental issues. Indeed, in Dilbeek most participants felt an important pressure resulting from the public debate on waste management on the level of the Flemish Community, because many points of view in the Flemish debate were opposite to those of the local debate in Dilbeek.

However, the Flemish regional institution dealing with waste policy management (OVAM) subsidised the campaign and the resulting initiatives by delivering important financial help (97,000 EURO). Half of the campaign costs could be covered with these subsidies. The municipality of Dilbeek contributed by establishing an informa-

[6] Packaging wastes and organic wastes were not segregated and thus formed part of the household waste.

tion office during the project that was replaced afterwards by environmental counsellors.

Based on the campaign's findings, the two major waste problems for Dilbeek to tackle are the prevention of packaging material and the composting of organic wastes.

2.3 Various measures implemented

Several measures have been implemented by the municipality together with representatives of different community groups, experts, environmentalists and politicians:

1. self-composting of organic waste;
2. the reduction of packaging waste;
3. segregation of waste, and
4. financial advantages taking into account the polluter-pays principle.

Composting of organic wastes

The idea of composting came from a neighbourhood initiative which wanted to use a piece of land in their neighbourhood in order to collectively compost the organic fraction of waste. In the beginning, they found no audience for their plans. Later on, waste management project plans were developed in order to support self-organisation for composting the organic wastes. At that moment neighbourhood representatives found some consensus about their initial aims and they became more involved in the entire process and finally played a crucial role in the success of the waste management campaign in Dilbeek. All together 20 volunteers have been coached and trained in giving advice to households with respect to composting of organic waste.

Now about 60 % of the population in Dilbeek are composting their organic wastes, either by themselves or by using one of the 3,000 small composting systems distributed by the municipality.

Due to this success OVAM has now set the objective to establish such a „compost management" programme in each Flemish municipality.

Reduction of packaging wastes

The packaging waste mostly resulted from the consumption of every day products by the inhabitants or by children at school and from using plastic bags for shopping. The implemented prevention measures on packaging waste introduced since January 1996 are as follows:

- *Shop-keepers* were asked to follow a new consumer policy: Instead of plastic bags they should provide cardboard boxes to put the purchases in and instead of selling drinks in plastic bottles or composite-packaging, glass bottles with deposit should be preferred;

- *Schools* were asked to reduce products delivered in composite-packaging and to promote the use of bread-boxes;
- The *population* was informed and encouraged to prefer less packed products, to reduce the use of composite-packaging, etc.;
- The *municipality* itself created a specific environmental commission for exchange of views between the population and the political institutions, as well as engaged environmental counsellors.

Segregation of waste

Within the waste management-system of Dilbeek the segregation of waste was enhanced and is now based upon a door-to-door collection system and a bring-system:

- household wastes: door-to-door collection every week;
- bulky waste: door-to-door collection every two months (max. 0.5 m^3);
- paper and cardboard: door-to-door collection every two months; bring-system in parallel;
- glass: door-to-door collection once a month, bring-system in parallel;
- small dangerous waste: door-to-door collection every three months;
- pruning waste, Christmas trees: door-to-door collection on request;
- gardening wastes: bring-system;
- metals, textiles, building waste, tires: bring-system.

Taxing and payment system

Upon implementation of the new waste management system, the general tax for household wastes was replaced after a transition period of two years (1996-97) by a payment referring to the individual amount of waste produced by each household.

Since 1998, inhabitants of Dilbeek have paid an individual fee according to the produced wastes that are collected by the municipality. In practise, the municipality of Dilbeek sells two kinds of plastic sacks, one for household waste and one for recyclable packaging waste. Each plastic sack costs between 0.84 and 1.12 EURO according to its size and volume. The costs for the waste collection are included within this amount. The total waste disposal cost for each household varies according to the number of plastic sacks they need to get their waste collected. The new payment system is therefore based on the polluter-pays principle. In order to pay as little as possible, people in Dilbeek try to minimise the production of waste at the source.

Table I.4 Schedule for the tax on municipal wastes

Year	Tax/inhabitant/year	Costs/plastic bags
1995	64 - 84 EURO (one person household) 74 - 96 EURO (2 or more person households) 92 - 134 EURO (Party places and restaurants)	-
1996-1997	29.75 EURO (each household)	0.87 to 1.12 EURO
1998	-	0.87 to 1.12 EURO

Source: Municipality of Dilbeek

2.4 Waste Minimisation Results

With 2/3 of the population following the waste prevention actions and elimination measures proposed, the schools following a policy of excluding composite-packaging and the municipal services being actively involved, Dilbeek reduced its quantity of household wastes by more than 60 % within only six months, in 1996.

All together, it resulted that the average household waste generated in Dilbeek fell from 495 kg/inhabitant in 1995 to 304 kg/inhabitant in 1996, which means a reduction of more than 60 %. Meanwhile, the Flemish average was stabilised at 490 kg/inhabitant (see Table I.5). Of the 304 kg produced by an inhabitant in Dilbeek in 1996, only 152 kg were burned in incineration plants or placed in waste disposals. In 1997, these results were maintained with 156 kg per inhabitant.

Table I.5 Waste minimisation in Dilbeek

Kg/inhabitant	1995	1996	1997	1998
Household waste	335.12	114.77	109.97	114.80
Segregated waste	114.76	152.44	130.48	138.46
Organic wastes	-	-	37.81	47.65
Others (bulky waste, textile, metals etc.)	45.56	36.87	46.26	38.20
Total waste /inhabitant in Dilbeek	495.44	304.08	324.52	339
Total waste/inhabitant in the Flemish Region	490.34	490.40	525.95	-

Source: Municipality of Dilbeek

2.5 Economic benefits

The financial gains for the municipality of Dilbeek due to the lower amount of waste are impressive. In 1995, the costs of municipal waste management were 1.77 million EURO, whereas in 1996, it decreased to 1.25 million EURO. For 1997 a further decrease to 1.24 million EURO was observed. Without the measures the costs would have been between 2.23 and 2.48 million EURO. Moreover, such an impressive

reduction allowed the municipality to save a total of about 2 million EURO in 1996 and 1997.

Also the collection fees paid by the population decreased with the waste prevention actions. In 1995, the inhabitants of Dilbeek paid 1.22 million EURO (an average of 32.5 EURO/inhabitant). The costs dropped to 1.12 million EURO (29.8 EURO/inhabitant) in 1996 and went further down to 1.08 million EURO (28.8 EURO/inhabitant) in 1997. This means that the average costs per inhabitant decreased from 32.5 EURO in 1995 to 28.8 EURO in 1997.

Table I.6 Costs of Dilbeek waste management

	1995	1996	1997
Costs of Dilbeek waste management	1.77 mio EURO	1.25 mio EURO	1.24 mio EURO
Costs for all inhabitants	1.22 mio EURO	1.12 mio EURO	1.08 mio EURO
Costs per inhabitant	32.5 EURO	29.8 EURO	28.8 EURO

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Environnement, qui participe? - Pushing back the waste in Dilbeek

3 Industrial Waste: Performance Roof Systems

In many European countries flat roofing production is an important segment of the building industry. Flat roofing can be made out of different materials, such as PVC or bitumen. On the international market the most used product to cover flat roofing is bitumen roofing felt. In 1995 in Europe 256 million m^2 of roofing were covered all together of which 180 million m^2 - that means about 70 % - were allotted to bitumen roofing felts. In France the total surface covered in 1995 was 25 million m^2 of which 21,25 million m^2 - 85 % - was covered by bitumen roofing systems. As a comparison, in Germany the total surface covered in 1995 amounted to 90 million m^2 of which about 55 million m^2 - 66 % - were bitumen roofing (see Table I.7).

Table I.7 Flat roofing production in Europe, France and Germany

	Europe	France	Germany
Total amount of covered surface in m^2	256 million	25 million	90 million
Bitumen roofing	180 million	21.5 million	59 million
Others roofing	75 million	3.5 million	31 million

Source: Braas Flachdachsysteme GmbH & Co.

These figures indicate the importance of bitumen roofing systems on the international level. Therefore, the waste prevention measures implemented at the Belgium company „Performance Roof Systems" (PRS) are not a specific single measure but could also be applied in other European companies producing bitumen roofing felts.

Since September 1978 PRS has been situated at the industrial area of Perwez, a community in the Brabant/Walloon Region at 20 km from Namur. During recent years, PRS became one of the world leaders in the roofing felt sector by producing Derbigum.

Derbigum is a tight waterproofed membrane made out of bitumen used for roofing systems as well as in the bridge and tunnel building sector. Derbigum is based on bitumen, modified by acatic polypropylene and strengthened by polyester and fibre-glass grilles.

Whereas in 1983 PRS produced 4 millions m^2/year of roofing felt, the production increased until now up to 11 millions m^2/year, of which about 4.5 million m^2/year is sold in Belgium, whereas the rest is exported.

In order to achieve a better environmental performance PRS committed itself several years ago to follow an internal voluntary environmental policy. The final target of this environmental policy will be to go beyond the requirements of Belgian legislation and to completely avoid waste disposal. In order to attain this target an environmental programme setting out the environmental objectives and activities for the coming three years was introduced at PRS. The programme started in January 1998.

Its main objectives are:

1. prevention: giving the staff an environmental education, reducing the disposal of waste;
2. waste management system: registration of input and output of materials and introducing recycling systems in order to reuse wastes as secondary materials;
3. monitoring: analysing the results and comparing them with the objectives.

As a result of its environmental activities, PRS is one of only three factories in the Walloon Region that has received a certification under the EMAS system.

3.1 Description of the original situation

Within the company, the administration, the production, the laboratories and the maintenance unit are producing different kinds of waste as indicated in the table 4.2.

Table I.8 Sources and types of waste at PRS

Sources	Types
Administrative level	Paper Various
Production level	Membrane waste Fibre waste Polymers
	Packing waste (cardboard, PE packaging, wood pallets, big bags, cardboard mandrel, tape) Paper Inert materials (talc, $CaCO_3$)
Laboratories level	Membrane waste Raw materials Solvent Paper
Maintenance level	Used oil Metal Cleaning solvent

Source: PRS

This case study is focusing on the Derbigum waste (membrane, fibre, and polymer waste) resulting from the production level, because it is the largest contributor to waste produced at PRS. In 1997, for example, the total amount of waste was about 1,200 tonnes of which about 714 resulted from the Derbigum production. Before the implementation of the environmental programme at PRS most of these Derbigum wastes had to be disposed because they could not be reused as secondary materials in order to minimise waste.

The total amount of the costs for disposing theses wastes were rather high. Indeed, the disposal of waste including all charges generally costs 61.97 EURO/tonne and for some types of waste even 86.76 EURO/tonne.

3.2 Description of the implemented measures

At PRS waste prevention consists of several measures: PRS trained its staff in environmental matters, limited the use of unnecessary packing materials and favoured a taking-back approach with its suppliers.

The main activity of waste prevention at PRS consisted in the development of new machinery. PRS invented and tested, with the financial help of the Walloon region, a

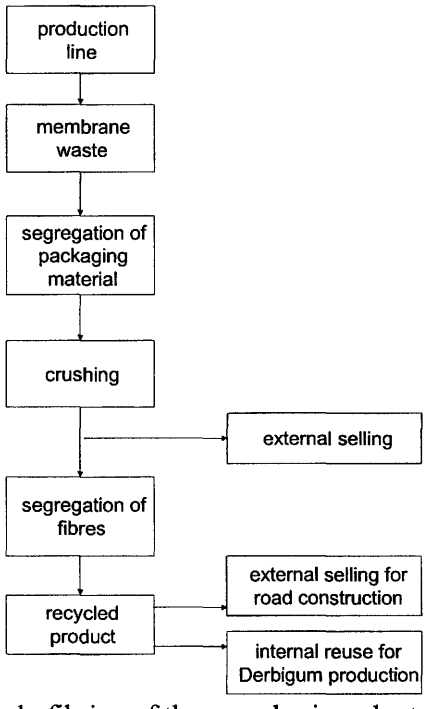
prototype being able to reintegrate the leftover of Derbigum production and Derbigum from used roofs into the production process of new Derbigum.

This prototype machinery has been used in a test phase since Juli 1997 and will enter into work as an independent production unit in June 1999. It will have a capacity to reuse 300 kg of Derbigum per hour and 1650 tonnes of Derbigum per year.

The three principle processing steps are pointed out in the illustration below (see Illustration I.1):

1) the selection of packaging material as well as the pre-cutting of the Derbigum membranes;

2) the crushing of the of the membranes in order to obtain small granules;



3) the de-fibring of the granules in order to obtain a bitumen binder.

Illustration I.1 Minimisation of production wastes

By applying this process a new product made out of bitumen waste is obtained. Therefore this new production unit will have two positive effects: Waste is minimised and a new raw material is obtained.

The newly created bitumen product can be used in two ways. It is sold to external customers especially in the road building sector or it is reused according to its initial purpose as a raw material for the production of Derbigum.

3.3 Waste Minimisation Results

The total amount of reused Derbigum in 1997 was about 490 tonnes, which corresponds to 68 % of the Derbigum wastes produced at PRS in the same year. The amount of Derbigum that had to be disposed went down to 188.7 kg. Looking at the figures of 1998 this figures are maintained, whereas in 1999 PRS will achieve its ultimate target to completely avoid any kind of Derbigum waste disposal. From July 1999 on, PRS will even be able to reintegrate 100-200 tonnes of external Derbigum wastes taken back from its customers.

Table I.9 Derbigum waste minimisation for 1997-1999

	1997	**1998**	**1999 (prediction until 31 May 1999)**
Total Derbigum waste generated	714,157 kg	756,375 kg	350,000 kg
Disposed Derbigum	188,771 kg	198,997 kg	0
Recycled Derbigum	491,639 kg	487,725 kg	260,000 kg
Stocked Derbigum	33,747 kg	69,653 kg	90,000 kg
Expected amount of external taken-back Derbigum	0	0	100,000 - 200,000kg (starting in July 1999)

Source: PRS

3.4 Economic benefits

The saving of costs by the implemented measures are very high. In 1997, almost 500 tonnes of Derbigum were recycled which corresponds to a saving of disposal costs of 19,830 EURO. In 1998 the savings of disposal costs even went up to 49,580 EURO not yet including the savings for raw materials. On a long term perspective the 371,840 EURO that had to be spent for the new production unit could therefore be measured with the savings made by the reuse of the Derbigum wastes.

3.5 Conclusion

The presented case of PRS has the advantage of being applicable also to other companies producing bitumen roofings. The philosophy followed by PRS to develop and to establish new technologies in order to minimise waste points a way ahead for Belgium industries to follow further waste minimisation activities.

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various interviews with PRS

II Denmark

In Denmark, waste minimisation and cleaner technologies have been given top priority in terms of waste strategy. Cleaner technologies involve preventive technologies which reduce the stress on the environment at source. This includes strategies such as substitution of hazardous substances and materials, more efficient use of resources, better design of products etc.

The total waste generation in Denmark amounted to 11.5 m tonnes in 1995 and 12.9 m tonnes in 1996. Concerning waste treatment of generated waste, recycling is given priority over incineration with lowest priority on disposal (more details in Annex VIII1.2 to this study).

Waste minimisation has been said to be one of the most significant challenges in the new Danish waste plan 1998-2004, "Waste 21." Indeed, since waste generation is closely linked to GNP and since a constant growth in GNP has been seen, it is difficult to point to extensively successful waste minimisation. The future challenge will be to de-couple waste generation from economic growth.

The Danish strategy of product-oriented environmental policies is expected to reduce the generation of waste in the long run, but it will take a couple of years before future products are discarded as waste. The Danish programme for cleaner products was due to be launched in Spring 1999. Thus, for at least the next couple of years, waste will still be characterised by older products.

The programme for cleaner products is based on the Danish programmes for cleaner technologies and the Danish programme for waste and recycling in 1993-97. The two programmes have recognised a large number of useful insights which will be utilised in the future programme for cleaner products.

The three examples

This paper presents three examples of waste minimisation:

1. **Municipal waste.** The waste generation in Denmark is linked to the GNP, and examples of waste minimisation from private households are hard to come by, except perhaps composting of green waste such as kitchen and garden waste. About 15 % of total waste in Denmark originates from the coal fired power plants. Energy and heating are energy services consumed in private households and, thus, waste from the coal fired power plants is directly related to energy use and heating in private homes.
2. **Industrial waste**. The wet treatment industries in Denmark generate waste water containing chemicals and heavy metals which end up in the sewage. After treatment of the sewage systems, the clean water is led into lakes, rivers or the sea.

The residue - sludge - is incinerated, dumped or applied to agricultural lands. Sludge is only applied to agricultural lands if it meets a set of environmental requirements. Thus, if hazardous substances are prevented from ending up in the sewage, the sludge can be recycled.

3. **Horizontal measure.** A large proportion of the PVC used in Denmark is incinerated with the waste. At least 50 % of the chlorine in waste originates from PVC products and packaging. The incineration of PVC causes environmental problems in flue gas purification products. The Danish authorities have taken a number of actions in order to reduce the amount of PVC in the waste stream.

1 Energy-Related Municipal Waste

Waste generation is a result of the combined activities in society. In 1996, the Danish GNP went up by 2.25 %, and at the same time the amount of waste went up by 1 to 3 %. The relation between GNP and waste is not equal for all sectors or fractions of waste. However, apart from home-composting of kitchen and garden waste, it is difficult to find solid examples of municipal waste minimisation in Denmark.

The only area within which there has been significant waste minimisation is that of energy use. After the energy crisis in 1973 - 74, the net consumption of energy has been constant. This is a result of a successful policy. The waste from energy and heat production is directly related to energy and heat consumption in households. Energy and heat are energy services consumed in households, but waste generation happens in the production process. Thus, saving energy and heat in Denmark also means waste minimisation.

Waste generated due to production of energy makes up a considerable part of the total amount of waste in Denmark. In 1995, approximately 1,7 m tonnes of waste were generated from the coal-burning plants out of a total generation of waste in Denmark of 11,466 m tonnes. When coal is burned, waste in the form of cinders, fly ash, gypsum and sulphuric acid is brought about. This, as opposed to burning natural gas and oil in which case almost no solid waste is generated. Using renewable energy, such as wind power and biomass (straw), the generation of waste is also lower than upon burning coal.

The targeted efforts made to reduce primary energy consumption within production, and to make households' use of energy in Denmark more efficient, have resulted in a reduction of waste generated from the production of electricity and heat.

1.1 Measures taken

Denmark has a tradition of pursuing an energy policy which is backed by a wide range of political parties, in the course of which a wide spectrum of actors participate:

energy suppliers, the business sector, NGOs, local councils, research institutions and consumers. Energy plans have been prepared since 1976.

The aim of the first energy plan, *Dansk Energipolitik 1976,* was to protect Denmark against a supply crisis such as the energy crisis in 1973-1974. The next plan, *Energi 81*, was further expanded based on the heavy rise in energy prices after the crisis in 1979-1980, and put more emphasis on economic and environmental regards. After a period of implementation of large projects and building up markets for natural gas and power/heat, the action plan, *Energi 2000*, was introduced. It listed the objectives for sustainable development within the energy sector. In 1996, *Energi 21*, was prepared. It contains initiatives within three key areas:

- Initiatives aiming at further energy-saving measures, corresponding to about one third of the desired reduction of CO_2;
- Initiatives aiming at supplies, further extension of renewable energy and making the power/heat production more efficient;
- Initiatives within transportation.

Thus, the focal point of the energy policies pursued has changed and these plans have come to include a wide range of measures which to a certain extent have made household consumption of electricity and heat more efficient. Several measures have been initiated, at first to protect Denmark against a supply crisis such as the energy crisis in 1973-1974, when Denmark's production of energy was based on oil. One of the most essential objectives in terms of energy policies has been to diminish the dependence on oil in relation to the energy supply. Until the beginning of the 1980s, the decline in oil consumption was primarily due to re-organisations - i.e. using coal for the production of electricity. But after that period the decline in the consumption of oil has been primarily linked to the extension of district heating facilities and increased use of natural gas in homes, within industry and district heating stations

The reason why it has been possible to make the gross consumption of energy remain almost constant since the beginning of the 1980s, when at the same time the final consumption of energy has increased, is that the electricity and heating supply has been made more efficient. Co-production of electricity and heating has greatly increased. There has been a substantial extension of the district heating supply in the vicinity of the large power stations in order to be able to exploit the heat from there. There has also been a re-organisation of local district heating stations to decentralised power/heating production which provides better exploitation of the fuel. Today, 70 % of the total district heating production derives from combined power/heating production.

From 1980 and onwards there has been a large extension of the district heating network which has also been of significance to improved exploitation of the fuel.

The consumption of energy to heat rooms declined until the beginning of the 1980s. Since the mid-1980s, the consumption of heating has remained more or less constant. The substantial decline in the consumption of energy is bound up with the subsidies granted for housing improvements, tightening up construction regulations, energy taxes and perhaps a higher degree of eco-consciousness. The large rise in real prices of energy during this period has also supported the energy-saving measures considerably.

An important element when safeguarding the economic foundation, both in terms of the extension of power/heating and the re-organisation for extended use of natural gas in the energy supply, has been to maintain high consumer prices for energy. This has been made possible by way of levying taxes on energy. Tax on oil and electricity was introduced in 1977 and tax on coal was introduced in 1982. Because of the soaring prices of crude oil in 1985-1986, the Danish parliament decided to raise the tax on energy so that the prices of energy for the consumers remained more or less constant. The result has been that the incentive for saving electricity and heating in the households has been upheld. (Energi 2000, the Danish Ministry of Energy, 1990).

1.2 Development of energy consumption in households

From 1972 to 1990, the consumption of energy from households (transportation not included) dropped about 30 %, whilst from 1990 to 1995 the consumption of energy increased by approximately 1 % (taking climate adjustments into account) (see Table II.1).

Table II.1 Energy consumption in households 1972-1995 (in TJ) (transportation not included)

	1972	1980	1990	1995
Electricity	23,427	30,670	35,960	37,731
District heating	40,416	37,880	47,838	60,655
Other forms of heating	173,372	136,522	85,287	89,251
Households, total	237,215	205,072	169,085	187,637

Source: Natur og Miljø 1997, p.237. Faglig rapport, Danmarks Miljøundersøgelser.

The development of final energy consumption for heating differs considerably from the general trend in terms of energy consumption. Table II.2, below, illustrates that there has been a minor total decline in net consumption of energy for heating from 1980 to 1997. This is to be compared to the 20 % increase of the heated area during the same period (Energy statistics 1997, the Danish Energy Agency).

Table II.2 Net consumption of energy for heating (in PJ)

	1980	1990	1991	1992	1993	1994	1995	1996	1997
Heating (net) total	171.8	164.1	164.1	162.9	165.5	163.3	168.5	168.2	167.5

The consumption has been made subject to climate adjustments. Source: Energy statistics 1997, the Danish Energy Agency, Energistyrelsen.

The energy consumption for heating has, thus, become considerably more effective and it might be added that since 1974, the need for heating in households per square metre has been halved. The main reason why the heating consumption has slightly increased again in the 1990s is that the housing area has increased.

Despite rising energy prices, the consumption of electricity has increased considerably due to increased use of electrical devices. The consumption of electricity for these devices has doubled since the 1960s due to the introduction of washing machines, tumble dryers, stereos, refrigerators, food processors, computers etc. In 1972, the consumption of electricity made up approximately 10 % of households' energy consumption and in 1997, it made up about 20 %.

From the end of the 1980s, the rate at which the number of household articles has increased has dropped and at the same time new devices have become more energy-efficient. Active saving campaigns have had the effect that the growing consumption of electricity in households has declined from the beginning of the 1990s until today (Natur og Miljø pp. 237-38).

1.3 Waste results concerning energy consumption

The energy consumption needs in Denmark are met by a number of collective and individual power supplies. Collective power supply plants include power stations, combined power and heating stations, district heating stations, and wind power stations. Individual power supplies include oil and natural gas-fired burners in detached houses and blocks of flats.

Since 1980, Denmark's gross energy consumption has almost been stable (increase by about 3 %) although, at the same time, there has been a growth in the GNP. The distribution of fuel which has been of significance to the generation of waste from the production of energy has improved during this period (see Table II.3., below). Since the mid-1980s, the consumption of coal has been more or less stable. A decline can be seen since the beginning of the 1990s. The reason for that is the increased use of renewable energy (wind mills and biomass), and natural gas for production of electricity and district heating stations, amongst others. Since the introduction of natural gas at the beginning of the 1980s, its usage has increased considerably.

The consumption of renewable energy has also steadily increased from approximately 25 Pj in 1980 to approximately 70 Pj in 1996. Renewable energy makes up approximately 8 % of today's gross energy consumption.

Table II.3. Gross consumption of energy (in PJ) and division into fuels

Fuel equivalent (PJ)	1980	1990	1991	1992	1993	1994	1995	1996	1997
Gross consumption of energy – Total*	813	820	826	822	818	819	832	839	838
Fuels									
Oil	547	357	352	349	340	345	371	378	379
Natural gas	0	83	88	93	103	115	132	149	164
Coal and coke	240	327	331	321	314	298	263	244	220
Renewable energy etc.	26	53	55	59	61	61	66	68	75

* The consumption of energy has been adjusted to the climate and deducted the consumption of fuel for net exports of electricity (figures are rounded up).

As there are many factors which have an effect on the amount of waste from the production of electricity and heat, it is not possible to illustrate the effectiveness which has taken place from the development in the formation of waste. Taking into account that the annual amount of electricity produced by coal fired power plants for export purposes differs substantially, the waste produced by these plants for energy consumption of Denmark has been declining in recent years. For example, in 1996, Denmark experienced much larger exports of electricity than in 1995 which resulted in larger quantities of waste from coal fired power plants.

Table II.4 Waste generation from coal fired power plants (in 1,000 tonnes) and annual net exports of electricity as share of domestic supply in Denmark (in %)

	1980	1988	1990	1994	1995	1996	1997
Waste generation from coal fired power plants				1,962	1,699	2,332	
Net exports, share of domestic supply	5	-14	-23	15	2	44	21

Sources: Energy statistics 1997, the Danish Energy Agency, Energistyrelsen *and* Waste 21, Danish EPA, 1998

However, if one distracts the waste generated due to higher energy exports the overall energy related waste amount, particularly that which is related to the lower energy consumption in households as described in Table II.1, decreased.

2 Industrial Waste: The Danish Dye Work Industry

As an example of industrial waste minimisation, substitution for chemicals in a Danish textile industry has been chosen, or to be more specific, wet treatment industries. Dye works discharge large quantities of waste water containing chemicals which to a certain extent end up in the waste water sludge. Extensive quantities of these chemicals in the sludge prevent recycling of the sludge by the means of application to agricultural lands.

The County of Ringkjøbing has, in collaboration with the trade association and the local authorities within that County, prepared a score system which makes it easier for the dye works to opt out the chemicals with the heaviest environmental impact in their productions.

The Danish carpet manufacturer, Egetæpper A/S, has adopted the score system and has experienced a substantial reduction of heavy metals in the dye stuff.

2.1 Waste water treatment and recycling of sludge

In 1987 the Danish Parliament, Folketinget, adopted an action plan for the water environment. According to the action plan, all large water treatment plants had to achieve improved waste water treatment facilities before 1 January 1993. The extension of the water treatment plants was finalised at the beginning of 1996 and, accordingly, 94 % of the waste water discharge in Denmark is treated mechanically and biologically. But the extension has also had the result that production of waste water sludge from the water treatment plants has risen and in 1996 approximately 1,212,000 tonnes of waste (wet weight) were produced at the municipal water treatment plants. The quantity of sludge amounts to 1,175,000 tonnes. (Affald 21, udkast til affaldsplan (1998-2004) p.114)

From the total amount of waste from water treatment plants in 1996, 75 % was recycled and applied to agricultural lands, 15 % was incinerated and 10 % was disposed. This meant that the former objective of the Government of 50 % recycling in 2000 was more than achieved. The goal is to exploit the contents of manure and energy in the waste water sludge as extensively as possible, but due to more strict limits on some of the chemical substances in the sludge, the large amount of sludge applied to agricultural lands at present is not expected to be maintained. Therefore, the goal is to retain 50 % recycling of sludge for agricultural lands in 2004. The quality of the sludge and the potentials for increased recycling on agricultural lands are sought to be improved by way of a general phase-out policy for substances injurious to the environment (Affald 21, udkast til affaldsplan (1998-2004)).

In order to meet the difficulties of sludge quality, permit limits have been set for heavy metals and substances in waste products injurious to the environment and agricultural lands.

As illustrated in Table II.5, below, most permit limits will be tightened in 2000.

Table II.5 Permit limits

	Permit limits from 1996/97		Permit limits from 2000	
Substance	**mg/kg dry matter**	**mg/total phosphorus**	**mg/kg dry matter**	**mg/kg total phosphorus**
Cadmium	0.8	200	0.4	100
Mercury	0.8	200	0.8	200
Lead	120	10,000	120	10,000
Nickel	30	2,500	30	2,500
Chrome	-	-	100	-
Zinc	-	-	4,000	-
Copper	-	-	1,000	-
LAS*	2,600	-	1,300	-
PAH**	6	-	3	-
NPE***	50	-	10	-
DEHP****	100	-	50	-

Source: The Danish Ministry of the Environment and Energy, Departmental order no. 823 of 16 September 1996

*Linear alkyl benzene sulfonate
**Polycyclic aromatic hydrocarbons
***Nonylphonolethoxylate
****Phthalates.

Several of these substances are used within the dye industry and are discharged with the waste water whereby they end up in the sludge. That might include chrome and the detergents LAS and NPE.

2.2 Wet treatment of textiles

In Denmark about 45 industries perform wet treatment of textiles, i.e. pre-treatment, dying, printing and/or aftertreatment. The majority of these companies are located in the County of Ringkjøbing.

Within this line of business, there is a large consumption of water, energy and chemicals. Total consumption of chemicals makes up approximately 22,000 tonnes per annum (1998), of which approximately 18,000 tonnes per annum make up the basic chemicals (especially salts, acids and bases). The dye stuffs make up approximately 900 tonnes per annum and the residue consists of excipients such as detergents, phthalates etc.

The waste water from wet treatment is typically heavily dyed and has large contents of salt, detergents, post-treatment agents and other chemicals. The total amount of waste water within this line of business makes up 6.6 billion cubic metres per annum. Most of the dye works discharge the waste water at the municipal water treatment plants but there are 4 dye works which have their own water treatment plants with a subsequent discharge to recipient. (Genbrug af procesvand fra reaktivfarvning af bomuld, Miljøprojekt nr. 374 1998, p. 15. Miljø- og Energiministeriet)

Introduction of a score system for evaluation of chemicals

The County of Ringkjøbing, in close collaboration with the local authorities of that County and the Federation of Danish Textile and Clothing Industries, has developed some tools for pre-sorting chemicals used by the dye works. This initiative was taken by the County as the County wanted to see a reduction in the discharge of substances injurious to the environment into the waste water.

In November 1989, the County agreed to a proposal setting up a working party to deal with the launching and co-ordination of the application of principles for evaluation of chemicals directed at textile dye works.

This working party was set up to help co-ordinate principles of the local authorities and the county authorities when applying a score system to govern chemicals. The working party was composed of technicians from four municipalities and the county council district of Ringkjøbing. Later on, there was an expansion of the working party to include representatives from the Federation of Danish Textile and Clothing Industries.

The score system was implemented in 1992-1993. The dye works in the County of Ringkjøbing had a duty to inform the supervisory authorities about their consumption of chemicals by using the score system.

Functioning of the score system

The score system is an administrative method of pre-sorting chemicals on the basis of information filed, especially from the chemical supplier's specification sheets. The pre-sorting allows a priority selection of chemicals which, because of actual consumption and information on environment behaviour, must be subject to closer examination.

The score system is based on the parameters which are usually considered to be the most important in connection with identification of industrial sewage substances injurious to the environment. Parameter A represents a score on the estimated amount of chemicals discharged into the environment as waste water. Parameter B is a score on biodegradability, C is a score on bioaccumulation, and D is a score on toxicity. (The detailed structure of the score system appears in the annex to this study on Score System of Danish Dye-Work Industry

Table VIII.3.)

Altogether, A, B and C indicate the potential presence of the substance in the environment - where, how long and how is the substance present in the aquatic environment. A exercises a certain influence on the effect of B and C, while B influences the effect of C. The total score which is obtained by multiplying the scores for A, B and C, is called the exposure score. The toxicity (D) should be evaluated concurrently in proportion to the exposure.

Each parameter lists a numerical value between 1 and 4; 4 indicating the most critical environmental impact. Lack of information gives the highest score. The result is that each substance can be given a score as to exposure (AxBxC) and also an independent toxicity score (D). Subsequently, it is possible to make a ranking of the chemicals.

Application of the system implies that the system is incorporated in the waste water permits or environmental approvals of the companies. Next, the companies should file information on consumption of chemicals as well as environmental data. At first, information on all chemicals employed should be submitted, but subsequently, reporting of new chemicals may take place concurrently with the employment of these. The statement of consumption should be updated at least once a year.

The Federation of Danish Textile and Clothing Industries is prepared to act as a "consultant" for the individual companies and it has established a database management system for storing of information on chemicals and scores computed. By means of the database facilities, it will thus be possible to print out a list of the chemicals employed and the score computed (*a Score Report*) for each specific company.

The aim is to enable companies and environmental authorities to "identify" chemicals by way of applying the score system, within which the data indicate whether they are located in the "heavy end" or when relevant information is not available. Theoretically, the system can also be applied to other chemicals.

A comprehensive list of what environmental results have been achieved due to the application of the score system does not exist. In order to illustrate the practical application of the system, the company "Egetæpper a/s" has been used as a case.

2.3 Implementation of the score system by Egetæpper a/s

Egetæpper a/s offers a wide range of products for indoor carpets for private homes and contract carpets for commercial use. The company dyes and manufactures tufted carpets. Egetæpper a/s is located in the municipality of Herning in the County of Ringkjøbing and forms part of a group employing a total of 630 persons.

In 1996, Egetæpper a/s was certified by Bureau Veritas Quality International pursuant to BS 7750. The company is actively working on environmental issues and therefore, the reduction in the usage of products containing substances injurious to the environment is not only due to the use of the score system but also other measures taken by the company in order to decrease the environmental impact. The score system is one tool among many used by the company.

On the basis of the scores an annual score report is completed. The score report is a tool for the company and for the local environmental authorities to agree on the environmental problems, to analyse the consumption patterns, to look for opportunities for substitution and to implement cleaner technologies.

The company's policies on procurement lay down, amongst others, an assessment of the working environment and effect on the environment, including the score allotted, before decisions are made on procurement of products (raw materials and excipients in the production).

In 1995 and in 1997 - 1998, Egetæpper a/s prepared some environmental reports which make up documentation for their results. The first annual score report which was prepared based on consumption in 1992, specifically shows that 68 different dye stuffs and chemicals were used. Hence, 17 had an exposure score (AxBxC) in excess of 24 and a toxicity score (D) of 4. The latest annual score report has been made on basis of the consumption in 1997 - 1998. In this case, 48 different products were used of which only one product has an exposure score in excess of 24 and a toxicity score of 4.

This seems to show that during the years, the number of products with a high score used in the production at Egetæpper a/s has been reduced considerably. This is partly because some of the products are not used by the company and partly because huge efforts have been made in order to procure missing data on the effects these products will have on the environment. As previously noted, lack of information about a certain product will automatically result in a high score in the score system.

Metal complex dye stuffs are used for dyeing synthetic fibres which to a large degree must be colourfast, such as production of mats which will be exposed to regular machine wash. Metal complex dye stuffs contain heavy metals.

In Egetæpper a/s' environmental report from 1995, the consumption of dye stuffs and excipients has been listed and in this report it is stated that:

> *"With the intent of reducing/eliminating the contents of heavy metals in waste water and sludge, Egetæpper a/s has strategically worked on restructuring the use of dye stuffs for the use of dye stuffs which do not contain heavy metals, during the last 4 years. The amount of dye stuffs containing heavy metals has been reduced from 40 % of the total dye stuff consumption to 10 % from 1993 to 1995. The results are continuously submitted to the environmental department of the local authority of Herning via the specific score system developed."*

Table II.6 Trends in the consumption of metal complex dye stuffs expressed in percentage of total consumption

Dye stuff	1993	1994	1995	1996/97	1997/98
Metal complex	40	30	10	8	5

Source: Egetæpper a/s' Environmental Reports of 1995 and 1997/98.

As the company has met the environmental obstacles in many respects, it is very difficult to point to specific investments and costs which can be directly interlinked with the use of the score system.

3 Horizontal Measures: The Reduction in the Use of PVC

A large proportion of the PVC used in Denmark is incinerated with the waste. About 50 % of the chlorine in waste originates from PVC products and packaging. The incineration of PVC creates an environmental problem in flue gas purification products. The Danish authorities have taken a number of actions in order to reduce the amount of PVC in the waste stream.

3.1 The use of PVC

The production of the raw materials for VCM/PVC or the production of VCM/PVC itself is not carried out in Denmark. The raw PVC material is imported and manufactured by the industry.

PVC is a unique material and is used for a wide range of products such as packaging, building materials, cable insulation, pipes, tubes, components for mechanical and electrical devices, toys, stationery, automobiles, clothing, furniture, medical devices and other consumer products.

Table II.7 Consumption of selected PVC products in Denmark 1988-1994. Tonnes.

PVC product	Year						
	1988	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
Pure PVC-resin	49,569	51,874	45,580	42,590	43,822	39,365	48,150
Hard PVC	7,663	3,848	3,104	3,056	2,932	3,770	1,868
Soft PVC	11,028	10,578	9,981	9,029	8,798	10,245	8,173
Total export of raw PVC	-3,243	-3,470	-2,947	-2,684	-2,589	-6,473	-7,138
Total consumption of raw PVC	65,017	62,830	55,718	51,991	52,963	46,907	51,053
Boards, foils and film	22,322	22,935	22,154	19,087	20,974	18,907	20,870
Flooring materials	3,994	2,616	3,081	3,013	2,654	2,680	2,199
Stationery	1,887	1,830	2,092	2,337	2,109	1,850	2,176
Total exports of *selected* PVC-articles	- 18,641	- 17,361	- 16,843	-15,924	- 18,593	- 17,528	-20,550
Total consumption of *selected* PVC-articles.	9,562	10,020	10,484	8,513	7,144	5,909	4,695

Source: Table from working report no. 82, 1995 from the Danish Environmental Protection Agency: Erfaringer med substitution af PVC ved renere teknologi og brancheaftale. (Experiences with substitution of PVC through cleaner technologies and voluntary agreements). The table is generated from the import statistics from the Danish Statistical Bureau (Danmarks Statistik). The figures are underestimated since only the main groups of PVC products have been chosen, neither PVC used as part of other products nor packaging on imported products are included.

3.2 PVC - a waste problem

The discarded PVC products follow the normal waste streams and in Denmark the major part goes to incineration. The inherent energy (feedstock energy) 29.56 MJ/kg in the PVC can be recovered at incineration for electricity or heat, usually at a rate of efficiency of about 74 %. Energy required for transportation is not included.

When PVC is incinerated, hydrochloride acid is formed and the flue gases are neutralised normally by the use of lime. Three types of neutralisation systems are predominant: dry, semi-dry, and wet systems. From the dry and semi-dry processes 1.8-5.6 kg of solid waste per kg of PVC incinerated are made up, and from the wet process high saline waste water and sludge are formed.

The flue gas purification residues from incineration of household waste contain calcium chloride, heavy metals and traces of dioxins. It is necessary to deposit those hazardous residues in controlled environments and under continuous collection and treatment of the leachate.

PVC products may contain heavy metals from pigments and stabilisers. Releases to the environment may occur from the disposal of PVC, in particular from disposal through municipal solid waste incineration. When disposed by way of incineration, the heavy metals are found in the solid residues from the incineration (slag) or in the acidic flue gas purification product.

The quantity of acidic purification products depends on the amount of hydrochloric acid in the stack fume. The hydrochloric acid content in the flue gas is dependent on the contents of PVC and other chlorine sources in the waste.

The presence of chloride ions makes it especially difficult to dispose of the purification product. The chloride ions take part in mobilising the heavy metals present in the purification product, and the purification product is designated "problematic waste" or "chemical waste" for disposal in controlled environments.

When deposited in landfills, hard PVC degrades very slowly, if at all. From plasticised PVC, plasticiser leaks from the product. This could be an important source of emissions to soil and water. However, the fate of plasticisers in soil is not well recorded.

3.3 Measures taken to reduce the use of PVC

A wide range of steering instruments have been employed in order to reduce the use of PVC in Denmark, involving a great number of actors.

Voluntary agreements

In 1987, the Danish EPA published a report (Substitution of PVC plastics with other plastic materials, miljøprojekt no. 87, 1987, Danish EPA). On the basis of an overall

description of the uses and dissemination of alternative plastic materials, the report concluded that PVC plastics could largely be substituted without any significant quality depreciation or increased cost factors within those industries which represent the largest volumes. The report formed the basis of the political initiatives to negotiate with the Danish Plastics Federation to substitute PVCs.

In April 1991, an agreement between the authorities, the industries and the trade manufacturers on the consumption of PVC products in the packaging, office supplies, building and construction and health care sectors, was drafted. The agreement includes production and distribution of products containing PVC and waste containing PVC in Denmark. Exported and imported products were not made part of the agreement.

According to the agreement, industry must reduce the consumption of PVC and substitute other materials in its place. The use of lead-containing stabilisers, pigments and chlorinated paraffins in PVC should be reduced to the extent technically and economically feasible. PVC packaging should be reduced by 85 % by the year 2000. The agreement contains a plan for recycling and PVC substitution measure for each industry. A recycling rate of 77 % in 2000 for construction and demolition waste should be achieved.

The aim of the agreement is, as far as possible, to avoid PVC products in waste incinerator plants where technically and economically justifiable and to establish a co-operation between industries and authorities, where the agenda is to safeguard optimal environmental and economic use and consumption of PVC. The industrial members of the Danish Plastic Federation and the Ministry of the Environment are the actors in this process.

Recycling

The advantage of recycling PVC is that it is kept out of the incineration process, though of course recycling is not considered waste minimisation. Material recycling of polymer products (PVC and other polymers) requires pre-sorting of the waste into generic materials. The level of impurities is critical for the quality of the recyclate. In Denmark, the recycling of used PVC products into new products has taken place on a very small scale. Recycling of PVC waste from private households, commercial enterprises and offices does not take place. However, recycling of PVC from production is carried out to a large extent in Denmark, especially concerning production waste which is very well defined by its original composition (Møller et al., 1996). Another possible area for recycling is building materials. In this respect, the environmental authorities, waste companies and industry are the main actors.

Substitution and cleaner technologies

The Danish Environmental Protection Agency has funded a number of cleaner technology projects in order to develop substitutions for PVC. As of 1995, 21 projects on substitution for a variety of PVC products had been initiated.

The Danish Plastic Federation has pointed out that substitution for packaging is difficult but practical experience from supermarkets has proven it possible. Likewise, stationery and hospital materials have a big potential for substitution of products containing PVC products. The potential has yet to be realised because the alternatives will be more expensive for the consumers due to a limited market volume.

A few products cannot yet be substituted. Tubes for medical use in hospitals must be flexible and can only be made of PVC. Likewise, it has not been possible to find substitutions for items such as PVC flooring materials for wet rooms. But the use of PVC in these areas is only a minor part of the total consumption.

Through the funding of cleaner technology projects, the Danish EPA has played an important role, as has the Plastic Federation. Other actors in the process are the industries, technological institutes and advisers.

Greener public procurement

For many PVC products good substitutes do exist. But these substitutes are often not marketed very well. Reduction of the use of PVC is one of the areas within the Danish strategy for greener procurement in the public sector. The aim of the strategy is to provide an incentive for the industry to develop and produce cleaner products, with a reduced environmental impact. When demanding cleaner products, the supply of the alternatives will grow and the prices will fall – thus making the alternatives more attractive to markets outside the public sector.

The Danish EPA issue a series of guidelines on specific products. In co-operation with the Danish EPA, the County of Aarhus has published a handbook on PVC-free purchasing (PVC-fri indkøb - hvordan?). The book contains a list of alternative products under the categories of hospital equipment, stationery, kitchenware, packaging and cleansing products. The book also lists where the products can be bought. The lists are continuously updated in order to give the industry an incentive to find alternatives. The list can be viewed at http://www.aaa.dk/pvc.

Experience shows that a co-ordinated effort can lead to significant results. The hospital of Grenaa in Denmark has a policy of buying PVC-free products and today more than 90 % of the PVC-based products have been replaced by alternative products. The remaining 10 % cannot yet be substituted since no satisfactory alternatives have been found.

The Danish EPA has played a major role in the strategy for greener public purchasing but has worked along with a number of major institutions in Denmark on the imple-

mentation. Greener public purchasing has been the most important attempt to organise a substantial demand for PVC-free products.

Private consumers

The use of cling film made of PVC has voluntarily been replaced by alternative products throughout the Danish retail sector. The voluntary substitution began after public discussions, with consumers and environmental NGOs as driving forces. The substitution of cling film and other PVC-packaging materials encourages the environmental image of the retail sector and illustrates the potentials of the market.

Taxation

In autumn 1998, the Danish parliament decided to levy a tax on foils for packaging (cling film) made of soft PVC. The aim was to promote the use of alternatives and to reduce the environmental problems in the incineration process. The price of soft PVC for cling film amounts to 2.96 EURO/kg and for the alternatives 6.05 EURO/kg. The proposed taxation will amount to 1.61 EURO/kg and thus increase the price of soft PVC for cling film by 55 % of the general retail price. The expected effect will be a reduction in the use of soft-PVC for cling film of 50 % - 350 tonnes/year.

Co-ordination with other initiatives

The efforts made to reduce the use of PVC are not all-encompassing. The Action Plan for Reduction of the use of phthalates in soft plastic is a follow-up on the agreement.

3.4 Results

An assessment from 1995 (Danish EPA, 1995, p. 44) concluded that results have been achieved due to the efforts included in the agreement. However, some of the reductions had been made even before the agreement was drafted. In the assessment it is also concluded that the agreement is incomplete in the light of the total PVC consumption and a large proportion is not covered by the agreement.

According to recent data from the Danish Minister for the Environment and Energy it is difficult to assess if the goals of the voluntary agreement will be achieved (they have not yet). In 1997, the recycling rate for construction and demolition waste achieved approximately 10 - 15 % (in comparison to the goal of 77 % set for 2000).

Table II.8 shows that many manufacturers have either substituted PVC or work with recycled PVC.

Table II.9 highlights that the main driving force for switching from PVC to other materials is the environmental image the manufacturers strive for and the customers' demand. These two reasons are followed by the PVC agreement. This underlines that

a voluntary agreement within this area cannot exist on its own but must be supplemented by other steering instruments such as cleaner technology projects for substitution, initiatives on the demand side of public purchasing, consumer information, and the above mentioned tax which is to be levied in 1999.

Table II.8 Manufacturers work with substitution and/or use of recycled PVC

Manufacturer (number of manufacturers)	Works with substitution	Percentage	Use of recycled PVC	Percentage
Construction materials (24)	10	42 %	13	54 %
Stationeries (16)	8	50 %	6	38 %
Packaging (10)	4	40 %	4	40 %
Food-packaging (7)	3	43 %	-	-
Medical equipment (9)	3	33 %	5	56 %
Hospitals (7)	5	71 %	1	14 %
Raw materials and parts (6)	4	67 %	3	50 %
Other use (9)	1	11 %	3	33 %

Table II.9 Reasons for working with substitution (multiple naming possible)

Manufacturer working with PVC substitution	PVC - agreement	Demand	Environmental Image	Economic advantage
Construction materials (10)	3	6	6	
Stationeries (8)	2	5	6	2
Packaging (4)	2	2	4	1
Food-packaging (3)	1	2	2	
Medical equipment (3)	1	2	5	
Raw materials and parts (4)	2	3	3	

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III France

1 Municipal Waste: The Case of Les Sorinières

Les Sorinières is a community of about 6,500 inhabitants situated in the area of Nantes.

As the quality of the environment plays an important role within the local policy, the municipality of Les Sorinières decided in 1997 to completely reorganise its household waste management system, especially by imposing a new charging system.

Before the implementation of the new system in Les Sorinières, the costs for waste disposal were covered by a special tax for household waste collection (TEOM - taxe d'enlèvement des ordures ménagères). This tax was, as in the other French towns, based on the rental value of the residence and calculated within the property taxes.

In practice, the efficiency of this tax was limited because it corresponded neither to the amount of waste produced by each household nor to the collection services provided twice a week by the municipality of Les Sorinières. Therefore, the individual responsibility for the production of household waste was no determinig factor within the TEOM. Another disadvantage of this system was its lack of transparency because the community could decide to charge only part of the total costs by the tax and cover the rest within the general budget via local taxes. So, the producer of waste did not get an insight into the real costs of the service. Moreover, some waste producers, e.g. public institutions, administrations and some companies, were able to avoid the tax.

The total amount of collected household waste in Les Sorinières increased from 1,392 tonnes in 1990 up to 1,750 tonnes in 1997. Without the new waste management system, it was predicted that household waste would grow to 1,937 tonnes annually.

Not considering the test phase of the new system, the average tax for the collection of household waste would have been 142 EURO per household in 1998.

1.1 Description of the implemented measure

The new system

The new organisation of household waste management introduced in Les Sorinières in 1997 was a pioneer in the French household waste system. The services were implemented by the council of Les Sorinières together with a world-wide business organisation for urban and industrial cleansing. The business organisation now intends to apply this charging system to all its customers world-wide, that is to say about 11 million people.

The acceptance of the new system is strengthened by similar management systems carried out in municipalities of other countries, such as Göteborg (Sweden), Prague

(Czech Republic), Bremen (Germany) and the Region of Dillburg (Belgium). This shows that the new system can be applied in larger entities, like cities and regions, and that the system's efficacy is not limited to France. Implementation of the new waste collection system in Les Sorinières therefore offers an excellent guide for cities and regions in France and throughout Europe.

Four main *objectives* are the guidelines for the new concept in Les Sornières:

- a greater responsibility of the population towards the quantity of waste generated;
- an increase of public awareness towards selective collection of waste;
- a better distribution of the costs for the management of household waste;
- a better adjustment of the collection service re adapted to the performance of each household.

In order to achieve these objectives two main *principles* are set out:

- household waste producers are obliged to sort their waste into humid waste, recyclable waste, paper and glass;
- the former charging system by tax was completely given up in order to establish a subscription fee.

The major innovation of the new waste concept in Les Sorinières is to replace the tax for the household waste collection (TEOM - taxe d'enlèvement des ordures ménagères) with a subscription fee (REOM - redevance d'enlèvement des ordures ménagères). The subscription fee includes all the costs related to the waste collection: the delivery of the containers and their replacement, the collection itself, the disposal of waste and all the fees related to management and good functioning of the disposal system. An annual subscription contract is signed between the inhabitants and the community of Les Sorinières in which the subscription fee is fixed individually for each household according to the volume of the delivered containers and the number of collections carried out for each household.

The first part of the invoice consists of the annual subscription fee taking into account the volume of the containers, e.g. containers of 120 litres, 140 litres, 240 litres or 360 litres. The fee includes the use of the different services provided by the community such as collection of household waste once a week (with limitation on quantity), handing out of transparent plastic bags for the collection of recyclable materials, collection of recyclable materials once a week (without limitations on quantities), collection of special household waste (e.g. batteries and paints) and the collection of glass in collective containers.

The second part of the invoice depends on how many times the containers with household wastes were indeed presented for collection within the year. The first 26 collections are included in the amount of the annual subscription fee. According to the size chosen, the price varies from 82 EURO to 223 EURO for the subscription fee.

Any further collections have to be paid extra. Here again the price varies according to the size of the container, from 2.69 EURO to 7.86 EURO. The invoicing is carried out twice a year. At the beginning of each semester, the inhabitant receives a personalised bill consisting of half of the annual costs for the subscription fee of the current year, whereas the supplementary collections are all charged by the end of the year.

In order to count the amount of collections carried out, each of the 2,000 households in Les Solinières got an electronic chip fastened onto the container, indicating the name and the address of the person owning the container. The dust cart is provided with a corresponding electronic system. Each time the container is removed, the electronic system reads in the name on the chip. The electronic system transmits the data to the local computer centre where the collections are counted. The invoices are account summaries based on all collections captured in the database.

Table III.1 Waste collection fees in Les Sorinières

	120 l	**140 l**	**240 l**	**360 l**
Annual subscription fee	82.00 EURO	92.00 EURO	149.00 EURO	223.00 EURO
Add. fee per collection	2.69 EURO	3.12 EURO	5.27 EURO	7.86 EURO
Predictable fees a year	117.25 EURO	132.76 EURO	217.19 EURO	325.16 EURO

Time frame of the measure

In October 1997, the municipality of Les Sorinières decided to develop the service for the reorganisation of the household management system.

- After the implementation of the one-year test phase the new system was finally implemented by the municipal council on 25 November 1998.
- Beginning of December 1998, an information campaign for the inhabitants of Les Sorinières started by posting information including the subscription contract to each household.
- In Mid-December 1998 the public was reminded of the new service. The community of Les Sorinières put information stickers on every container indicating the date and time when the dump truck with a double compartment passes by in the area.
- The deadline for the return of the subscription contracts was the 20 of December 1998 in order to start the new services on 1 January 1999.
- On 1 January 1999 the test phase started with the possibility of presenting the containers for household waste as well as transparent plastic bags for recyclable waste once a week.

The advantages of the new system

The reorganisation of the collection service allows each individual to take a stronger responsibility for the production and minimisation of waste:

- each household can actively participate in the selective collection of waste;
- each household can ask in its contract according to its individual waste production for only one collection a week instead of two as in the former system.

The individual responsibility and invoicing also leads to financial advantages. It is intended to present a logical and reasonable solution in order to avoid the continuous increase of the individual and collective costs. These are in particular:

- appropriate link between the amount of the bill and the effective service;
- transparent costs of the service;
- mastering the community's general budget for the collection service.

Based on a more rational household waste management, the general subscription fee needs the involvement of the citizens. Regarding the test phase, the inhabitants were able to mobilise themselves by "playing the game." This new consumer behaviour led to waste minimisation and savings that were impossible to be achieved in the context of the previous tax system.

1.2 Waste minimisation results

Although introduced very recently, positive impacts of the new concept could already be observed in the field of waste minimisation and cost effectiveness.

The implementation of the new system gives each individual the possibility to control his/her waste production on the invoice received. Because people from now on have to pay according to the amount of waste they produce, they tend to minimise the quantity of waste in order to save money.

Comparing the annual waste quantity before and after the implementation of the new system is the best way to show the effectiveness of the test phase in Les Sorinières.

The total production of waste per year, including household waste, recycling waste and glass waste would have been 1,937 tonnes/year using the former system. By introducing the new system, only 1,545 tonnes/year of waste were produced, that is to say a difference of 392 tonnes/year in total. This means that, on average, each individual minimised his/her waste production by 60 kg/year.

The yearly production of household waste alone would have been 1,872 tonnes/year (288 kg/inhabitant/year) using the former system. By introducing the new waste management system, only 1,144 tonnes per year (176 kg/inhabitant/year) of household waste were produced, a difference of 728 tonnes per year in total (112 kg/inhabitant/year).

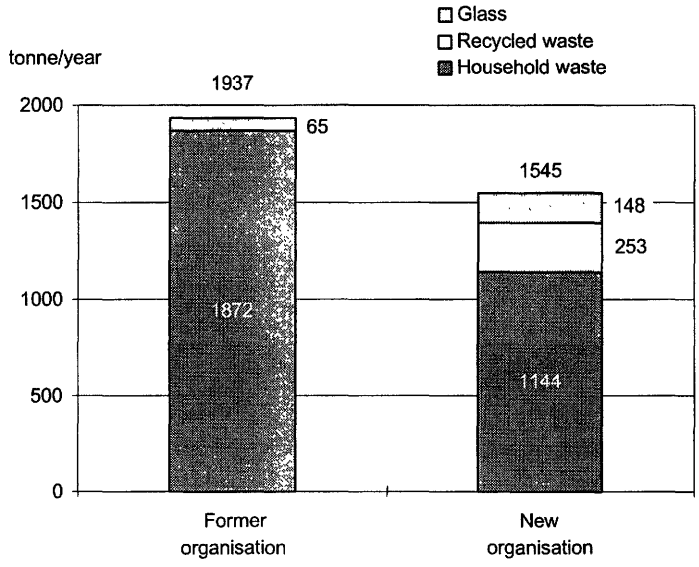

Illustration III.1 Waste minimisation in Les Sorinières

At the same time other positive results can be stated. The collecting services in Les Sorinières are much better used by its inhabitants, because the frequency of the presentation of containers decreased in most households to only one collection per week. Additionally, waste that have to be put into incineration plants were reduced by 30 % to 40 %.

1.3 Cost effectiveness

For the Community of Les Sorinières the above stated results of the test phase also have positive financial impacts by saving 53,360 EURO within the test phase. This is especially due to the reduction of waste that have to be put to incineration plants, as the incineration costs the community more than 91 EURO per tonne.

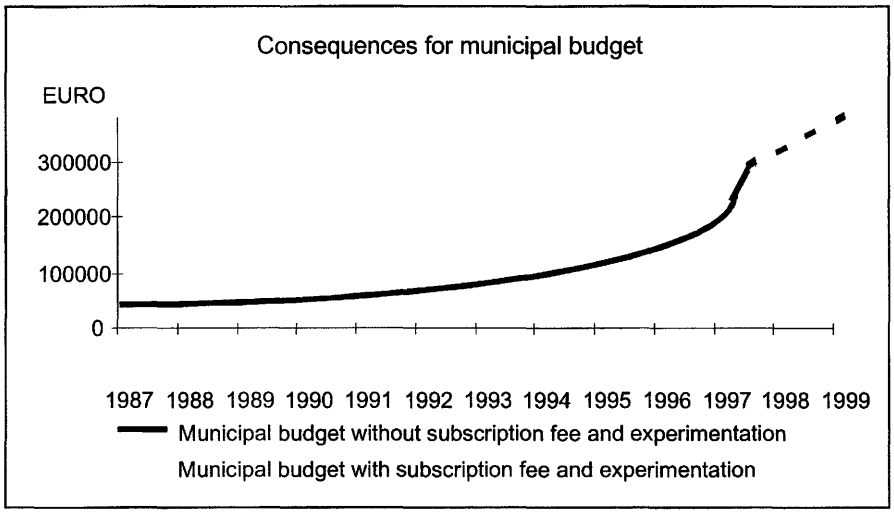

Illustration III.2 Cost effectiveness at Les Sorinières

For the 90 % of citizens that are using 120 litres or 140 litres containers, the average fees went down from 142 EURO to 117 EURO (82 EURO subscription fee plus 13 additional emptyings each for 2.69 EURO) or 133 EURO (92 EURO subscription fee plus 13 additional emptyings each for 3.12 EURO).

1.4 Conclusion

The system introduced in Les Sorinières led to waste minimisation at its source by taking into consideration the individual responsibility of the inhabitants. Considering the test phase of one year the results were all together so positive that the community of Les Sorinières decided to finally implement the new system beginning of 1999.

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2 Industrial Waste: Retreading of Tyres at „Pneu Laurent"

As many other European countries, France is facing the problem of increasing rubber waste, mainly resulting from used tyres. Minimisation of rubber waste is absolutely necessary, looking at the annual figures for used tyres in France. On the national level, every year 29 million tyres for cars and 2.3 million tyres for lorries are needed. The annual use of tyres in France corresponds to an amount of about 400,000 tonnes.

In France, used tyres are dealt with in different ways, for example they are incinerated in order to gain energy, they are moulded for the production of sports ground or they are retreaded. Of these different forms of reuse, retreading is considered to be the most appropriate activity because it significantly contributes to rubber waste prevention. Retreading also has a lower overall environmental impact than chemical recycling, which itself has a lower impact than burning tyres in power stations.

Retreading is a well-established procedure that has already been successfully introduced in many European countries. Retreading of a tyre means to replace the used tread with a new one and to reintegrate all the other original material of a tyre in the production process. Therefore, more then 80 % of the material of a tyre is prevented from becoming waste. Only the treads themselves, accounting for about 20 % of the material, have to be renewed. Moreover, retreading still has the potential to be increased, especially in the car tyres sector.

„Pneu Laurent" (PL) is situated in the municipality of Avallon, Arondissement de l'Yvonne in central France. Since it was founded in 1952, PL has been dedicated to the development, the production and the marketing of a large range of retreaded tyres. In 1996, PL opened up a new production plant, multiplying its yearly production capacity for treads by four. Now having production plants not only in France, but also in Germany, Belgium and Luxembourg, PL has become the largest industrial retreader in Europe.

Every day more than 4,500 tyres are retreaded in PLs main production fields:

- retreading of car and van tyres;
- retreading of lorry and civil transport tyres;
- fabrication of treads for internal use or export.

2.1 Description of the implemented measure

Retreading is a process by which the used treads are taken off a tyre in order to replace them with a new tread. This reuses the major parts of the tyre, as for example the carcass, the beads and the inner liners, which still have the same qualities as a new tyre.

The quality requirements of the different types of tyres vary a lot depending on the load capacity, the suitability for high speeds, etc. However, similarities between the different types can be pointed out. Most of the tyres used for passenger cars or commercial vehicles are radial tyres. The structure of radial tyres is divided into a relatively soft carcass whose cords run at 90° (radially) to the tire cirumference, and a one- or two-layered belt, with high rigidity in the circumferential direction.

A passenger car tyre is a very complex and elaborate combination of materials. It is made up of a single-layer carcass linking and enclosing the two beads, that can take the form of cables or be square in cross section. On the outside of a tyre are the tread and the sidewalls. On the inside is the inner liner, which mantains the internal pressure as steady as possible over long time-periods. The sidewalls and the inner liner are joined by the bead area, which also insures the seating of the tyre on the rim (see Illustration III.1).

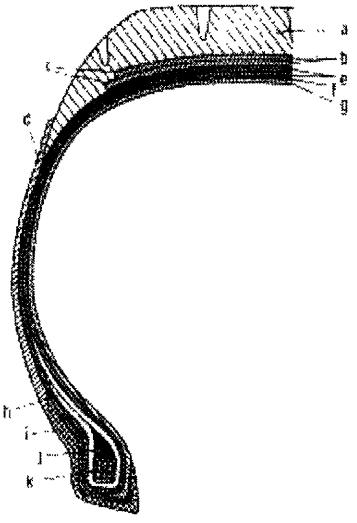

Illustration III.1 Construction of a passenger tyre

a) Tread; b) Belts; c) Edge protection; d) Sidewall; e) Cord plies; f) Intermediate layer; g) Inner liner; h) Flipper; i) Bead cushion; j) Bead apex; k) Bead
Source: Ullmann's Encyclopedia of Industrial Chemistry

At PL the process to rebuild tyres is generally carried out in six main steps:

1. Examination/selection

   At the beginning all the outer tyres are examined by professionals of PL in order to estimate which tyres fulfil the material and security conditions for retreading.

2. Elimination of the treads

   Special machines are then used to tear away the used treads from the tyres. The predefined roughness of the surface is taken into account by the special geometric and dimensional characteristics of the machine in order to guarantee the cohesive strength between the carcass and the treads.

3. Brushing and material replacement

   The outer tyres are then brushed, in order to remove the oxidated parts. The carcass is afterwards repaired by replacing all the material that had to be taken off by new material. This process repairs damaged tyres in order to further use them.

4. Covering

   This is the actual operation of retreading, which means that new treads are being put on the repaired outer tyre.

5. Vulcanisation

   This part of the process ensures that the repaired outer tyre and the new treads will perfectly stick together. During this processing step the tread gets its full physical characteristics.

6. Controls

   Throughout the fabrication process, and again before being marketed and sold, the quality of the recycled tyres is closely monitored and controlled.

2.2 Environmental and economic results

Retreading tyres is one of the most significant measures for minimising rubber waste, since almost 80 % of the former tyre are reused. The very specific about retreading is that the tyres are reused according to their original purpose and that they have the same quality of performance and durability as a new one for a speed of up to 240 km/h.

Moreover, retreading has financial advantages for the customers. The cost for a retreaded tyre is at least 30 - 50 % lower than that of a new tyre.

Of the 29 million car tyres used every year in France 2,232,000 pieces (8 %) are retreaded per year. Additionally, 2.3 million lorry tyres are used every year, of which about 1,000,000 pieces (46 %) are retreaded every year. Speaking in figures, this means that in France 72,000 tonnes of waste were avoided in 1998 by retreading car and lorry tyres. This amount could be increased even more, taking into account that only 8 % of the car tyres are currently retreaded in France.

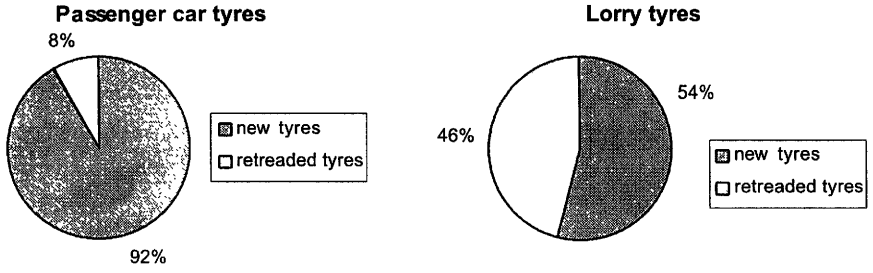

Illustration III.2 Source: SNCP = Répartition des ventes de pneumatique de remplacement en unités

PL contributed to these figures by retreading more than one million tyres each year since 1996, of which 700,000 can be alloted to car tyres, 300,000 to lorry tyres and 150,000 to van tyres. In tonnes this means that every year at PL, about 30,000 tonnes of tyres are prevented from being disposed.

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3 Horizontal Measure: Prohibition of Mercury in Clinical Thermometers

About 60 tonnes of mercury are used in France every year in different industrial production sectors (CNIID 1999). Mercury is used for example in the electro-technical industry to produce batteries or fluorescent tubes or in the dental practise for fillings (Rauhut 1996). Other industries need it for the production of controlling instruments such as manometers, barometers or thermometers (Römpp 1993). Although mercury

has such a broad area of application one should not forget that mercury is highly toxic and has a number of devastating effects on human health and the environment.

Before the French government decided to prohibit the marketing of clinical mercury thermometers, the total number of thermometers in France was estimated to be about 15 to 20 million (CNIID 1999).

Each thermometer contains about 2 grams of mercury. More than 12 tonnes of mercury - which is equivalent to 20 % of the above mentioned total yearly amount of 60 tonnes of mercury - have been used in thermometers every year (CNIID 1999). Between 1.5 million and 5 million thermometers are broken every year. Mercury thermometers used in hospitals for example have an average lifetime of only one month. Therefore between 3 and 10 tonnes of mercury are released into the environment from thermometers every year.

Table III.2 Use of mercury in thermometers in 1995/1996 in France

	Use of thermometers in pieces	**Mercury volume in tonnes**	**Release of mercury by broken thermometers in tonnes**
Hospitals	ca. 5 million	10	-
Others	ca. 1.5 million	2	-
Total	ca. 6.5 million	12	3 - 10 tonnes

In household use of clinical mercury thermometers, human health - in particular the brain, the kidneys and the bowels - may be directly affected when the thermometers break. Human individuals are directly exposed to the vapours of the mercury by broken thermometers. But mercury thermometers can also be broken in the rectum or reach open wounds. It must also be remembered that the ingestion of mercury, especially by children, is a frequent accident. Several cases are reported to the Anti-Poison Centre in Paris every week.

Mercury from broken thermometers is a considerable waste problem because it enters and pollutes the environment in different ways. First of all, it could get into the environment through the solid waste path, when thrown into the household waste. Once in the solid waste path, it may travel either to a waste disposal site or to an incineration plant. In both cases, mercury would most likely get into the soil, contaminate the ground water and may even find its way into the human food chain. Mercury also could enter and pollute the environment by getting into the water waste path, especially by washing it away trough toilets or sinks. It then remains in the sewage or in the sludge. Finally, the mercury vapours that are released into the atmosphere are very harmful to the environment, because they are oxydised and then deposited by rain onto the soil and again get into the ground water.

3.1 The new regulation

The measure taken to prohibit the marketing of clinical mercury thermometers in France is a ministerial enactment. As of 1 March 1999, it is prohibited (Arrêté of 24 December 1999, Journal Officiel, 31 December 1999) to market thermometers for the internal measurement of the temperature of the human body in France.

Under the new regulation it is also prohibited to market the product in other EU countries. However, the enactment does not prohibit their export to non-EU countries. Article 2 of the law stipulates that:

> *„Prohibition is not applicable when the thermometers are placed under EU external transit customs law or under any economic customs regime in the sense of the regulation CEE n° 2913/92 of the Council of 12 October 1992 notwithstanding that they are re-exported to a non-EU-member country or put under free practice in another member State or destroyed under the said regime."*

The obvious goal of the French enactment is the minimisation of the mercury waste in order to prevent the release of a significant share of mercury into the environment, thus reducing its effects on the environment and human health.

3.2 The actors

The whole process of prohibiting mercury thermometers was promoted by two main categories: Actors contributing to the run-up of the ministerial enactment and actors responsible for its implementation.

Actors contributing to the ministerial enactment run-up

Various institutions have pointed out the importance of the prohibition of mercury thermometers. Therefore they substantially set off the elaboration process for prohibiting mercury thermometers in France.

The *French Superior Council for Public Health* (Conseil Supérieur d'Hygiène Publique de France) issued a statement of 9 November 1995 in which it recommended:

- to establish a policy that reduces the risks of mercury exposure and therefore to encourage in particular the replacement of mercury thermometers by other devices;
- to implement an in-depth information policy about the risks of mercury poisoning and release into the environment;
- to envisage the prohibition on using mercury thermometers within two years;
- to organise the recovery and reprocessing of the mercury from broken or unused thermometers.

The *General Health Directorate* (Direction Générale de la Santé) and the *Hospital Directorate* (Direction des Hôpitaux) attracted attention to the risks linked to mercury thermometers in a circular dated 22 April 1997 addressed to the professionals of the health sector. It also recalls the statement of the French Superiour Council for Public Health and the promotion of alternative thermometers.

The *Consumer Safety Commission* (Commission de la Sécurité des Consommateurs) on 9 September 1998 issued a 23-page statement. The Commission, an official body composed of 16 members representing the State, the professional sector, consumers and sciences, organised hearings to evaluate the feasibility of the prohibition and the replacement solutions. The evaluation led to the following statements:

- It is "desirable to prohibit the production and the distribution of mercury thermometers."
- The equipment with electronic thermometers should be encouraged for example by the organisation of the exchange of a mercury thermometer for an electronic thermometer.
- Information shall be provided to the general public about the risks of mercury and the proper response in case of the dispersal of mercury.

Actors responsible for implementing the regulation

The main actors in charge of carrying out the terms of the regulation are identified in Art. 3 of the enactment:

- the General Health Directorate (Direction Générale de la Santé);
- the Hospital Directorate (Direction des Hôpitaux);
- the General Directorate of Concurrence, Consumption and Repression of Fraud (Direction Générale de la Concurrence, de la Consommation et de la Répression des Fraudes); and
- the *Director General of Customs* (Directeur Général des Douanes et Droits Indirects).

In order to implement the prohibition to market mercury thermometers, these actors will be responsible to supervise that no thermometers are imported to France or exported to an EU member state.

3.3 Expected waste minimisation results

Taking into consideration that the regulation has just been adopted recently, there can not yet be presented any concrete results. However, the prohibition has already shown some positive effects.

First, there are no longer any producers of mercury thermometers in France. With no producers in France, the expected minimisation of mercury waste is about 12 tonnes of mercury/year - a reduction of 1/5 of the total yearly mercury waste production in France.

Second, mercury thermometers are not only being prohibited from future sale or export in the French market, but also thermometers sold before the prohibition are already being replaced by households and hospitals. A complete replacement is expected within two years time. Because of the dangerousness of mercury, an appropriate recovery and reprocessing is absolutely necessary. In order to support correct recycling or disposal, many households have returned their mercury thermometers to pharmacies during the first month of this year.

3.4 Reprocessing and replacement costs

The prohibition of mercury thermometers basically results in two types of costs: costs for the reprocessing of the former mercury thermometers and costs for buying new thermometers.

The average reprocessing costs for mercury are expected to be about 3.05 to 4.57 EURO/kg. The costs for replacement thermometers are generally higher than those for mercury thermometers.

However, due to the short life-span of mercury thermometers, the overall cost of replacement thermometers - even when considering maintenance costs and one-way tips - is considered lower in the long run.

The individual *electronic thermometer* costs between 11 and 20 EURO per unit and about 305 EURO per unit for the professional electronic device. The individual *eardrum thermometer*, which measures the temperature of the human body by catching the infra-red rays sent out by the eardrum and converting them into temperature, is available at 69 EURO.

The professional tympanic device costs 305 EURO to 610 EURO.

Table III.3 Reprocessing and replacement costs

	Reprocessing costs	Replacement costs
Mercury thermometer	3.05 - 4.57 EURO per kg	-
Electronic thermometer	-	11 - 20 EURO 305 EURO professional device
Eardrum thermometer	-	69 EURO 305 – 610 EURO profess. device

All together, the replacement costs are difficult to evaluate because they will depend to a high degree on the number of thermometers being turned in and replaced. Nevertheless, assuming that 15 % of the total amount of thermometers would be returned in the first year the costs would be some 3.81 million EURO. This figure is based on the number of households using mercury thermometers, the costs for the reprocessing and the costs for new thermometers.

3.5 Conclusion

The prohibition on marketing of clinical mercury thermometers has been very successful in France, and is a very good example that can and is being applied in other European countries. In Germany, for example, the marketing of mercury thermometers is still allowed, but the German government will soon follow a policy similar to the French one. On 30.06.1999 the Bundestag fractions of the SPD and the Greens formally proposed to prohibit the production and marketing of mercury containing clinical thermometers, barometers and manometers, to inform the public about the proper disposal of these instruments and to initiate the harmonisation on EU level.

Apart from that, prohibiting mercury in thermometers through ministerial enactment or legislation is a measure that could also be implemented for other industrial sectors using mercury. The technical provisions for replacing mercury in batteries, manometers, barometers or in dental fillings are already given.

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IV Germany

1 Municipal Waste: Waste Reduction in Schools

In the following, the example of schools will be analysed, since:

- the number of schools is rather large, a fact which should not be neglected;
- schools generate similar kinds of waste as private households (apart from organic waste;
- few studies presently exist compared to those of waste prevention in private households.

The organisation of waste prevention and separation of waste in private households is relatively simple due to a homogenous social structure, whereas the organisation in schools is quite difficult to cope with. The reasons for this are the numerous, heterogeneous and somewhat difficult to distinguish influencing factors and actors, some of which are listed as questions below:

- Where does the waste stream start, at home and/or at school?
- Who is responsible for the generation of waste: pupils, teachers, parents and/or the administration?
- Who is responsible for measures to prevent and sort waste: students, teachers, the caretaker and/or the headmaster?

The example of the Landkreis (administrative district) Darmstadt-Dieburg shows how the problem of waste generation in schools can be tackled and what achievements have already been made.

1.1 Initial Position in the Landkreis Darmstadt-Dieburg

The Landkreis Darmstadt-Dieburg in the German State of Hesse has about 80 schools with an approximate total of 31,000 students [Flemming 1997/1]. Most of the schools are elementary schools; though there are also 17 comprehensive schools, three grammar schools, one vocational school and six special schools for children with learning difficulties. The number of students per school varies between less than 100 pupils (special schools and some elementary schools) and nearly up to 2,000 pupils (vocational schools and comprehensive schools). Some schools are situated in socially problematic areas.

The Landkreis Darmstadt-Dieburg and the city of Darmstadt have joined a Zweckverband (local administration union) for the disposal of household waste. In order to save costs, the Landkreis set up another administration union to standardize the sorting of waste and secondary resources in the district and to recycle a high

proportion of waste in late 1992 [Flemming 1997/2]. These two unions are also responsible for the collection and disposal of waste from schools.

At the beginning of the nineties, the charges for waste disposal in schools amounted to about one million DM, which is on average 16.36 EURO per student per year.

1.2 Initial measures

All measures taken by schools have been voluntary. The schools have been supported by intensive consultations from a waste consultant of the Landkreis. The State of Hesse has not offered any support.

Special events

As a result of the high waste disposal charges at the beginning of the nineties, authorities started in 1992 introducing sorting of waste in schools and regularly held events on waste management to motivate pupils and teachers to act in an environmentally friendly way. These events comprised of numerous theatre performances, hiring of learning material boxes (e.g. boxes for elementary schools containing learning materials on waste, compost and soil, raw resources and waste - one world), paper boxes, and poster campaigns (e.g. "clear as glass - returnable bottles are better") [Flemming 1997/1].

Research studies

The district commissioned research studies and initiated a school competition to obtain more knowledge of the possibilities for waste prevention in schools as well as of impediments to implementing waste programmes.

In 1995, the first analysis was conducted by the working group on waste technology of the WAR institute at the Technical University of Darmstadt [Jager 1997]. The group examined the remaining waste from 11 different schools with regard to its composition. The result showed that the remaining waste still consisted of large quantities of avoidable and reusable waste. The following contents were found:

- 23.4 % Vol. packaging;
- 22.6 % Vol. paper and cardboxes;
- 23.5 % Vol. waste from third parties not related to normal school activities, e.g. textiles, tapestry, construction waste;
- 4.7 % Vol. organic waste;
- 25.8 % Vol. remaining waste

In 1996-97 the same institute conducted a study [Klomann 1997] which analysed the behaviour of different actors of a school to deduce measures for motivating the actors to prevent waste.

The following measures were proposed:

- *Promotion of the individual experience of competence and control.*

  An individual in a school should feel that he or she can do something concrete for the environment and should not feel helpless toward environmental problems.

- *Feedback regarding improvements and achievements.*

  Each individual involved should experience the feedback which acknowledges his or her own behaviour as useful.

- *Transferring a "We-feeling".*

  The failure of environmental behaviour is often based on the notion that other people will counteract one's own efforts or simply not participate. The feeling of achieving a goal together and being actively involved in one's environment encourages the "we-feeling" and eases the frequent feeling of helplessness.

- *Planning small solutions.*

  Often, a maximum of demands regarding waste prevention are made. If it turns out that they cannot be completely met, feelings of helplessness and guilt arise. The perceived "failure" leads to motivation problems. An approach towards a larger goal should be made in small steps.

Competition at the school level

In 1996, questionnaires were sent to each school in the Landkreis, which were to provide statistical data such as waste disposal charges and information on the measures taken for waste prevention and sorting waste [Flemming 1997/1]. To encourage a high number of questionnaires coming back, the Landkreis Darmstadt-Dieburg advertised a competition endowed with a total of 3,000 DM. Schools taking the most creative measures for the prevention of waste should be awarded a prize.

The charges for refuse collection showed a substantial difference between the schools. The margin varied between 1.02 EURO and 59.82 EURO per pupil per year. It must, however, be pointed out that figures which lie below 2.56 EURO per student per year must be considered unrealistic. According to the waste consultant, the lowest realistic figures lie between 2.56 and 5.11 EURO per pupil per year.

The evaluation of the various measures taken by the schools shows that the majority of the measures led to a separate refuse collection after which the waste was recycled.

1.3 Further measures

The experiences gained from the investigations and the competition were summarised in a booklet and distributed in the schools [Flemming 1997/1]. The waste consultant visited such schools which had not yet implemented single measures and encouraged

them to follow the exemplary measures of other schools. These measures are listed below:

Self-composting

Although organic waste was already composted by 40 % of the schools, other schools should follow their example. It is believed that self-composting plays a special pedagogic role in school life, as students can directly observe the "decomposition process" in its single stages. Moreover, this subject could be integrated into biology lessons.

The Landkreis offered and delivered box composters free of charge to foster self-composting in schools. Up to now 56 box composters have been ordered and installed by 32 schools. Schools can order the learning material box called "compost and soil" from the office of waste management of the Landkreis specifically for teaching purposes. Besides general information, the box contains concrete proposals for school lessons, non-fiction books, games and materials for experiments as well as magnifying glasses for observing earthworms, woodlouses and mites.

Display & sale of environmentally-friendly school material

At the beginning of every school year a small display takes place to promote the use of environmentally-friendly school materials. Local shopkeepers have the opportunity to offer their goods made of ecological materials for school use at sample stands.

Furthermore, schools offer "green" ecologically-friendly school materials at cost. In particular, the sale and use of the following products contribute to waste prevention:

- pens with converters for refilling,
- bread cases and drinking bottles,
- tools made from more resistant materials than plastic, e.g. sharpeners, pencil cases, rulers.

Communal breakfast with a minimum of waste

In the meantime, a lot of schools in the Landkreis have a communal breakfast in the classroom. Pupils bring their breakfast in reusable packaging, e.g. bread boxes. They use their own glasses and cups, which are washed and kept in the classroom. Drinks are filled in returnable bottles or drinking bottles.

Use of durable tableware for school parties and events

The Kreistag (district assembly) of the Landkreis Darmstadt-Dieburg has ordered schools to sell drinks only in returnable bottles to reduce the use of drinks offered in one-way packaging as much as possible.

So far, only a few schools have durable tableware. However, since all cities and counties in the Landkreis have their own mobile dish carts, most of the schools make use of this service for their parties and events and thus avoid a lot of waste.

Mobile dish carts are containers or trailers containing sufficient durable tableware and a powerful dishwasher. They can be connected to the water supply. With this equipment the mobile dish cart can be used for large events and parties at different places.

1.4 Accompanying measures

Besides direct measures for waste reduction, accompanying measures have been taken such as the setting up of a working group of "ecological school" and the collection of further working materials and information for lessons on waste.

Establishment of a working group "Ecological School"

In summer 1997, the waste consultant of the Landkreis Darmstadt-Dieburg set up a working group called "Ecological School" within a meeting of waste consultants in Hesse. The working group is open to anyone who wishes to work on this subject. At the time being the working group meets about every two months. The goal of the working group is to exchange information and experiences. Furthermore, material on specific subjects is collected, worked on and then published by the environmental ministry of Hesse in the form of brochures. To date, brochures on cork, self-composting and drinking cans have been prepared.

Teaching materials and information on waste

Since then, new material has been added. This includes a general working file on "the waste project," a working file for the high school level I and II on "waste is no rubbish," and a working file on the Agenda 21 "Global! That's none of my business?" as well as several video films, e.g. "Kasper and the rubbish heap hill," "Don't use any packaging" and "White toil - drinking cans."

1.5 Achievements

Results vary by schools. About two-thirds of the schools could reduce their waste charges per pupil per year.

Table IV.1 Reduction of charges per pupil per year from 1995 to 1997

Reduction of charges from 1995 to 1997	Number of schools
by • 10 %	52 %
by 11- 49 %	35 %
by • 50 %	13 %

All in all, the measures taken can be judged as successful, since the charges, which the district had to pay for waste disposal at the schools, declined by 25 % while the amount of the charges remained constant over the years.

Table IV.2 Disposal charges paid by the Landkreis Darmstadt-Dieburg for the schools

Year of charging	Charge	Charge on average per pupil per year
Early 90's	511,000 EURO	16.36 EURO
1995	424,000 EURO	13.80 EURO
1998	383,000 EURO	12.27 EURO

It can be concluded from the decline of the waste charges that the total quantity of waste also declined by at least 25 %, since the charges remained the same over the years. Actually, the reduction of the quantity of waste is most likely over 25 %, because the charges are not levied according to the quantity of waste, but according to the size of the containers and the collection intervals. It was, however, not assessed what quantity of waste was prevented. Therefore, no data is available.

It can be expected that due to the involvement of the waste consultant of the district, the quantity of waste will continue to decline in the future.

1.6 Conclusions

The main problem in implementing waste-prevention measures is the motivation of the actors. Most of the pupils could be motivated to take part in the measures, whereas at the beginning most of the headmasters, teachers and caretakers showed little interest in supporting the measures or in assuming responsibilities. Since pupils cannot be expected to show "good behaviour" when persons who should be their mentors do not act accordingly, motivation of and change in the attitude of the grown-ups is one of the main priorities. Intensive consulting and organisation of courses for the further education of teachers is necessary.

Young people are not often prepared to observe the rules and instructions given by grown-ups. They must be motivated instead. If pupils are motivated in an optimal way, ie. with fun and without repression, they usually are willing to take an active role in the school's waste-management project. For pupils, motivation should not mean just to comply with the requirements of authorities and to have to reckon with reprimands instead of information when not behaving appropriately. To reach an optimal motivation level, teachers should not just work on the subject of waste in their lessons but should also be prepared to offer working groups about waste outside their lessons when their pupils wish to do so.

After all, every school has to find its own way of how to contribute most effectively to the prevention of waste. In special working groups, an intensive exchange of

experiences should take place, so that schools do not waste time by starting from the very beginning.

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2 Industrial Waste: Advisory Programme for Avoiding & Recycling Hazardous Waste of Baden-Württemberg

German waste law provides for the prevention of waste as a basic principle. Waste which cannot be avoided must be recycled, and waste which can neither be avoided nor recycled must be deposited. Although prevention is given priority, the federal government has not developed any measures until now which solely address the prevention of hazardous waste. The following section will focus on the "Advisory programme for avoiding and recycling hazardous waste" of the state of Baden-Württemberg. This programme was developed to address waste prevention as well as recycling, but it could be modified in order to prioritize prevention.

At the beginning of the nineties, German waste authorities forecast a shortage of incineration and landfill capacities caused by an increasing amount of hazardous waste. At the same time, plans for new incineration and landfill facilities were met by strong resistance from the local population. Costs for depositing waste also increased. In this situation, both local and state authorities as well as private firms increased their efforts to avoid hazardous waste.

To reduce hazardous waste the state of Baden-Württemberg founded the "Advisory programme for avoiding and recycling hazardous waste", a relatively new approach for reducing industrial waste. It offered firms technical advice from external consultants on their relevant waste-generating processes. More than 200 firms in Baden-Württemberg participated in the programme. The final report contains an evaluation of waste reduction from 125 of those firms.

2.1 Goals, measures and duration

The "Advisory programme for avoiding and recycling hazardous waste" was targeted at specific sectors and firms. The programme contained the following features:

- voluntary participation of the firms and advice free of charge;
- firms determined which kinds of waste and which processes should be investigated by external experts;
- advice could be asked regardless whether plants require official licences or not
- expertise by external counsellors included firm and sector-specific measures of avoiding and recycling hazardous waste;
- explicit agreements between the firms and waste authorities guaranteeing implementation;
- obtaining extensive sector-specific know-how by the state-owned "Waste Counselling Agency" on potentials for avoiding and recycling hazardous waste and on implementation problems;
- preparation of sector-specific reports for the information and support of firms which did not take part in the advisory programme, and for authorities who had to monitor the legal implementation of the waste prevention and recycling ordinance (implementation of § 5-I-3 of the Federal Immission Protection Act and the Closed Substance Cycle & Waste Act).

The programme lasted about three and a half years. It was instigated in the autumn of 1993 and ended in March 1997. However, the implementation of measures suggested by the experts and agreed upon by the firms and waste authorities has not yet been completed (MUV 12/98).

2.2 Actors participating in the Advisory Programme

The programme was developed by a steering committee formed by members of the responsible State Ministry for Environment and Traffic of Baden-Württemberg as well as the state-owned Waste Counseling Agency. The programme was supported by industrial and commercial associations. The 150 firms, respectively 152 plants, which were finally selected for the programme, cover nine sectors. The entire programme was co-ordinated by a private firm of consulting engineers. They also were responsible for the quality of counseling the firms received. In order to secure implementation of the suggested measures, waste authorities and firms signed agreements.

2.3 Motivation & Acceptance

Firms received counseling free of charge. On the one hand, it mostly resulted in a reduction of depositing or recycling costs and possibly resource costs. On the other

hand, the programme imposed costs on firms as the measures suggested by experts had to be eventually implemented. Apparently, many firms also participated to gain a specific image.

The state's motive of starting such a programme is, of course, to reduce the overall amount of waste. In a dynamic perspective, the state also gained sector-specific data on the potential to reduce hazardous waste. This know-how which can take the form of benchmarks for specific processes can be utilised in regular licensing procedures.

An advisory programme is a voluntary measure. Consequently, acceptance by industry was relatively high. About 50 % of the firms asked to participate directly offered co-operation in the programme and implementation of the measures suggested by the experts.

2.4 Examples of the prevention of cooling lubricants used in the metallic working sector

In the framework of the Advisory Programme cooling lubricants and other wastes were examined in respect to their prevention and recycling potentials. Cooling lubricants mostly arise in the metal-working industry. They are quantitatively the most important hazardous type of waste. In total, the ministry selected 23 firms (with over 2,100 machines) from this sector, in which individual analyses were carried out.[7] For almost 74 % of the metal-working machines, water-mixable cooling lubricants were employed.[8] The main production processes were turning and grinding (about 50 %). (MUV 1996)

Companies of different sizes took part in the programme. The main focus was on companies with more than 500 staff members.[9] The waste quantity of cooling lubricants in the analysed companies was about 10,000 t per year (as of 1994), including waste contaminated with cooling lubricants, e.g. chips and sludge.[10]

Almost the total quantity of cooling lubricants which was not reprocessed internally[11] and re-used, was recycled externally (97 %). The largest part (76 % of the recycled quantity), which consisted of metal shavings contaminated with cooling lubricants, was recycled in foundries and steel works. Small quantities were used as a substitute for fuel in the cement industry.

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[7] None of the analysed plants required a license according to the Federal Immission Protection Act.

[8] The other firms use non-water mixable cooling lubricants (23 %) or carry out a dry treatment or a minimal quantity cooling lubrication (3 %).

[9] Small firms (<250 employees,7 firms); medium-sized firms (250-500 employees, 5 firms) and large firms (>500 employees, 11 firms).

[10] Furthermore, quantities of cooling lubricants arose which were treated internally (mostly in emulsion splitting plants).

[11] A treatment of cooling lubricants becomes necessary if they remain under certain quality limits due to the high thermal stress, the non-intended increase of finest metal particles, organic impurities, etc.

In total, the experts recommended 70 measures within the programme, through which the quantity of waste for disposal or external recycling could be reduced by 670 t/a (28 %). Thirty-eight percent of cooling lubricant waste can be avoided only through measures prolonging the service life. Through membrane processing, a further 6 % can be avoided (MUV 1996).

Besides the saving of cooling lubricants resulting from the programme considerable quantities of water (almost 1,800 t/a) and waste water (approximately 1,200 t/a) were also saved. In total, the metal-cutting industry could achieve energy savings of 16,000 kWh per year due to the recommended measures.

The way of preventing cooling lubricants varies from company to company. Depending on the size of the company, manufacturing processes, requirements of the product being manufactured, the age of the machinery, measures already taken for the reduction of cooling lubricants, etc., different measures are efficient. There are four principal ways how waste from cooling lubricants can be avoided:

- optimisation of the management of cooling lubricants;
- conversion to metal-working processes without using cooling lubricants or to minimal quantity cooling lubrication;
- prolongation of the service life of cooling lubricants through maintenance of cooling lubricants (e.g. ventilation) inclusive management of cooling lubricants;
- treatment and re-use of cooling lubricants in the plant (e.g. through mobile installations for bath maintenance).

In the annex to this study four concrete examples for the prevention of cooling lubricants are described which have been conducted under the Advisory Programme (see Annex, chapter VIII2, Germany)

2.5 Results of the Advisory Programme

Implementation

In the framework of the Advisory Programme, 152 plants have been analysed, of which 23 plants are from the metal-working industry. For 98 of all plants (64 %), and for all plants from the metal-working industry, with the exception of one, directly transposable measures could be proposed. Eighty-three plants, i.e. 85 % of the plants, for which measures have been taken, have already implemented the measure. Eighty-nine per cent of the plants in the metal-working industry already implemented the recommendation (as of 1998). The measures to be implemented were agreed upon in statutes between 21 plants and authorities (MUV 1998).

Economic Results

Economically, two general aspects are relevant: costs of the actual measure occurring to the individual firm and information costs for the firm on relevant data as well as measures. Costs of measures were not reduced by the programme, but information costs were lowered considerably. The programme revealed that information costs can hinder waste reduction as waste is generally no crucial concern of the firm. Therefore, the Advisory Programme can mobilise relatively high potentials of waste reduction with little funds.

For the firms the programme is economically interesting as waste reduction measures often include a reduction of inputs and thereby lower resource costs of firms. The example of cooling lubricants shows that measures for the prevention of cooling lubricants have an above-average cost-benefit ratio (see more details in the Annex to this study.

Environmental Results

The Advisory Programme was not primarily focused on prevention, although it could be implemented just as well with such an exclusive perspective. The programme yielded benchmarks for certain industrial processes and sectors. As these benchmarks could be incorporated into the general permit procedures of plants, waste reduction potentials were much higher than the actual reduction covered by the programme.

In most cases, the recommended measures, which can be implemented on a short and medium term basis, showed prevention and recycling potentials varying between 20 and 70 %. Prevention and recycling potentials of long-term measures came partly to over 90 %.

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3 Horizontal Measure: Elimination of Chlorinated Hydrocarbons

The four most important chlorinated hydrocarbons, tetrachloroethylene, trichlorethylene, dichloromethane, and 1,1,1-trichlorethane, are extensively used. They have become notorious due to their toxicity and their adverse impact on the environment. Apart from 1,1,1-trichlorethane, all these compounds are carcinogens or at least suspected to cause cancer. Resulting from its high persistence in the atmosphere, 1,1,1-trichlorethane contributes to the depletion of the ozone layer. Also, the disposal of these substances is problematic, because incineration leads to negative environmental effects, such as the release of dioxin.

These chlorinated hydrocarbons were used extensively as solvents. For example, approximately 248,000 t of the four substances were used in Germany in 1982, about 70 % as solvents in degreasing plants [UBA 1985]. These figures demonstrate the importance of the degreasing process in contributing to the use of chlorinated hydrocarbons. The largest sector, metal degreasing, has been selected as an example for closer examination.

3.1 Measures: Legal provisions to limit the use of hydrocarbons

To restrict negative impacts of these hazardous substances, the Federal Government took several legal steps. In 1986, an **ordinance was enacted limiting emissions of volatile halogenated hydrocarbons** (Second Federal Immission Control Ordinance), to which the aforementioned substances belong to.

With this ordinance, the amount of halogenated hydrocarbons which could be employed was restricted, and the use of trichlorethylene was completely banned in certain plants. Furthermore, the ordinance contained a number of specifications for technical equipment and operating methods as well as for self-control and monitoring.

The requirements were made stricter by the 90 and 91 amendments to the Second Federal Immission Control Ordinance. The **ban on chlorinated hydrocarbons was also extended.**

An **Ordinance on the Disposal of Used Halogenated Solvents [HKWAbfV]** followed in 1989. These compounds are halogenated hydrocarbons, which are only used as solvents. The main obligations of the ordinance are:

- to keep halogenated solvents separate;
- to ban the mixing of solvents among themselves, with other substances or waste;
- to take back used solvents; and
- to label solvents in packing drums.

Several German States set up waste consultant agencies, commissioned research on the prevention of these substances, and initiated promotion of programmes, which served for the search for substitute substances and new cleansing procedures (aqueous cleansers and cleansing systems, water-hydrocarbon emulsions, plasma degreasing) as well as for providing the financial support of firms during their conversion.

3.2 Environmental results

First of all, the legal measures were aimed at reducing air emissions and at improving the recycling of used chlorinated hydrocarbons which had been employed as solvents. At the same time, this led to a decrease in the consumption of these substances, e.g. in metal degreasing. Thus, the waste volume containing these chlorinated hydrocarbons also decreased considerably. Waste is still generated, but it no longer contains halogenated hydrocarbons. For example, it contains oil-water mixtures, used in degreasing with aqueous cleansers.

Due to the measures taken, the consumption of the aforementioned chorinated hydrocarbons dropped to approximately 63,500 t (55,000 t fresh substances, 8,500 t recycled material) in 1992. The amount reduced from the metal degreasing sector was about 25,000 t. [Enquete 1994].

The waste amount decreased coorespondingly. For instance, in Baden-Württemberg 13,400 t halogenated solvents and solvent mixes was generated as waste in 1987. In 1990 it was not more than 8,100 t, and in 1992 only 2,748 t of this hazardous waste was generated. The measures can thus be regarded as very successful.

3.3 Economic results

The Second Federal Immission Control Ordinance and the Ordinance on the Disposal of Used Halogenated Solvents were the main factors contributing to the declining use of chlorinated hydrocarbons as solvents and the conversion to other systems. In particular, the Second Federal Immission Control Ordinance led to comprehensive and expensive investments to update old plants so that they comply with new requirements.

Furthermore, the operational costs resulting from a continued use of chlorinated hydrocarbons as solvents rose considerably. Thus, the use of chlorinated hydrocarbons no longer presented a cost advantage as compared to the use of alternative systems. According to the Enquete report, [Enquete 1994] cleansing costs with alternative systems (without chlorinated hydrocarbons) are not higher than those of plants operated with clorinated hydrocarbons, which were converted with state-of-the-art technology.

Not only the costs of conversion of old plants and the operation of plants were decisive for the decline of usage. Increased investment costs for new plants also contributed to this situation. For example, the investment costs of simple vapour degreasing plants, which were operated with chlorinated hydrocarbons as a solvent, increased tenfold and purification plants for multi-stage processes by about a factor of two to three [Enquete 1994]. Under these conditions, the construction of new plants was only taken into consideration if the use of chlorinated hydrocarbons could not be prevented.

Consequently, competitive disadvantages for plant operators have led to competitive advantages for plant manufacturers. Additionally, plant operators will have an advantage over their European competitors if they update their plants early to alternative systems under the aspect of a tightening of European Law [Enquete 1994].

Follow-up costs resulting from the former use of halogenated hydrocarbons, must also not be neglected. These costs include expenses resulting from damage to health and the environment, and costs resulting from the clean-up of contaminated sites. For example, most of the sites with metal degreasing plants had to be extensively decontaminated (soil and groundwater). The costs for this cleanup had to be borne by the firm, provided that it still existed, or by the state or municipalities.

The example of the Bosch and Siemens Household Applicances GmbH, Berlin Plant, which converted its degreasing plant from trichlorethylene (tri) to aqueous cleansers, demonstrates:

- the relevant reasons for the conversion;
- the technical challenges to be addressed;
- the achievements regarding waste reduction; and
- the economic repercussions for the company.

3.4 The example of Bosch and Siemens household appliances GmbH, Berlin Plant

Until the mid-80s, the Bosch and Siemens Household Appliances GmbH (BSH), Berlin Plant, was operating a degreasing plant for their metal components. Trichlorethylene was used as a solvent and was not recovered. The plant was redeveloped in 1988 and after that continued to use trichlorethylene, which was now recovered.

Although the plant met the technical requirements, the BSH decided in 1990 to demolish it and construct a new degreasing plant, which currently degreases metal components with aqueous cleansers.

Reasons for the conversion

According to the BSH, economic as well as ecological reasons were the decisive factors in the conversion of the degreasing process with trichlorethylene to aqueous cleansers. The Ordinance on the Limitation of Emissions from Volatile Halogenated Hydrocarbons (Second Federal Immission Control Ordinance) and in particular the Ordinance on the Disposal of Used Halogenated Solvents [HKWAbfV] were responsible for this development. According to Art. 2 of the Second Federal Immission Control Ordinance as of 21 April 1986 the use of the solvent trichlorethylene was allowed only until 30 June 1990.

The use of tetrachlorethylene instead of trichlorethylene as a solvent was rejected for safety reasons. The disposal of the solvents was not considered as safe in the long term. The BSH doubted that the use of other than aqueous solvents would meet future environmental requirements.

The firms concerned did not contact the waste consultant agencies or make use of other measures on the States level. They did not apply for financial support either.

Difficulty in the conversion of solvents

The objective of the BSH was to build a degreasing plant which complied with the principle of integrated environmental protection. The plant should generate as little waste as possible and the waste should be recyclable. For example, the cascade backwashing should use water as economically as possible. In order to save energy, excess heat should be recovered by means of heat exchangers. The plant should be also be cost-effective.

Since such plants and cleansers which met the aforementioned requirements were not available on the market at that time, extensive research was necessary. This research was made either by each firm itself or in co-operation with other firms. For example, in co-operation with the Henkel company, the BSH developed a new cleanser, a neutral solvent which is demulsifying and silicate-free. With the BP company, punching and drawing compounds were adjusted to the cleanser in several steps. The result was a biodegradable vegetable-based oil.

In the beginning, the difficulties were tackled at the level of the laboratory and could be solved later to a large extent. Later, fine adjustments and optimisation were executed in the degreasing plant. Since small parts, amounting to less than 10 % of the parts to be degreased, could not be cleaned and dried, their processing was converted in such a way that they no longer needed to be degreased.

Results

Due to the conversion, the consumption of trichloroethylene dropped from 25 t in 1989 to zero t since 1990. Replacing the 40.4 cubic meters of oil containing trichloroethylene waste in 1989, 40 to 50 cubic meters of halogen-free oil-water mix needed to be disposed of since 1990. The process for disposing of tri-containing oil was to return it to the supplier who then forwarded it to a disposal service for incineration. The oil-water mixture now generated is separated by a process of fractionated distillation. Depending on its quality, the separated oil is either reused or recycled (energy-related). The aforementioned statistics reveal that the conversion has considerably mitigated environmental impacts.

Table IV.3 Tri consumption and waste volume

Year	Tri consumption	Waste volume	
		Tri-containing oil LAGA key no. 55213 EAK key no. 140102	Oil-water mixture LAGA key no. 54408 EAK key no. 120301
1987	58.2 t	Ca. 90 m^3	-.-
1988	45 t	Ca. 70 m^3	-.-
1989	25 t	40.4 m^3	-.-
Since 1990	-.-	-.-	40-50 m^3

The conversion not only positively impacted the environment, but also, according to the BSH, considerably influenced the financing of the plant. The investment costs for the construction of the degreasing plant as well as the running costs were considerably lower than the projected costs of a degreasing plant operated on halogenated hydrocarbons.

The BSH gives a proportion of trichloroethylene to aqueous from nine to one which are calculated into the costs of capital and daily operations. This means that the costs of capital and daily operations with the trichloroethylene degreasing process were nine times higher than those incurred from the current degreasing procedure with aqueous cleanser. According to the BSH, the main reasons for higher costs were the cost of trichloroethylene, the discharge costs of the tri-containing oil and costs of ensuring safe working conditions. The savings in costs of running the plant amount to about 0.26 million EURO per year. The degreasing plant itself was more cost-effective by a factor of four than a plant operated with halogenated hydrocarbon. Thus, the conversion resulted in considerable positive economic effects.

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V Italy

Before starting the analysis of specific examples of waste prevention and minimisation, a short introduction about the Italian waste situation is given. In 1995, industrial waste production in Italy was approximately 35 thousand tonnes per year, of which a third can be classified as hazardous.

In 1997, municipal waste production in Italy amounted to approximately 26.6 thousand tonnes, equal to about 462 kg per inhabitant per year (see Table V.1.). After the rapid growth of the 70's and 80's, waste production stabilised partly for structural reasons, such as the smaller growth of the tertiary sector and consolidation of consumption, as well as for reasons deriving from economic recession and the ensuing decrease in household consumption.

Table V.1 Municipal waste production in Italy (t/a)

Year	Tonnes per Year	kg per inhabitant per year
1993	26,386,422	462
1995	26,055,507	455
1997	26,605,200	462

Source: Ministry of the Environment (for 1993 and 1995 data), while the source for the 1997 data is the Osservatorio Nazionale sui Rifiuti- Agenzia Nazionale per l'ambiente (1997).

From 1995 to 1997 there was a considerable increase of separate collection and recovery of municipal waste, with the national average increasing from 6 % in 1995 to 9.4 % in 1997. In 1996, more than 100 municipalities had already attained the goal of 35 % of waste collected separately (as required by law for 2003).

1 Municipal Waste: Reduction through Home Composting

The municipal organic waste fraction accounts for about 30-35 % of the total household waste and is mostly disposed of in landfills. Several problems are connected with this kind of disposal, such as biogas production, difficulties in running the installations and the environmental impact on the neighbouring inhabitants.

Separate collection of organic waste has become very popular in many parts of Italy. Meanwhile, there are areas where the separation of the organic fraction from the inorganic one is not necessary, because virtually every family unit self-disposes of its own organic fraction by home composting. Thus, part of the municipal waste turns from waste into resource. This case study describes the favourable effects of home composting, the quantity of substance removed from the waste stream and lastly the circumstances under which home composting has achieved its best results, in order to promote an exemplary model to communities in Italy and other EU Member States.

1.1 Home composting

The self-disposal of organic waste can be made by the households in many ways, thus enabling the best adaptability to the environmental circumstances of each area.

In detail the most common systems are:

- **Composting pit**: waste is put into an aired hole dug in the ground;
- **Composting box**: waste is put into a construction, usually wooden, on ground;
- **Manure pit**: this is the traditional system, used especially by those who add the organic fraction disposal to the one resulting from farming or cattle-breeding;
- **Dunghill**: without any supporting framework, the organic waste is heaped and regularly turned over. That's the easier system and the one that achieves the best results;
- **Composter**: this is a specific container made of stiff plastic or metal cage.

In any of these cases, the observance of some simple rules (recurrent turning over, correct mixing, proper airing, observance of ripening times) avoids nasty smells and produces, at the end of the composting process, an excellent organic fertiliser for plants.

1.2 Examined areas

In order to consider the effects of home composting, we have gathered data and information from two Municipal Administrations that have achieved a remarkable percentage of home composting support by the family units.

All data gathered have been then examined in connection with the size of the municipal territory, the territorial context, the separate collection and other variables. Martellago (Ve), the largest community selected for this case study, is located in Mestre hinterland and is very urbanised. Some features of the municipalities examined are shown in Table V.2 below.

Table V.2 Features of the municipalities examined

Municipality	Area (km^2)	Inhabitants	Households
S. Giustina in Colle	18	6,300	2,000
Martellago	20.9	18,834	6,200

Besides looking at the two case study municipalities, we have also taken into account experiences from 57 municipalities in Lombardia. Their administrations, collaborating with the co-operative La Ringhiera, have started a big promotion of home composting by delivering composters to the households. In this case we investigated only a few aspects, due to the peculiarity of this example.

1.3 Promotion of home composting through information campaign

Both, Martellago and S. Giustina in Colle conducted informative campaigns, aiming at reaching all the citizens, because all the citizens that had never self-disposed of the organic waste needed to learn how to work with the systems and avoid problems as well as drawbacks.

The campaigns were conducted by means of sending leaflets to citizens, holding informative public meetings and using placards and banners (the last two turned out to be very successful methods to involve people). Together with the information, citizens received a form to declare they would do home composting and give up using normal bins for organic wastes. In both cases it also turned out to be useful to combine home composting information with sensitising people on separate collection of waste.

The 57 Lombard municipalities decided to act in two phases:

- First, a small group of inhabitants started home composting;
- The results achieved have then been advertised and the practice thus extended to all households.

In both phases about 3,000 composters (300, 400, 600 lt. of capacity) were delivered for free. Using composters allows the practice of home composting in areas where houses are very close to each other.

1.4 Fiscal initiative

In the municipalities of Veneto, composting - and thus minimisation of household waste - is rewarded with less waste tax to be paid by the inhabitants. The chance to gain a reduction in the waste tax was essential to get the inhabitants' support. In fact, **the higher the reduction was, the higher the percentage of support**, as Table V.3 shows.

Table V.3 Support for home composting

Municipality	Fiscal reduction	Support (Participants*)
S.Giustina in Colle	33 %	75 %
Martellago	20 %	45 %

*in relation to all households

These data must also be compared to the typology of the settlements in the municipalities. For instance, at Martellago there are mostly apartment buildings without gardens.

Field inspections have also been used, as basic instructive means, to verify the disposal of the organic substances and to check whether the people who are composting have any problems. Some municipalities have checked all households, while others just a sample. Generally, the number of households misusing the composters has been very low and has tended to decrease as the inspections were carried on. The households who made mistakes in composting amounted to a mere 5 %.

1.5 Environmental results

One way to show the effects of home composting on the municipal waste amount can be made by comparing the situation before and after home composting was introduced into the municipalities investigated. The comparison demonstrates that the reduction of organic waste through home composting achieved up to 71 % of the original municipal organic waste (Table V.4). In the case of the Lombard Municipalities, the analysis of data gathered from the citizens of the co-operative La Ringhiera showed that an average family (3 - 4 persons) with a garden of 300 - 400 m^2 put about 1,300 kg organic waste per year into the composter, of which approximately 1,000 kg was the green fraction from the garden and 300 kg can be allocated to the organic fraction from the household.

Table V.4 Organic waste reduction through home composting

Municipality	Organic waste		Reduction of organic waste collected	
	Without home composting (kg/year)	with home composting (kg/year)	(kg/year)	%
S. Giustina in Colle	383,900	111,600	272,300	71.0 %
Martellago	2,321,000	1,080,350	1,240,650	53.4 %

Before home composting was introduced organic waste had been estimated (but not measured separately) to account for 30 % of the whole municipal waste, while the other data have been measured exactly.

Home composting can essentially contribute to waste minimisation which can be seen when comparing the total municipal waste with the home composted organic waste. Table V.5 shows that the waste reduction achieved could total up to 23 %.

Table V.5 Reduction of total waste amount achieved through home composting

Municipality	Support (in %)	Total waste (1997) (kg/a)	Home composted organic waste (kg/a)*	Total waste reduction (in %)*
S.Giustina in Colle	75 %	1,173,000	272,300	23.2 %
Martellago	45 %	7,736,000	1,240,650	16.0 %

* Figures of 1998

1.6 Economic benefits

The only investment made by the municipalities we have considered were the costs for the informative campaign on home composting. The average expenditure for the informative campaign, including the project and the illustrative material, amounted to 0.52 EURO per inhabitant (6,197 EURO for a municipality with 12,000 inhabitants). The managing costs for the households supporting home composting are included in the whole managing costs of the separate waste collection.

Some administrations who decided to inspect all the family units by employing municipal personnel or „social workers" made further investments. This non-quantifiable expenditure, however, has been paid off by the savings from the minimised disposal costs. The savings for the municipalities resulting from lower disposal costs, based on reduced amounts of organic waste to be disposed, are illustrated in Table V.6, below.

Table V.6 Savings through home composting (1998)

Municipality	Organic waste not disposed with municipal waste (kg/a)	Average cost of disposal onto landfill (EURO/kg)	Average waste transport charges (EURO/kg)	Total savings (EURO)
S.Giustina in Colle	272,300	0.06	0.02	22,599
Martellago	1,240,650	0.06	0.02	102,967

Moreover, there was a higher reduction of waste where the municipalities also motivated the self-disposal of brushwood, as at Santa Giustina in Colle (23.2 %). In all municipalities investigated, home composting turned out to be a basic means to manage and promote separate collection. The good effects of home composting combined with the ones coming from separate collection, lead to a synergistic effect.

The benefits implied by home composting have been:

- reduction of organic waste the municipalities have to dispose of and consequently a reduction of the environmental and economic impacts;
- increase of separate collection by the households, which has, as induced effect, more than doubled, based on all households (from 30-35 % to 70-75 %);
- local administrators had the chance to meet residents and ask for their willingness to co-operate in waste minimisation.

Home composting achieved best results in the areas with scattered houses and garden or a small green area. In small towns with a great availability of green open spaces home composting could replace almost totally the collection of organic waste. The investment expenditures have been compensated by the reduction of costs of organic waste collection and disposal. Besides, use of fertiliser created by self-disposal of organic waste has slowed down soil impoverishment caused by the removal of humus and organic substances produced by the gardens.

2 Industrial Waste: Solvents Reduction in Tannery Waste

Italy is the leather sector's most important location in Europe in terms of establishments, employment and production. Spain ranks second, with France, Germany and UK accounting for most of the other European leather industry firms.

Tanneries in Europe are mostly small and medium sized enterprises of which only about 10 % employ more than 20 people. Most often, companies are family businesses with a long tradition.

2.1 Tanneries Area of Arzignano

The Italian tannery industry is composed of 2,400 firms which employ 25,000 people. In 1997 revenues amounted to 5,680 million EURO. The production in 1997 amounted to 189 millions m^2. (see Table V.7, below). In 1997 the revenues of the leather industry amounted to 5,547 million EURO.

Table V.7 Leather production in Italy in 1997

	Amount
Leather sole	54,000 tonnes
Bovine hides	132 mio m^2
Calf hides	15.5 mio m^2
Ovine hides	21.8 mio m^2
Goat hides	18.4 mio m^2
Others	1.3 mio m^2
Total amount	189 mio m^2

Table V.8 Leather products in Italy in 1997

Products	Millions m^2	%
Shoes	95.0	50.3
Furniture	35.5	18.8
Clothing	27.1	14.3
Leather goods	28.4	15.0
Others	3.0	1.6

The industrial area we are focusing on is located in the Valle del Chiampo (in the province of Vicenza) and includes 10 municipalities. More than half of the tanneries are in the municipality of Arzignano.

The tannery area of Arzignano began growing after the second World War. Former textile installations were renovated and restructured into small or medium tanning companies, whose number grew from 80 (with 1,091 employees) in 1951 to 761 (with 8,420 employees) in 1997. This tanneries area is one of the biggest in Europe and provides 50 % of the Italian production. The manufacturing concentrates on bovine hides (90 - 95 %) for shoes, furniture and other leather goods.

Table V.9 Tanneries Area of Arzignano (1997)

Employees	8,420
Tanneries	761
Revenues	2,851 million EURO
Export	1,059 million EURO (40 %)
Average number of employees	11
Production market	Italy, Germany, United States
Finished product	About 77,000,000 m^3

Because of the utilisation of large quantities of chemical compounds during several phases of the tanning process, tanneries have a strong environmental impact on air and water pollution and generate high quantities of toxic waste. The main polluting agents are chromium, sulphur, chlorides and solvents as reported by the Department of the Environment (Province of Vicenza). Organic waste is also produced.

During the beamhouse process (separation of raw hide components and liming) 50 - 60 % of the whole organic load in effluents is generated (75-80 % of chlorides, 100 % of sulphur, 50-60 % of suspended solids and 70-80 % of nitrogen compounds in effluents). During the tanning process high amounts of chrome are discharged in solid waste and effluent (Buljan et al., 1998).

The use of solvents in the finishing process produces organic compounds, either volatile or suspended in the effluents. This process encompasses two phases: covering and fixing (the pelts are put into a special box in which they get sprayed with paints and chemicals). The covering phase aims at colouring, covering and making hides full and dense. It needs the largest quantity of chemicals (from 6 to 30 wet gram per ft^2). In the fixing phase, chemicals (from 1 to 3 wet gram per ft^2) give the hides compact and long-lasting qualities.

The 1995 data show that the chemicals used per year in the spray finish process amounted to 20,000 tonnes (85 % in the covering phase, 15 % in the fixing phase). It

is notable that up to 80 % of the solvents used in this phase become hazardous waste under the EWC hazardous waste code (code-no. 07 03 04).

In 1997 the Department of the Environment (Province of Vicenza) pointed out the environmental problems coming from the spray finish process and suggested possible interventions to improve the situation. They set out two main directions: introducing innovative machines (such as low pressure airbrushes or high pressure airless airbrushes instead of high pressure airbrushes), and using chemicals dissolved in an aqueous solution.

This case study focuses on the measure introduced in the spray finish process by the Gruppo Conciario Veneto, consisting of the reduction and replacement of metoxy propanol, a toxic solvent.

2.2 Reduction and replacement of Metoxy propanol in the finishing process

The Gruppo Conciario Veneto includes 4 companies - La Veneta, Conciaria Adriatica, Sacpa and Veneta Conciaria Valle Agno - with a total of 340 employees in 26,500 m^2 of indoor plants. Sales amount to 103 million EURO per year.

In the Veneta Conciaria Valle Agno tannery the utilization of the solvent *metoxy propanol* has been reduced and replaced with alternative substances.

Metoxy propanol is the solvent generally used in the tannery industry; it is a class III hazard (maximum allowed emission 150 - 300 mg/standard m^3) under Italian law. The Italian law rules[12] establish five classes (in a decreasing order of hazardousness) depending on the maximum allowed emission of each substance. Solvents used in tanning are thus classified:

- Metoxy propanol - class III (150 - 300 mg./standard m3)
- Isopropyl alcohol - class IV (300 - 600 mg./ standard m3)
- Butyl acetate - class IV (300 - 600 mg./ mg./standard m3)
- Ethyl alcohol - class V (600 - 1,200 mg./standard m^3)

An alternative soaking solvent has been tested in order to optimise the spray finishing process and reduce the toxicity of the waste generated.

Components of the solution for the finishing process are:

- 900 shares of water;
- 100 shares of isopropyl alcohol (instead of metoxy propanol);
- 30 shares of other, less harmful solvents.

[12] Ministerial Decree on 12/07/1990 "Guidelines for the control of the polluting emissions from the industrial plants and for emission limits".

Since August 1998 other solvents have also been tested, and testing is still under way. Table V.10 and the respective illustration show the amount of the solvents that were used in 1998.

2.3 Environmental results

In detail, the use of Metoxy propanol has considerably decreased from 7,300 kg before and in August 1998 to 1,300 kg in December 1998, a reduction of 82 %. It has been partly replaced by the less hazardous Isopropyl alcohol and Butyl acetate (class IV solvents) which have therefore increased in consumption (see Table V.10). Nevertheless, the total amount of solvents decreased from 10,650 to 5,007 kg per month (53 % reduction). Correspondingly, lower quantities of hazardous waste have been generated in the Veneta Conciaria Valle Agno tannery (no quantitative figures available).

Table V.10 Solvents consumption in kg (1998)

	Metoxy Propanol	**Isopropyl Alcohol**	**Butyl Acetate**	**Ethyl Alcohol**	**Total amount of solvents**
August	7,300	1,030	20	2,300	10,650
September	3,520	1,100	139	600	5,359
October	3,000	600	114	2,350	6,064
November	2,600	2,200	633	2,100	7,533
December	1,300	2,000	97	1,610	5,007

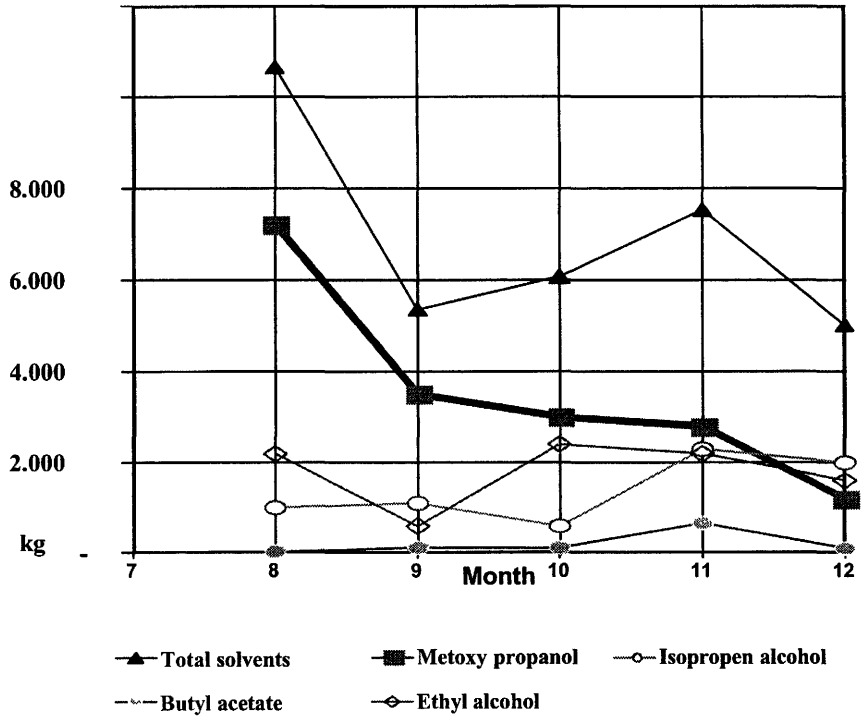

Illustration V.1 Decrease of solvents (1998)

2.4 Economic benefits

The reduction in the amount of the solvents used lead to substantial economic savings achieved during the testing phase. The monthly expenditure for solvents consumed decreased from 10,509 EURO in August 1998 to 3,794 EURO in December 1998 (see Table V.11, below), which corresponds to a reduction of expenditures by 64 %. The savings achieved have been the main incentive to the company's innovation.

Table V.11 Savings

Monthly expenditures for solvents in the spray finish process (in EURO)	
August	10,509
September	5,247
October	5,240
November	6,020
December	3,794

3 Industrial waste: Reduction of hazardous substances in the sludge of wood paint

The painting of wood has a high potential for waste minimisation in terms of both amount and hazardousness of waste in virtually all EU Member States.

The final stage in the manufacturing process of wooden furniture consists of the painting / spraying and smoothing of the surface in order to make wood sufficiently polish and shielded and to enhance its aesthetic qualities. During this stage a considerable amount of mud and sludge is generated (especially from use and cleaning of the spraying machine), with a high content of heavy metals, solvents and other hazardous substances. The mud and sludge are usually either incinerated or disposed of in special landfills for toxic wastes.

This case study focuses on the painting of wood in a single firm (Mobileur) that manufactures pieces of furniture and has managed to reduce the hazardous substances in their sludge by improving the production process and using new water soluble paints (currently the use of water soluble paints for wood paints in Italy accounts for a mere 5 % of the total production). The company Mobileur was founded in 1990. It manufactures technological pieces of furniture and end-products such as doors and tables. The plant examined is located in the industrial area of Oderzo (province of Treviso), in the middle of Veneto. The whole area of the plant is 10,000 m^2. The company has 36 employees.

3.1 Measures taken

The production cycle at Mobileur comprises the following stages:

- sawmill;
- pressing;
- square-beading;
- roller coating (painting) and smoothing;
- manufacturing of frames;
- fitting up.

In 1998 the company introduced a new paint, instead of continuing use of conventional paints. In detail, during the roller coating stage, the new paints used have a lower volatility of organic substances and are based on acrylic instead of containing solvents. New glues have also been used since 1998.

The painting technique has also been optimised so that paints can be applied in thinner layers than before. The consumption of paints could be reduced and consequently the generation of hazardous waste. Also, since the spraying machine needs less cleaning now, less sludge is produced from the cleaning process.

The firm's introduction of these new paints was largely due to the motivation to minimise the hazardous substances, in order to develop an eco-friendly image. The whole market strategy of Mobileur consists of advertising eco-friendly products. The lower environmental impact the production cycle has, the more eco-friendly the finished product will be. Besides, one should not underestimate the positive economic effects of this choice (see below paragraph 3.3).

3.2 Reduction of hazardous sludge

In 1997 the sludge generated at Mobileur amounted to 13,152 kg. Although the production increased in 1998 by 10 %, only 5,645 kg of sludge was produced in that year. Apart from the reduction in the quantity of sludge, there was also a remarkable minimisation of the hazardousness of the sludge, as can be seen in Table V.12. In particular, the amount of chromium and lead, which are very carcinogenic, substantially decreased by 85 % and 92 % respectively. Notably, Etilbenzene is the only substance that has increased since 1997, while all the others have considerably decreased.

Table V.12 Hazardous substances in sludge (in kg)

SUBSTANCE	1997	1998
Chromium	61.4	8.9
Lead	68	5.7
Ethylacetate	33,500	1,650
Metilisobutilchetone	114,000	0
Metilcelosolve	23,000	1,000
Toluene	91,600	1,300
M p-xiloli	38,000	950
Etilbenzene	12,600	15,900
Cicloesanone	18,000	1,500
Buthylacetate	91,200	8,300

3.3 Cost savings

The new paints that were used turned out to be more expensive, but this cost increase was balanced by a reduction of the quantity of paint needed.

Table V.13 points out the relationship between the cost of the paint per kg and the amount of the paint that has been used. Illustration V.2 shows that the cost of paint increased 43 % during the two-year period we have considered but at the same time the amount of paint used in 1998 decreased by 60 %. In total, the cost of painting per m^2 has therefore decreased by 29 %.

Table V.13 Costs of paints

Year	Quantity of paint	Cost per kg (EURO)	Cost of painting per m^2
1997	200 g per m^2	3.51	0.70
1998	80 g per m^2	6.20	0.50

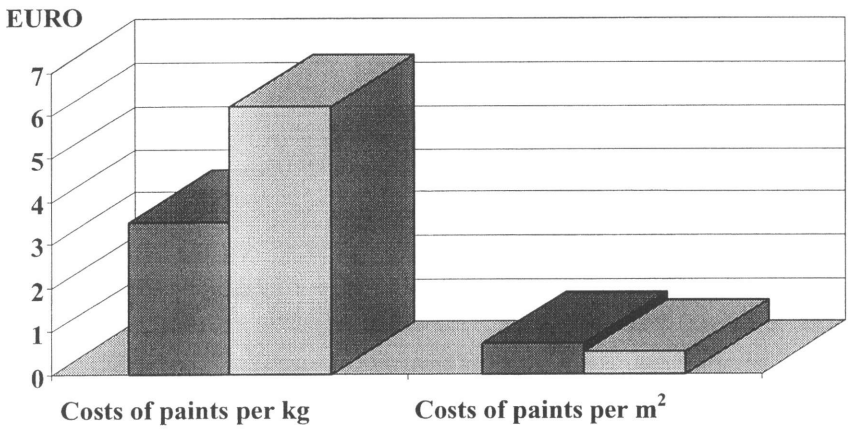

Illustration V.2 Costs of paints (red = 1997; green = 1998)

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VI Spain

1 Municipal Waste: Pilot Project Minimal Waste / Deposit Return System for Champagne Bottles

The programme "Residu Mínim" (Minimal waste) was conceived as a pilot project in 1991. Its integrated waste management concept is unique, as it provides for different collection, treatment and recycling schemes for the municipal waste fractions and also includes measures for the prevention of municipal waste generation.

The programme is applied in the following municipalities: Sant Cugat del Vallès, Torrelles de Llobregat, Molins de Rei and Montcada i Reixac, which are all municipalities in the metropolitan area of Barcelona. At the same time there is a similar - but specific- programme being applied at the Universitat Autonoma de Barcelona.

We will focus on one part of the „Residu Mínim" Pilot Project in Sant Cugat del Valles: the introduction of a deposit return system for champagne bottles. In 1996 this municipality had a population of 47,210 inhabitants and generated 25,688 tonnes of municipal waste.

„Residu Mínim" in Sant Cugat del Valles

According to an agreement between the Ministry of Environment of the Autonomous Government (Departament de Medi Ambient de la Generalitat), the City Council of Sant Cugat del Vallès and the NGO CEPA, the Residu Mínim Pilot Project has been carried out from 1992 to 1999, with a modification in 1997. CEPA was responsible for the programme management. The motivation for the political actors (autonomous Ministry, Municipality, NGO) was primarily environmental. The agreement may be interpreted as a first test for the implementation of waste minimisation as a priority, as stipulated in the Waste Law of Catalonia.

The Residu Mínim Pilot Project has taken diverse measures targeting municipal waste generation, such as:

- Environmental awareness actions in schools;
- A campaign No l'emboliquis més (don't wrap too much) aimed at the reduction of packing waste;
- Promoting the use of cotton sacks, shopping baskets and shopping carts, to reduce use of plastic sacks.
- Campaigning municipal markets in favour of the distribution of cotton sacks and raffle of baskets and carts;
- The creation and promotion of a service for lending and washing dishes (Geschirrverleih), aimed at reducing use of disposable products in festivities and

celebrations (subsidized by the Departament de Medi Ambient). The lending-service firm is the Taller Jeroni de Moragas, a social entity for labour integration. The lending capacity was increased from 100 pieces in 1996 to 250 pieces in 1997;

- Since summer 1998 the lending and washing service of Taller Jeroni de Moragas also includes reusable plastic tumblers (subsidized by the Municipality of Sant Cugat). The lending-service started with 2,000 pieces; and
- **Introduction of a deposit return system for champagne bottles in 1996.**

We will focus on the last measure (deposit return system for champagne bottles in Sant Cugat), because this case demonstrates simple but also very effective way to minimise the generation of waste. We are convinced that these - or similar- measures can easily be implemented in other EU Member States, too.

Deposit return system for champagne bottles

A champagne bottle is a very expensive and high quality product. The bottles are standardized in the production process and are thus very well suited for reuse. In Catalonia large quantities are produced and consumed, particularly at Christmas, Saint John's Day celebration (23-24 June), during local summer festivities and on other main festivities.

In the past, used bottles were returned to the champagne producer after they were collected by ragmans. In Spain approximately 20 Mio. champagne bottles have been collected annually of which about 7 Mio. bottles have been collected in Catalonia. However, in recent years the institution of ragmans disappeared, therefore destroying the traditional reuse path. With the traditional reuse path no longer available, champagne bottles started to be commonly disposed of as household waste, or at best in street containers for glass. But this is only second best option as champagne bottles are not refilled then (packing waste generation is not prevented) but, instead, only recycled.

The introduction of a deposit return system for used champagne bottles was therefore aimed at the restoration of the old reuse path, with champagne bottles going back to champagne producers for refilling. Since introduction of the system as a pilot action in June 1996 it has been modified several times.

1.1 Operation of the measure

First period: June - November 1996

In the beginning, six retail trades, four restaurants and one catering-firm participated in the action. Citizens returned used bottles to these establishments and received 0.03 EURO/bottle as reward. During the first period the company Labore S.A. was

then responsible for collecting the empty bottles, paying the establishments 0.06 EURO/bottle. Labore S.A. then washed and sold the bottles to the champagne producing companies.

Since the start of the project "Residu Mínim," the waste minimisation team has edited an information paper called "Clar i net" (clear and clean) that is distributed to households and shops throughout the city. The team also stays in permanent contact with the association of retailers and with people responsible for the municipal market in order to improve the system.

Second period: December1996 - May 1997

During the second period, Fundació Engrunes and its local branch co-operative Miques s.l. became responsible as an intermediary for the collection and storage of the bottles. The bottles were then sold for 0.09 EURO/bottle to LABORE S.A. for cleansing. Fundació Engrunes and the Cooperativa Miques s.l. are entities with social objectives aimed at the re-integration of persons with social difficulties and problems into working society. The objective of including Fundació Engrunes was to improve the collection of champagne bottles by means of a local entity's participation.

The return of a champagne bottle by a citizen still was rewarded with 0.03 EURO. However, the retailer no longer achieved any direct economic gains as it received only the same 0.03 EURO from the intermediary. Instead, the profits for the retailer were indirect marketing gains: His name and address was mentioned in all information papers as well as in the local press describing the campaign. As the start phase was in the pre-christmas period, when more champagne is sold, this paid off for the retailer.

The collection by Fundació Engrunes was made in the retailers stores, at house entrances and glass containers. It was supported by different activities during a promotion campaign in the first week:

- A retail trade offer: one cotton sack was given away in exchange for 5 champagne bottles,
- At the glass containers: a poster asking citizens not to leave champagne bottles in the containers but *at* the containers for collection.
  This is an important step because the existence of containers for glass recycling proved to be a major obstacle for the implementation of the measure as people tend to throw any and all bottles into the container;
- At households: a flyer left at all households asking citizens to put empty champagne bottles at the front door to be picked up between 27 December and 2 January;
- A general media information campaign (newspaper, radio, flyer: „clar i net").

From 24 June to 12 July (during and after Saint John's Day) the promotion campaign was repeated.

Third period: June - November 1997 and thereafter

Investments for the design, the co-ordination of all actors and the promotion of the measure were concentrated on regular collection and no longer on single events.

A campaign for the extension of permanent return places was started. Shopping centres and other locations such as restaurants were included. Due to an increase in acceptance, a total of 25 retailers were now willing to participate (in comparison to six in the beginning). Motivation of the retailer to participate in the collection was environmentally driven as well as by expectations to raise publicity for their shop.

Since October, the intermediary was no longer *Fundació Engrunes*, but instead its local branch, the cooperative *Miques s.l.* This cooperative already had an agreement for the collection of other waste fractions (clothes,..).

There are currently plans to expand and consolidate the whole measure in the long term. It shall become a permanent activity which is independent from the end of the „Residu Mínim" project. Manyoher communities in Catalonia have already started similar activities.

1.2 Environmental results

The number of collected and reused champagne bottles has increased substantially, especially in the beginning of 1999. Table VI.1 shows how many bottles were collected between July 1996 and March 1999.

Table VI.1 Collected bottles

	1996	**1997**	**1998**	**1999**
January		1166	1534	3440
February		396	406	2546
March		364	636	1294
April		852	476	
May		469	1204	
June		515	1277	
July	240	619	1092	
August	1338	1056	689	
September		1039	952	
October	615	665	605	
November	598	430	437	
December	1088	769	1172	
Total	3879	8340	10480	(7280)

The figure also shows that it is important to start with a take-off phase because it proved to be easier to attain the interest of new participants by showing the success of the previous ones.

The lower bottle return total in December 1997, compared with the December 1996 total, indicates that promotion campaigns (such as the ones used in December 1996) are very useful tools to increase short-term motivation of the customers to return the bottles.

Regarding the establishment of different return places, it is more important for the mid- to long-term to enhance the number of regular return places, as this proved to be more successful than the glass containers and collection at the front door.

1.3 Economic benefits

The collection and reuse of champagne bottles is connected with no or few additional costs for the actors involved:

- For the Municipality: there is a small direct benefit equivalent to the cost for collection and disposal of champagne bottles;
- According to the intermediary (local co-operative Miques s.l.) the money they receive for the bottles (0.06 EURO/bottle) covers the collection costs;
- The trade receives indirect economic benefits through the increased publicity, as evidenced by the growing number of trade participants;
- For the citizen: there is a direct gain of 0.03 EURO/bottle.

2 Industrial Waste: Borse de Subproductes de Catalunya

The increase of industrial waste generated in Catalonia[13] is largely the result of the growth and intensity of industrial activities. The Spanish economy generally and the Catalonian economy in particular currently show a strong economic growth rate. This fact partially counteracts the results of prevention policies.

	Increase from 95 to 96	**Increase from 96 to 97**
Waste generation	5.7 %	8.2 %
Enterprises production	7.3 %	15.8 %

Source: Paymasa (1998)

	1995	**1996**	**1997**
Waste amount per production unit	4.94	4.86	4.54

[13] The industrial waste production in Catalonia is illustrated in the Annex to this study in chapter VIII3, Spain.

2.1 Establishment of the Borsa de Sub-productes

In 1989, the Autonomous Parliament of Catalonia asked the Autonomous Government to facilitate an exchange for the recuperation and reuse of reusable "by-products". In other industrialised zones of Spain, similar "waste-exchanges" already had some tradition. In 1991 the Government started the negotiations with the industry on the establishment of a "waste exchange for by-products". In 1992 a by-product stock and exchange market named "Borsa de Subproductes de Catalunya" was created by the Waste Agency (Junta de Residus) of the Ministry of Environment of the Autonomous Government of Catalonia, in collaboration with the 13 chambers integrated in the Council of the Official Chamber of Commerce, Industry and Navigation of Catalonia.

For the Council of the Official Chambers the goal was to create a new service for the enterprises to promote the reduction of the waste management costs (economic policy) and at the same time reduce the impact of the industry on the environment (environmental and industrial policies).

The Borsa is a free-of-charge information service open to all enterprises that produce waste in Catalonia and to all those that wish to use these wastes in the production process, be they located in Catalonia or any other part of Spain. The Borsa puts those companies which produce by-products in touch with other industries that can use the by-products as raw materials in new production processes. Thereby it acts as a mediator for the market in reusable wastes.

2.2 Functioning of the exchange

The Borsa offers data on supply and demand of reusable wastes / by-products, by means of classified advertisements. Any business that is interested in placing advertisements either offering or requesting by-products first of all needs to be registered with the exchange. When registering, the business must state the company's name, its tax number, a contact person plus his/her position in the company, and the address of the company.

Once this is done, offers and requests may be presented. These are addressed to the Exchange which then directs them to interested parties.

The service works strictly confidentially. It provides services by giving away data only one way. Only the advertiser gets to know if a company is interested in his offers. Information on the advertiser is never given away to the prospective customer, public authorities or any other interested party. Thus it is solely up to the advertiser to react on the customer's demand and thus get in contact.

The advertisement contains the following information:

- Code of the advertiser (anonymity guaranteed);

- Type of material offered or requested;
- Quality and main composition of the material;
- Generation process;
- Amount and frequency of product and production;
- Presentation (form of shipment);
- Geographical location of the by-product;
- Possible application; and
- Other exchanges where the by-product has been advertised.

The supplies and demands of reusable wastes / by-products are grouped into fifteen categories (see Table VI.2, below).

Table VI.2 Categories of by-products in the Borsa de Subproductes de Catalunya

No.	Substance	EC waste code*	No.	Substance	EC waste code*	No.	Substance	EC waste code*
01	Chemicals	06 00 00 07 00 00	06	Textiles	04 02 00 20 01 11	11	Animals & Vegetables	02 00 00 20 01 08
02	Plastics	02 01 04 20 01 06	07	Gums & Rubber	08 04 00 20 01 12	12	Oils & Mineral oils	05 00 00 13 00 00
03	Metals	17 04 00 11 00 00	08	Glass	10 11 00	13	Scrap iron & Slag	10 01 00
04	Paper & Cardboard	20 01 01	09	Skin & Leather	04 00 00	14	Diverse	
05	Woods	03 00 00 20 01 07	10	Rubble & Mining	01 00 00 17 00 00	15	Packages	15 00 00

* As defined in the EC list of waste (94/3/EC). Note: The waste code numbers may not be complete and necessarily identical for all wastes defined, as the substances of the by-product list are not (!) categorised in accordance with the EC waste list.

The coding of offers and requests uses the same system as that employed by other by-product exchanges in Spain. The producer of the by-products itself is responsible for their coding, since these can be categorised in a number of ways. For instance if a producer considers that its cartons can be used in packaging it must code it as packages. If the producer believes that the cartons are useful for paper production the cartons should be coded as paper & cardboard.

Information about the products is provided by the journal "Subproductes-revista de la minimització i la valorització de residus" with free distribution through the internet website (http://www.subproductes.com). Neither the "exchange office" nor the promoters of the borsa can be held responsible for the state of the products advertised nor as to whether they comply with applicable legal requirements.

In the scheme for the prevention of contamination, the Borsa operates between the minimisation strategies at source (responsibility of the Center of Clean Production

Initiatives, see below, chapter 3.1) and an external recovery since by-products can be used in other company's production processes without any pre-treatment.

2.3 Environmental results

The acceptance of the measure by individual users of the service as well as by the industrial societies increased with the time. This is confirmed through the steady increasing of advertisements (see results) and the participation of another eleven industrial societies as promoters for the Borsa. Because of its position as mediator, the Borsa can provide information about the developing of supply and demand advertisements (See Table VI.3).

Table VI.3 Development of the number of advertisements published (approximately)

	Jan 93	Jan 94	Jan 95	Jan 96	Jan 97	Jan 98
Supply	310	570	710	850	920	1060
Demand	120	170	270	310	350	370

According to Elies, X., Funcionament i resultats de la Borsa de subproductes de Catalunya, Borsa de subproductes de Catalunya, Barcelona, 1998

However, it has not drawn up statistics on the exchanged waste amount, its classification and developments. In order to resolve this question, a fill-in section on "by-products" was introduced in 1994 on the Yearly Waste Declaration that has to be submitted by all companies in Catalonia. Since then, there is some information available through the Borsa about the amount of waste reused by means of trading.

Table VI.4 Development of industrial waste disposal in Catalonia (Memòria d'activitats 1996 and 1997, Junta de Residus)

Treatment type*	Total 95(t)	% 95	Total 96(t)	% 96	Total 97(t)	% 97
Internal Recovery	271,449	7.3	308,029	7.5	377,070	8.1
External Recovery	913,710	24.7	1,162,164	28.4	1,497,205	32.2
By-product	745,047	20.1	709,252	17.3	824,113	17.7
Storage	34,125	0.9	83,596	2.0	46,704	1.0
Phys.-chem.-biolog. Plants	139,931	3.8	348,801	8.5	327,754	7.0
Controled disposal (landfilling)	1,356,074	36.6	1,342,351	32.8	1,444,547	31.1
Incineration	36,486	1.0	37,181	0.9	50,502	1.1
Inadequate treatment or disposal	77,649	2.1	41,303	1.0	40,350	0.9
Not specified	127,948	3.5	56,432	1.4	41,481	0.9
Total	3,702,419	100.0	4,089,109	100.0	4,649,726	100.0

*The results are partly affected by a change of criteria in 1996.

"By-product" means that these "wastes" have been traded through the exchange. It is thus possible to confirm that the amount of recuperated/reused waste through the

"Borsa de Subproductes" is approximately 17 % of the total industrial waste generated.

2.4 Economic benefits

One direct economic gain is based on the waste treatment and disposal costs which are dropped as a result of an exchange of the by-product. According to a speaker form the Borsa de Sub-productes, costs for waste treatment and disposal depend on the quality of the respective waste. Hence, the concrete benefit depends on the characteristics of the waste and its respective disposal costs. Basically, the average cost for industrial waste disposal in Catalonia can be estimated to be the following (1998):

- for physical-chemical treatment	0.07 EURO/kg
- for landfill disposal	0.03 EURO/kg
- for incineration	0.18 EURO/kg

Besides, there is a possible income for the selling enterprise in the price of the sold by-product. There is also a direct economic benefit for the purchasing enterprise that it gained through cheaper purchase of material needed for production.

3 Horizontal measure: Reduction of Toxic Sludge

3.1 The Centre for Cleaner Production Initiatives (CCPI)

As a result of the Management Plan for Special Waste (Programa de Gestió dels Residus Especials a Catalunya), the Ministry of Environment of the Autonomous Government of Catalonia created in 1994 the Centre for Cleaner Production Initiatives (CCPI). The CCPI started as an internal area of the Waste Agency but in October 1998 it became an autonomous institution. The CCPI is a tool of the Autonomous Government of Catalonia to urge and support Catalan companies to adopt practices and technologies that lead to the effective reduction of polluting waste at the source.

The CCPI objectives and functions are:

- to promote, foster and co-operate in initiatives adopted by the enterprises that aim at the effective reduction of waste and emissions in the production phase;
- to promote the concept of clean production and prevention at the source, collecting and providing information and consulting to companies; and
- to analyse and study the technical and economic feasibility of minimisation options.

In the beginning, the CCPI's main task was to care for the proper application of the Special Waste Minimisation Action Programme (Programa d'Actuació per a la Minimització de Residus Especials). This programme described priority action fields for the minimisation of hazardous wastes such as halogenated solvents, asbestos, pesticides, PCBs, waste from surface treatment, distillation fluids and "mother waters," paint, varnish and dye or substances from small laboratories and photographic sectors

The programme defines for each substance or sector:

- the total amount of waste produced (total t/a);
- the industries and activities waste and pollution sources (National Activity Code, CNAE);
- the number of enterprises with production levels > X t/a.

The programme thus identifies, where possible, the main producers and proposes methods to achieve reductions. However, as the programme lacked support from the industry, the tasks of the CCPI have changed.

Currently the CCPI:

- conducts studies and projects for the prevention of contamination at the source and also demonstration projects;
- intervenes in the management and policy of aid and subvention;
- educates and publishes flyers entitled "production & clean" (fitxes de producció & neta) describing cases applied by Catalan enterprises demonstrating the viability and profitability of the measures. Nowadays it distributes 20 flyers, and four are in preparation.

3.2 Minimisation Oriented Environmental Diagnosis (MOED)

Two main tasks of CCPI are first, the co-ordination of working-groups with participants from specific industrial sectors in order to promote information and research results about technological alternatives for the respective sector, and second, drafting of a so-called Minimisation-Oriented Environmental Diagnoses (MOED).

The MOED is an expert assessment of an industrial activity or process in order to determine possible opportunities for preventing and reducing pollution at the source, as well as feasible alternatives. The MOED constitutes a preliminary stage, after which the company will have sufficient information to decide, plan and execute pollution or waste prevention projects for each selected alternative. Once the MOED is drafted, the technical and economic feasibility of selected alternatives can be analysed carefully with regard to available technologies, changes needed during the production stages, additional need for training etc. (see the webpage CCPI at http://www.junres.es/cipn).

3.3 Financial support for waste minimisation activities

The General Programme for Special Waste defines possibilities for gaining financial support for the realisation of an environmental diagnosis and for the execution of waste minimisation projects. The financial support may be given in two ways:

- direct: aids and subventions;
- indirect: fiscal reductions.

Direct financial support

Since 1996 direct aids have been granted by the Catalan Environmental Ministry for two sorts of activities.

Category A comprises activities for the realisation of the Minimisation-Oriented Environmental Diagnosis (MOED). The amount of the direct financial support subvention is determined in each case according to the expected cost of the MOED and the size of the enterprise.

Provided that an agreement between the public administration, an enterprise and an external consultant has been reached to conduct a MOED, up to a maximum 50 % share of the cost of this procedure can be granted. For small enterprises (< 100 employees) and for MOED that cost less than 3,000 Euro the support is increased to a maximum limit of 80 %. The MOED shall be authorized by the technical staff of the CCPI before it gets supported.

Aid may also be granted for the implementation of measures and realisation of concrete projects that are not category A activities. The amount of subvention is determined in each case in accordance with categories B, C and D.

Category B comprises projects implementing process modification and technological improvements. Up to 15 % of the overall costs can be given for measures that help the company to conform with what is legally required by environmental laws and up to 30 % for measures that go beyond the legal requirements.

Financial aid up to 25 % can be given for R & D (Research and Development) projects falling under **Category C**. Measures that personally teach and inform a company's employees of activities and responsibilities related to Category B measures fall into **Category D** and can be supported by up to 40 %.

So far about 18 Million Euro have been granted as subsidies according to activities under the General Programme for Special Waste.

Fiscal reductions

Since 1997 enterprises may also receive fiscal reductions for technical investments that implement measures which follow a MOED. Ten percent of the investments of a company to reduce its air pollution, water pollution or waste generation, and thus

help the company to either meet legal obligations or go beyond these requirements, are tax-free.

3.4 Motivation of the enterprises to participate

Although there does not exist an in-depth study about the motivation of different enterprises to start programmes for waste minimisation and prevention at the source, the experience of the CCPI highlights the following main reasons:

- the possibility of economic gains because of a lower consumption of chemical products, raw materials, water and energy;
- economic benefits through improved treatment of waste and decreased disposal costs;
- changes in the enterprises' philosophy and environmental performance due to higher awareness of environmental issues;
- opportunity to renovate old technical equipment with financial support;
- local authorities in some municipalities advise enterprises to do a MOED and address them to the CCPI when issuing or revising a license.

Additionally, cleansing costs are higher than measures at source because discharges of fluids have become higher since the 1981 "Cànon de sanejament" tax was amended in 1992. A "Declaration of Discharged Pollution Charge" (DDPC) was introduced into this tax as obligatory for large industrial establishments which discharge relatively highly polluted wastewater in comparison to the average household, and also for those users whose water consumption is more than 6,000 m3/a. Industries covered by the new charge now have to pay a substantially higher charge for water discharges than before and are more interested in using low-emission technologies.

3.5 Working group Galvanic Baths

The first two working groups initiated by the CCPI were constituted with enterprises from the Galvanic Baths sector. The first working group was formed with participants from six enterprises of the *Unió Patronal Metallúrgica* between April and November 1995.

A second working group was established between November 1995 and April 1996 with participants from 11 enterprises of the *Confederació d'Empresaris del Baix Llobregat*. All participating companies were small and medium enterprises (SME). The task of both working groups was to examine application possibilities for new technologies in order to achieve a maximum reduction of waste and discharges produced.

Each enterprise obtained an evaluation of its processing procedures and alternatives for the reduction and prevention at the source in accordance with the MOED described above.

In early 1998 the CCPI conducted a study about the implementation rate of the proposals elaborated in the working groups, through consultation of the enterprises involved. This was the first and presently only evaluation of the results of the working groups. It showed that the implementation rate was fairly good with 71 % of the suggested measures implemented among the enterprises of the first working group and 59 % of the second working group (see Table VI.5, below).

Table VI.5 Implementation of all measures proposed in the working groups (in %)

	Group I	**Group II**
Implemented Measures	71 %	59 %
Non-implemented measures for technical reasons	24 %	29 %
Non-implemented measures for economic reasons	5 %	12 %

Both the results and the methodology used were evaluated positively by the enterprises and by the CCPI.

Description of the original situation at Linecrom S.A.

Linecrom S.A. is an enterprise dedicated to the treatment of plastic ABS (Acrylnitril-Butadien-Styrole) surfaces with chrome and gold. The company had 26 employees in and revenues of 2.7 Mio EURO in 1996. The company participated in the second working group to sort out options for reducing its amount of wastewater. In 1996 Linecrom S.A. produced 5,760 m^3/a of wastewater charged with sulphuric and chromic acid.

The preparation of the surfaces of ABS to give them conductivity (pre-processing bath and electrolytic chromium plating) and the physical-chemical cleansing of waste water produced in that process are the main factors for waste generation.

Table VI.6 Disposal costs (reference year 1996)

Cost of the chemical products for the waste water treatment:	19,112 EURO/a
Cost of the water consumption:	6,226 EURO/a
Sludges management cost:	17,309 EURO/a

Description of the measures implemented

In the first semester of 1996 the workgroup II on Galvanic Baths, guided by the CCPI, conducted a MOED aimed at the reduction of chemical consumption for the surfaces pre-treatment and for the wastewater cleansing, minimisation of the sludge

amount and as a consequence the reduction of the waste management costs. Saving water was another goal. The motivation of the enterprise was primarily driven by economic reasons. The MOED was 80 % financed by the authorities and only 20 % by the enterprise. The enterprise also emphasised its interest in demonstrating good environmental management. As a result of the diagnosis two main technical measures were identified:

- the installation of a static instead of a continuous swill for the recuperation of chromium
- the installation of a reverse swill cascade.

The implementation of these measures required an investment of 7,200 Euro.

3.6 Results

Table VI.7 shows the environmental results that were projected. The waste amount produced could be halved. Water consumption could be reduced by more than 98 %.

Table VI.7 Environmental balance

	Before the measure	**After the measure**
Consumption of chemical products		
- Chromic acid	9.6 t/a	2.4 t/a
- Sulfuric acid	14.4 t/a	6.0 t/a
- Lime	72 t/a	48 t/a
- Sodium bisulphite (33 %)	84 m^3/a	50.4 m^3/a
Water consumption (first cleansing)	5760 m^3/a	76.8 m^3/a
Waste production (sludge from the physical-chemical treatment	288 t/a	144 t/a

Economically the measures would also pay off. The amount of chemical substances needed for production purposes could be reduced substantially and hence spending for these substances. Cost for water consumption would drop by almost 92 % and costs for waste management would decrease by 50 %. Thus, the investments by Linecrom S.A. would pay off after about 2.3 months (see Table VI.8).

Table VI.8 Economic balance

	Before the measure	After the measure
Costs of the chemical substances		
- Chromic acid	18,752 EURO/a	4,688 EURO/a
- Sulfuric acid	2,423 EURO/a	1,010 EURO/a
- Sodium bisulphite (33 %)	12,621 EURO/a	7,573 EURO/a
- Lime	6,491 EURO/a	4,327 EURO/a
Cost of water consumption (first washing)	6,226 EURO/a	511 EURO/a
Cost of waste management (sludge from the physical-chemical treatment)	17,309 EURO/a	8,655 EURO/a
Total Costs	63,823 EURO/a	26,763 EURO/a
Annual Savings		37,060 EURO/a
Investments		7,212 EURO
Return of Investments		2.3 months

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VII United Kingdom

Until today, waste management strategies in the UK very much concentrated on the increase of recycling shares rather than waste prevention or minimisation at source.

In fact, waste minimisation in the UK often means or at least partly includes recycling activities. The following case studies, however, focus on waste minimisation at source. Unfortunately, no proper example could be found of a horizontal measure related to the elimination of hazardous substances from the waste stream. Instead, two cases from the industrial sector which are very different in terms of industrial area and measures taken, are investigated.

1 Municipal Case Study: Project Integra

Project Integra is an integrated waste management strategy for dealing with household waste in Hampshire. The project has been adopted and undertaken through a partnership between the 11 district councils of Hampshire, Portsmouth and Southampton unitary authorities, Hampshire County Council and the private contractor Hampshire Waste Services.

Project Integra includes all aspects of household waste management ranging from waste reduction and reuse to the final disposal of waste. It has been formed on the basis of a seven point action plan which includes actions on waste minimisation with particular respect on composting. It is probably the most prominent example of municipal waste-related activities in the UK.

1.1 Baseline situation

The Hampshire, Portsmouth and Southampton County Councils are responsible for the disposal of over 750,000 tonnes of household waste every year. By the year 2001 the whole region is expected to be faced with the disposal of up to 900,000 tonnes per year. The target of Project Integra therefore is to keep the waste amount at the 1995 level.

The specific goals of Project Integra are:

- to reduce the proportion of controlled waste (household, commercial and industrial) going to landfill from the present level of 70 % to 60 % by 2005;
- to achieve a recycling target of at least 25% of household waste by 2000 and 40 % in the longer term.

With respect to reduction of waste production levels, the target of the project is to keep the household waste at 1995 levels through various waste minimisation activities. Household waste means all waste collected from homes as well as materials

recycled through banks, litter, street sweepings, bulky waste collections, fly tipping and civic amenity waste[14].

1.2 Motivation for starting the Project

At the end of the 1980's it became clear that Hampshire was facing a growing waste disposal crisis. Landfills were steadily filling up while four incinerators built in the 1970's were not going to meet new EU emission regulations. These incinerators were shut down in November 1996. The existing landfill sites will be used up by the turn of the century. At the same time waste levels continue to grow.

In 1993 Hampshire County Council and the 13 district councils undertook a county wide public consultation process to take into account the views of the residents of the County on how to deal with the waste problem. The consultation process resulted in the introduction of Project Integra.

1.3 War on Waste campaign

The campaign „War on Waste" was launched in October 1996. It aims to raise public awareness on the waste problem in Hampshire and encourage people to take personal action in minimising waste, maximising recycling and increasing public understanding of the need for unpopular waste facilities.

The aim is that the logo for „War on Waste" become well known in the public and that it serve to effectively communicate the message of waste reduction and recycling.

A green bear in uniform is the mascot of Project Integra and leads the „War on Waste" throughout Hampshire County. He frequently visits schools to inform kids about the „three R's" (reduce, reuse, recycle). He is said to be particularly popular with young children.

Several other measures have been initiated within the war on waste campaign which are described below.

Trash Attack Information Guide

A small information guide called „Trash Attack" was launched in 1997. The guide was initially piloted in 3000 households. It can also be ordered for free by anybody calling the waste line. The small 16-page guide has been produced to encourage residents to reduce the generation of everyday waste in households.

The booklet provides information and plenty of suggestions, for instance, how to stop junk and advertising material being posted, why to buy re-usables and products without packages and how to avoid wasting materials at work.

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[14] According to Project Integra/HCC standard statistics.

Included in the information pack were a few re-use labels for envelopes, a door sticker „No circulars or leaflets please", a large sticker „ I've joined the War on Waste ... Remember! Reduce, Reuse, Recycle" and a leaflet headed "the general waste guide to reduce and re-using".

Education pack "Wastebusting in schools"

In 1998 a school information package was written and published by the Hampshire County Council on behalf of Project Integra as part of the project's strategy to raise awareness of waste issues. The comprehensive education pack, called „Wastebusting in Schools", was first distributed to teachers in Hampshire in May 1998 and officially launched in the region later that year.

The waste information and case studies making up the pack are designed for pupils between 8 - 14 years old to heighten their awareness and promote understanding towards waste reduction. The materials collected introduce pupils to a series of activities which explore five different aspects of waste management issues such as packaging (waste minimisation), composting, recycling, landfill and incineration.

The education pack contains „real life" case studies on the three „R's" (reduce, reuse recycle), information and explanatory activities all labelled with specific symbols. Pupils are encouraged to develop ideas on the reduction of waste generation as they can receive prizes from Hampshire County Council for sending in these ideas.

All head masters were invited for a promotion event of Project Integra to get across the meaning of the „War on Waste" Campaign in October 1998. Exhibition panels and a waste notice board could also be ordered by schools as support.

Also, a pilot waste audit guide for schools has been devised. Moreover, a review of County purchasing arrangements to identify less wasteful materials and recycled alternatives has been conducted.

Roadshow to promote responsible shopping

A „War on Waste" roadshow has been touring in many towns of the Hampshire Council particularly in 1997 and 1998. The roadshow is lead by the mascot General Waste and incorporates a waste exhibition and a touch screen computer.

Many supermarket chains and single stores in the Hampshire region joined the Project Integra campaign and supported the roadshow. For instance, Sainsbury and Asda signed up and offered waste reducing tips to their customers in the shops. Moreover, a „War on Waste" week was launched by the local newspaper focusing on one of five different key areas of waste generation each day.

Composting

Hampshire has become a leader in recycling green waste compared to other regions in the UK. Home composting has been promoted as a vital element of Project Integra's „War on Waste" campaign. Several promotion events have been held and large „do it yourself" retailers such as B & Q supported the campaign by hosting a series of instore demonstrations showing the value of home composting. However, as yet there has been no direct financial incentive given to customers to buy composter.

Nappies waste

Throwaway nappies make up about 4 % of household waste. 800,000 tonnes of nappy waste are generated in the UK annually. Reusable nappies produce 60 times less solid waste. Therefore, two NGOs started the "real nappy initiative" in the UK promoting the use of washable nappies and nappy laundering services. Approximately 20 of these services have been established UK-wide. A few communities in the Project Integra area also supported the real nappy initiative and offered nappy laundering services for parents using washable nappies.

1.4 Results

The results of the project are not yet impressive in terms of waste minimisation[15]. However, one has to keep in mind that between 1994 and 1997 the population of Hampshire County grew by over 20,000 new inhabitants (from about 1,595,000 to 1,615,000 inhabitants).

Table VII.1 Development of household waste in the area covered by Project Integra

Year	Total household waste (tonnes)	Household waste (household/year)	Household waste (head/year)
1994/95	684,556	1054 kg	426 kg
1995/96	673,765	1027 kg	419 kg
1996/97	711,400	1076 kg	442 kg
1997/98	750,853	1126 kg	465 kg

[15] The recycling levels already went steadily up by about two percent of the overall waste amount annually since 1995: 21 % of the total household waste is expected to be recycled in 1998/99 compared to 13% in 1995/96.

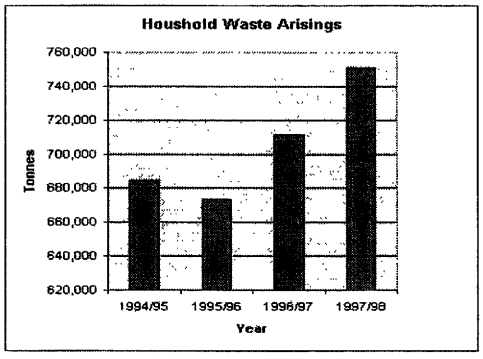

Illustration VII.1 Household waste development in the Project Integra area

The number of compost bins for home composting was 39,770 in March1998. According to market research done in November 1997 the number of households in the Integra project area who are home composting was then estimated at 39 %.

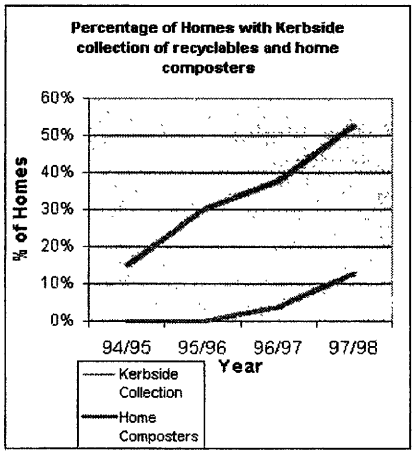

Illustration VII.2 Increase of number of households using home composters

Besides one has to keep in mind that the whole project did not start before autumn 1996 and several activities (such as the „wastebusting in schools" pack) have been initiated very recently.

1.5 New legal support for local waste minimisation initiatives

The good example given by Project Integra may find imitators in the UK soon because a new law has recently strengthened the formal position of local authorities towards waste minimisation activities. On 12 November 1998 the British parliament adopted a supplement to the Environmental Protection Act which reads:

"A relevant authority may do, or arrange for the doing of, or contribute towards the expenses of the doing of, anything which in its opinion is necessary or expedient for the purpose of minimising the quantities of controlled waste, or controlled waste of any description, generated in its area." (Article 63 A)

In the past many local authorities felt restricted being more active in terms of waste prevention because these initiatives may have been seen as *ultra vires* (outside the authorities power). Now, they not only have the formal power to promote waste prevention but can also include waste minimisation strategies within any waste plans or have clear reduction targets in waste contracts.

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2 Industrial Waste: Sand Reclamation at J Youle & Co Ltd.

Environmental Technology Best Practice Programme

Most waste minimisation activities have taken place within industry and commerce on a voluntary basis. Part of the "Environmental Technology Best Practice Programme (ETBPP)", which is jointly funded by the Department of Trade and Industry (DTI) and the Department of the Environment, Transport and the Regions (DETR), is a range of activities with respect to waste minimisation.

The ETBPP helps companies in the UK to improve their environmental performance by reducing waste at the source. The Programme is promoting the establishment of regional and local waste minimisation clubs in the UK. About 550 companies have

joined the now approximately 50 club projects achieving a reduction in waste generation of about 130,000 tonnes. The waste minimisation clubs are run at the local level by local organisations or local authorities.

The ETBPP projects generally try to achieve waste minimisation by introducing cleaner production technologies; it offers an Environmental Helpline which receives around 500 calls a week of which 100 are specifically to find out more about waste minimisation.

Two cases are presented addressing different issues and describing and evaluating the success of different measures:

1. Sand reclamation at Youle, showing substantial economic and environmental benefits in a particular industrial area that exists in all EU Member States,
2. The Swift Group Ltd. (producer of caravans) representing a good practice case that can also work in other industries.

2.1 Original situation at Youle & Co. Ltd.

Waste foundry sands are industrial waste of important quantity. In Germany, for example, 2.5 million tonnes of waste foundry sands were generated in 1990; this amount declined to 1.3 million tonnes in 1993. In France, 1.2 million tonnes of waste foundry sands were generated in the late eighties[16].

Because of the often very high contamination of these sands with polyaromatic hydrocarbons, some of them even potent carcinogens, dumping of these sands in landfills (without appropriate safety measures) or using them in road construction is problematic.

The following case demonstrates which environmental and economical benefits a small foundry operator in the UK achieved. The J Youle & Co Ltd. results have become a good practice case study under the ETBPP.

J Youle & Co Ltd is a major supplier of small non-ferrous castings in the Yorkshire area. They produce about 300 tonnes/year (1997). The company employs 14 people and has revenues of around 640,000 EURO. The company produces all types of non-ferrous castings, and specialises in small aluminium products produced by a chemically bonded sand moulding process.

Until September 1996 the production processes of Youle were based on a standard alkaline phenolic binder system using exclusively virgin silica sand. All the moulding sands were sent to landfill.

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[16] Figures for Germany from Statistisches Bundesamt, 1997. Figures for France from EUROENVIRON 1993 "are usually based on official statistics raised some years ago" (Industrial Waste Management Report, p. viii.)

2.2 New technology introduced

By the mid 1990s the company decided to update its appraisal of primary reclamation equipment. Youle had investigated the idea of using sand reclamation to reduce the high sand costs of its operating practise (which amounted to about 4 % of the revenues) some time before but had previously been unable to justify capital expenditure to purchase a primary reclamation plant.

Once finance had been arranged, Youle selected suitable equipment by competitive tender. The equipment chosen was a mechanical reclamation plant, with a vibratory attrition unit, capable of processing three tonnes of sand/hour. The equipment was installed and commissioned during August and September 1996 with little disruption to the foundry.

In partnership with its binder supplier, Youle could raise the sand reclamation level from 0 in the beginning to 70 %. During the increase in the sand reclamation rate, a detailed analysis of the sand quality was carried out.

Samples of sand at each reclamation level were analysed to compare sand strength, loss on ignition and potassium levels. Test results confirmed that the sand quality was acceptable for all moulding processes and casting operations, including core making.

The tensile strength of the sand has reduced with increasing reclamation rates, but it worked well within the range for non-ferrous casting. Similarly the loss on ignition and potassium levels have altered, but - according to Youle - have not caused any moulding or casting problems.

The binder (resin and hardener) addition rates were also adjusted to produce the optimum performance. Between September 1996 and February 1997 a number of modifications were made to the resin and hardener addition rates to achieve the optimum mould quality and therefore maintain high quality castings.

This enabled Youle to optimise the resin and hardener addition rates to minimise sand additions while maintaining sufficient mould quality. Use of reclaimed sand has not led to an increase in either internal scrap levels or customer rejection rates.

Eventually a 70 % reclamation level was achieved while reducing resin addition rates from 1.65 % to 1.5 %. Future plans are to reduce this to an even lower rate of 1.3 %.

To maintain mould quality, the binder system was upgraded to one specifically designed for high reclamation levels. In addition, the type of virgin silica sand used was changed to maintain sand strength. By February 1997 the new sand was established in the moulding line. As part of the planned programme developed with the binder supplier, Youle increased the reclamation level up to 80 %.

2.3 Motivation

The motivation of Youle to introduce new sand reclamation technologies was mainly economically driven. Not only a possible reduction of high costs for virgin sand, but also a landfill tax that was then proposed (and meanwhile introduced), made an attractive financial case for primary reclamation. Calculations showed that annual savings in excess of 30,000 EURO were achievable at a 75 % reclamation, giving a simple payback period of around 18 months.

Youle also wanted to improve its environmental performance, which meant minimising the environmental impact of its operations. Reclaiming used sand reduced the need for virgin sand for mould, thus saving natural resources, and decreasing the amount of waste sent to landfill. Transport requirements are also reduced, lowering vehicle emissions.

2.4 Environmental results

At Youle, 80 % of sand used is now reclaimed. Sand reclamation must not be misunderstood as a waste treatment process; rather it is an integral part of the foundry sand preparation system to avoid generation of waste. At Youle this led to substantial environmental and economic benefits.

The environmental benefits are threefold:

1) Resource preservation:
   The requirement for new sand is reduced, decreasing the environmental burden of sand extraction.
2) Reduction in waste to landfill:
   The use of reclaimed sand reduces the proportion of sand disposed of in landfills; this disposal has been cut by some 800 tonnes each year.
3) Reduction in chemical use:
   Monitoring sand quality ensures that minimum resin and hardener additions can be made.

2.5 Economic benefits

The economic benefits shown at Youle include:

- Net cost savings of almost 32,000 EURO/year and a payback period of less than 19 months;
- Disposal of waste and consumption of new sand cut by 80 %;
- Reclamation technology applicable to other foundries using chemical binder systems;
- Investment appraisal technique applicable to most industries.

Table VII.2 Costs and savings through use of primary sand reclamation equipment (1996 prices)

Item	Costs (EURO)	Savings (EURO)
Cost of reclamation equipment	49,306	
Reduced need for virgin sand (27.40 EURO/t)		21,921
Reduction in disposal of used sand (19.14 EURO/t)		15,308
Total annual cost savings		37,225
Increased binder system costs (1.07 EURO/t)	1,066	
Increased equipment operating costs	1,522	
Finance costs	2,835	
Total annual cost increases	5,422	
Net annual cost savings		31,807
Payback Period		18.6 months

Source: ETBPP case Study Report GC 99 (1997)

According to Youle the payback period would be even shorter at foundries able to purchase equipment without a bank loan. However, despite partially funding the equipment costs and repaying the loan with an interest rate of 9.5 %, the project realised cash benefits for Youle during each year of the loan.

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3 Waste minimisation at Swift Caravans

3.1 Project background: The Humber Forum Waste Minimisation Project

This case is from the Humber Forum Waste Minimisation Project. The Humber Forum was launched in February 1995 with 11 companies participating. It is one of a series of UK waste minimisation clubs and monitored by the ETBPP. The project aims to convince company managers that waste minimisation contributes to economic benefits as well as enhancing environmental performance and that waste minimisation should be placed on top of each company's agenda. Training in waste stream analysis has been given to enable the participating companies to identify opportunities to reduce waste generation and implement waste minimisation programmes.

As of December 1995 annual reductions of off-site waste disposal within these 11 participating companies already amounted to 5,350 tonnes of waste, with potential to reduce another 18,000 tonnes. Since the launch date they achieved savings of approximately 1.5 million EURO annually. Most of the cost savings were achieved through a reduction in the use of raw materials and utilities.

Humber Resource Efficiency Centre

The Humber Resource Efficiency Centre was established in 1996 to build on the success of the Humber Forum Waste Minimisation Project. Over a five year period the HREC aims to help at least 145 companies in the region to implement a waste minimisation programme and conduct other environmental activities. The non-profit centre has been awarded a Government grant to help subsidise the training and consulting services that it provides.

3.2 History of waste minimisation at Swift Group Ltd.

Swift Group Ltd., part of Adam Dale Industries, is the UK's largest manufacturer of touring caravans and motorhomes. The company has an annual turnover of around 152 million EURO and employs 1,000 people.

The waste minimisation case at Swift not only provides a good example for the caravan industry sector in the EU. While some measures taken at Swift are specific for these kind of manufacturers, some activities and particularly the overall waste minimisation approach and methodology at Swift are exemplary for use in many other industrial sectors. In fact, the principles underpinning the waste minimisation strategy at Swift can be applied to any business of any size.

Swift Group Ltd. is a participant in the Humber Forum Waste Minimisation Project. Before joining the Humber Forum, the company had already started a programme to improve production efficiency and reduce waste generation. In 1998 the company

started the so-called "Swift waste minimisation and business improvement project". This endeavour builds upon the Humber Forum Waste Minimisation project.

Over 40 individual projects to improve the environmental performance of the company have been established. The goal of the whole project, which is still on-going is to demonstrate environmental improvements for customers and employers, and to improve profitability of the company. The company was motivated to start with the "waste minimisation and business improvement project" by a number of reasons:

- The environmental projects increased job satisfaction & fulfilment of all involved;
- The changing culture within the company;
- The full commitment from the Managing Director.

Because of its numerous activities and successes the project has been the subject of a promotional video issued by the Environmental Agency.

3.3 Waste minimisation principles and activities at Swift

Three principles have been applied at Swift to achieve optimal waste prevention and minimisation:

- Put in only what is needed
  (use only those resources which are necessary to achieve a high quality final product);
- Get the most out of what is put in
  (use resources in an optimal manner);
- Make the best use of what comes out
  (segregate the waste fractions that remain for recycling).

Swift calls the philosophy behind these principles: "Design for manufacture and not for waste".

Swift started its waste minimisation campaign by listing all input materials such as raw materials, ancillary materials, consumable materials and packaging materials. The purpose was to identify particular material wastes in order to determine the type and value of waste generated. In conjunction with HREC, detailed waste stream analysis of all production processes was made to identify waste and to determine its value.

Five specific teams were then established for the five main material streams identified (timber, paper/cardboard, styrene, plastic/GRP, waste management issues). Each cross functional team had a team leader supported by the waste management leader and the HREC. Regular team meetings were held, and progress reports and presentations were given at quarterly steering group meetings.

HREC provided a time-phase framework used to meet project deadlines and targets, educate staff and provide project support. The costs for removal of skip, drum and

other wastes were identified by waste management contractors. It was then assessed how much money is spent on the resources (input) and what can be saved.

The measures inside Swift were readily accepted as many of the ideas and suggestions came from within the company, rather than have something forced upon the individuals. The management introduced schemes to promote work-force suggestions because they could best identify the potential for waste reduction at their particular working place. About 250 suggestions were made of which approximately 50 % could be used. There was generally a very positive involvement in the project throughout the factory.

For instance, sections of ash-timber used for door manufacture were larger than necessary resulting in excessive waste from the rip-saw and the moulding machine. Changing the purchase specification reduced the volume of waste timber requiring disposal. By making a table 40 mm smaller laminate sheet wastage was reduced by 30 % - each sheet now covers three tables instead of two. Some rejects proved suitable for use in other applications. Resin is now supplied in drums that have a liner. Nearly all of the resin can be squeezed out and the clean drums returned to the supplier for re-use.

Other raw material savings were identified through discussions with Swift's suppliers. One supplier agreed to take back offcuts of polystrene sections used in the van sides. Besides, the hazardousness of waste was reduced. Solvent-based adhesives were replaced by non-solvent based ones. The thickness of adhesives applied could also be reduced. According to Swift product quality was improving at the same time.

3.4 Environmental results

Over 40 individual projects to improve the environmental performance of the company have been established. Taking these projects collectively, there has been a significant reduction in the amount of waste generated. Basically, the ways of reducing the waste can be grouped into six categories:

- Process change
- Nesting of component production
- Re-use of materials and packaging
- Recycling of timber, polystyrene, paper and cardboard
- Minimising packaging
- Setting up of returnable packaging systems.

The waste was monitored in each process area and analysed by a database. The handling and management of waste was improved by constructing a central waste compound which also improved monitoring and made the waste more visible.

As a result of all these projects there has been a 35 % reduction in the waste disposal bill. In early 1997, for every caravan produced, over 300 kg of waste was disposed to landfill. In 1999, this figure has been reduced to 150 kg waste to landfill for every caravan produced.

Approximately 2 tonnes a week of paper and cardboard was collected for recycling in 1997 which has risen to 8 tonnes a week in 1999. Approximately 4 tonnes a week of timber was collected in 1997 and has risen to over 25 tonnes a week in 1999.

3.5 Economic Results

Within the first year of the waste minimisation project Swift achieved cost savings of approximately 125,000 EURO and identified further annual savings potential of 184,000 EURO (Table VII.3). There are no figures available on the actual savings achieved by the company in 1997 and 1998.

Table VII.3 First year cost savings at Swift (1996)

	Annual savings (EURO)		
Measure	Achieved	Identified	Total
Improved ash utilisation	39,600	-	39,600
Reduced waste disposal charges	38,000	22,700	60,700
Optimised laminate use	5,400	-	5,400
Resin-drum liner	4,600	-	4,600
Reduced adhesive use	-	91,300	91,300
Recycling of timber offcuts	6,200		6,200
Smaller items	31,200	70,000	101,200
Total	125,000	184,000	309,000

Source: Case History Fact Sheet CH 64, ETBPP 1996

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Final Conclusion

The situation regarding national measures on the prevention and minimisation of waste in the fifteen Member States is quite different due to economic, cultural, ecological and historic reasons. Different national strategies are used in the Member States, which are most often of a technical, voluntary or educational character but also include some legislative and economic measures.

The case studies show that regional and local authorities often have a leading role in waste management planning, particularly with regard to prevention and minimisation of waste flows in the municipal waste sector. On the other side it is remarkable that many different industry branches in the Member States voluntarily initiated various measures to reduce hazardous substances from their waste or their total waste amount generated.

Waste generation is linked to production, use and disposal of products. The environmental obstacles met within the production, use and disposal of products are results of a wide range of activities and decisions among actors such as industry, public purchasers, financial institutions, designers, distributers, consumers, researchers and local and central authorities. The product-oriented environmental policy seeks to influence the decision-making process of these actors with - if necessary - the full width of political steering instruments: Eco-labels, substitution of hazardous substances, Eco-design of products, life-cycle assessments, development of cleaner technologies, info-sheets, awareness campaigns, guidelines, regulations and taxation.

Therefore, a strategy on product-oriented environmental policies is a proper answer to the waste minimisation challenge in the long run. In Denmark waste prevention and minimisation activities are already based on such a product-oriented strategy. In most other EU-Member States pro-active product-oriented waste minimisation strategies are in their early stages. The emphasis of most waste minimisation strategies often lies on end-of-the-pipe concepts that concentrate on recycling and recovery activities rather then waste prevention at source.

However, the study shows that good examples for waste minimisation can be found everywhere. The environmental benefits of waste minimisation at source are often enormous. Besides, many case studies demonstrate that waste minimisation activities most often pay off economically, often even in a short term.

VIII Annex

1 Denmark

The waste generated in Denmark is handled in different ways:

- **Recycling**. Recycling is given top priority among the different forms of concrete waste management. Waste is depleting resources and the challenge met is to reduce the loss of resources in an environmentally efficient way by recycling substances and materials.
- **Incineration**. Incineration has been given second priority in the Danish waste strategy. Waste which cannot be recycled must, where possible, be incinerated and used to provide energy for electricity and district heating.
- **Disposal**. Disposal of waste in landfills has been given lowest priority since the waste is not utilised as a resource and disposal can lead to contamination of the ground water.
- **Special treatment**. Finally, hazardous waste must undergo special treatment.

1.1 Waste generation development

The total amount of waste increased by 10 % from 1995 to 1996, and from 1985 to 1996 there is a tendency towards increased generation of waste per GNP (Danish EPA, 1998). The relation between household waste and GNP is constant but increased waste generation from the service sector is seen.

Table VIII.1 Total waste generation in Denmark 1994-1996 (in 1,000 tonnes)

Source	1994	1995	1996
Total	11.105	11.466	12.913
Households	2.575	2.610	2.767
Institutions, trade and industry	0.656	0.834	0.854
Manufacturers	2.309	2.563	2.632
Building and construction	2.433	2.559	3.086
Waste water treatment	1.156	1.195	1.212
Coal fired power plants	1.962	1.699	2.332
Other	0.014	0.006	0.030

Source: Waste 21, Danish EPA, 1998

As illustrated in the table, the major increase in waste generated derives from the building and construction sector and sludge from the coal fired power plants.

From 1993 to 1997, the Danish action plan for waste and recycling set the target for recycling at 54 % and the target for landfill disposal at 21 % of the total waste generated. This target has been reached and can primarily be attributed to the

extensive recycling of waste from the building and construction sector. The development in recent years is illustrated in table 2 below.

Table VIII.2 *Waste treatment in Denmark 1994-1996. Percentage.*

Treatment	**1994**	**1995**	**1996**
Recycling	56 %	62 %	60 %
Incineration	20 %	20 %	19 %
Disposal	23 %	17 %	20 %
Special treatment	1 %	1 %	1 %

Source: Waste 21, Danish EPA, 1998

1.2 Score System of Danish Dye-Work Industry

Table VIII.3 Score system for pre-sorting of chemicals on basis of environmental data and information on consumption. Exposure score (AxBxC)

Score: Parameter:	**1**	**2**	**3**	**4**
A Discharged quantity of chemicals (kg/week) (kg/year)	<1 <50	1-10 50-500	>10-100 >500-5,000	>100 >5,000
B Biodegradability Recipient water (%) Sludge culture (%) BOD/COD-ratio	>60	10-60 >70 >0.5	<10 20-70	<20 ≤0.5
C Bioaccumulation BioConcentrationFactor (BCF) or C1, C2, C3	<100			≥100
C1, where MW>1000g/mol	*			
C2, where 500≤MW≤1000 g/mol P_{ow}–data Water solubility	<1,000 >10	≥1,000 10-2	<2	
C3, where MW < 500 g/mol P_{ow} –data Water solubility g/l	<1,000 >100	100-2	<2-0.02	≥1,000 <0.02
No data				*
D Effect concentration divided by discharge concentration	>1,000	1,000-101	100-10	<10
No data				*

2 Germany

The below mentioned cases for the prevention of cooling lubricants are practical examples which have been conducted under the Advisory Programme for avoiding & recycling hazardous waste of Baden Württemberg (see MUV 1996, p. B 19 ff.).

2.1 Example no 1: Optimization of the management of cooling lubricants

A plant which produces electric tools uses 140 machines for metal cutting. Cooling lubricant oil is used on 39 machines. Nine machines are operated without cooling lubricant oil; on the remaining machines cooling lubricant emulsions are used. Forty-one bigger machines are supplied through central installations. The remaining rest are supplied individually. Spent cooling lubricants emulsions, which are not used anymore, are treated through ultra-filtration. After treatment with an ion exchanger the water is discharged into public canalisation.

To optimise the **management of cooling lubricants,** staff members are thoroughly informed and advised on the use of cooling lubricants and potential health hazards. Furthermore, the results of the bath monitoring of cooling lubricants by the environmental representative are recorded and analysed. In co-operation with the respective operator, specific qualities of the machines are analysed and evaluated. Through these measures, the average bath service time of an individually-supplied machine can be doubled (to 20 weeks).

Financial aspects

No new **investment costs** are incurred from this measure. **Cost savings** resulting from savings on concentrates amount to 1,943 EURO per year (at a price of 2.05 EURO per kg of the concentrate, 5 % concentration and 19 t of fewer used emulsions of cooling lubricants). Thus, the costs for the separation of emulsions are reduced by 486 EURO per year (at 26 EURO per t of variable costs). The quantity of reduced residues from the emulsion splitting plant is 1.2 t per year. The disposal costs can thus be reduced by 184 EURO per year (disposal costs of 153 EURO per year). Furthermore, the reduction in the number of emulsion changes and machine down times leads to savings on staff and financial resources, which have not been considered in this study.

Ecological relief

Due to the prolongation of the bath service time by 100 %, the quantity of spent baths to be disposed of will be reduced by half (here about 19 t per year or 50 % respectively). This also means a reduction of almost 19 t of fresh water consumption per year, 890 kWh energy consumption for emulsion splitting (50 Wh/kg permeate),

1.2 t of cooling lubricants waste, which is forwarded to an external dispose, and a reduction of about 18 t waste water per year.

Conclusions

The plant's **cost savings** amounted to about 2,556 EURO per year due to the cooling-lubricant management. No technical measures had to be taken and no investment costs were incurred. Additional expenditure resulting from further education and advising of staff members was partly compensated through time saved due to reduced bath changes. Considerable amounts of waste were saved and waste quantities were reduced. Moreover, despite a longer bath service time, health risks to staff members can be further decreased due to intensive monitoring and improved information.

2.2 Example 2: minimal quantity cooling lubrication

This example describes a firm which uses 110 machines predominately for milling, turning, polishing, and machining in machining centres.

Five machines (for sawing, drilling, milling) are converted to **minimal quantity cooling lubrication**. This means that no cooling lubricants spent baths arise, but that only so many cooling lubricants are added as are actually used (lost lubrication with about 10 to 100 ml/l oil per installation). Thus, a bath service time of 26 weeks (per 150 l) results in a reduction of 1,500 l of cooling lubricants spent emulsions per year (5 x 2 x 150 l = 1,500 l/a).

Financial aspects

The **investment costs** of minimal quantity cooling lubrication plants varies between 511 EURO and 1790 EURO per unit. It is estimated that the costs for five installations are 6,390 EURO. In total, the annual investment costs amount to 2,400 EURO. The costs of acquisition for the new cooling-lubricant oils are fewer than 51 EURO per year and are therefore neglected in the following calculations.

Savings are made in the acquisition and disposal of the previous 1,500 l of cooling lubricants. The costs of acquisition are about 128 EURO per cubic metre (with a medium concentration of 5 % and a price of 2.56 EURO per l of cooling lubricant concentrate). The costs of disposal resulting from the operation of the vacuum evaporating plant are about 25.56 EURO per cubic metre (incl. costs of disposal for coke residues). Therefore, about 153 EURO per cubic metre per year or a total of 230 EURO for the four plants with a bath content of 1.5m³ arise respectively.

Ecological relief

The use of minimal quantity cooling lubrication not only avoids the use of cooling lubricant baths and their disposal, but also approximately 1,500 l of fresh water for the treatment of baths are saved (plus small amounts of evaporation losses). Moreover,

energy of 100 Wh per kg of distillate for the boiling down of spent emulsions of cooling lubricants is saved. Additionally, 30 kg of evaporation residues per machine can be avoided per year. Furthermore, the necessity for the production, consumption and disposal of chemicals necessary for the regeneration of baths has become obsolete.

Conclusion

Minimal quantity cooling lubrication can be regarded as a new technology. For the example chosen, only a few machine units were equipped with minimal quantity cooling lubrication. For the remaining machines, a conventional cooling lubrication was used. If within a plant only minimal quantity cooling lubrication is used, the economic advantages are obvious. Thus, machine down times and saved personnel costs for bath maintenance as well as avoided investments in conventional cooling lubricants, bath maintenance installations and the treatment of spent emulsions of cooling lubricants, can be taken into the economic calculations.

2.3 Example 3: Prevention through tempering and airing

For the production of precision parts, 58 metal-working machines, which are individually supplied with cooling lubricants, are used. Water-mixable cooling lubricants are used in 22 machines. The remaining machines are supplied with non water-mixable cooling lubricants. Some of the machines have appliances for bath maintenance.

The installation of **cooling lubricant ventilators** in storage tanks facilitates a reduction in the growth of anaerobic bacteria through airing, circulation, and cooling of the stored cooling lubricants, particularly during machine down times (eg. during factory holidays). Furthermore, the bath service time can be doubled and the number of cooling lubricant changes can be reduced by half.

Financial aspects

The **investment costs** for the ventilators (water pond or large aquarium ventilator) are 92 EURO each or a total of about 2,045 EURO. The investment dependent costs per year amount to 767 EURO (depreciation period of three years, and a medium interest rate of 8 % on 50 % investments) plus 900 EURO for one-time installation costs (41 EURO each).

The **daily operational costs** are estimated to be 256 EURO per year for maintenance and 383 EURO per year for energy.

Costs savings result from the reduced acquisition costs for emulsions amounting to 211 EURO per t of cooling lubricants (7 % concentration; 3.02 EURO per l) as well as from the reduced disposal costs of 120 EURO per t of cooling lubricant. The total sum is 331 EURO per t. As half of the cooling lubricant spent baths, or nine t per, year, have been saved, savings on materials amount to 2,982 EURO per year.

Therefore, the plant studied shows a **payback period** for the measure of less than 1.5 years.

Ecological relief

Due to ventilation, the plant analysed saved 9 t of cooling lubricant spent baths per year and accordingly about 9 m^3 fresh water per year. The ventilation requires a power input of 50 W at most. This energy consumption factor is compensated for through savings in emulsion splitting.

Conclusion

The installation of ventilation aggregates is technically easy to carry out and pays off after approximately 1.5 years. Plants which have to do bath changes for water mixable cooling lubricants due to longer exposure times of machines (extended weekend, work holidays, sporadic use of machines etc.), can thus contribute efficiently to easing the strain on the environment and can save costs at the same time.

2.4 Example 4: Prevention through mobile bath maintenance installation

The plant studied is a large car supplier with 158 metal working machines (sawing, milling, turning, drilling, honing, polishing). Except for the honing machines, all machines are individually supplied with cooling lubricants. The plant has purchased a **mobile bath maintenance installation**, which first removes solid matters and liquid impurities (e.g. hydraulic oil). Secondly, the finest impurities are retained. Thus, the bath service time can be increased by a factor of five. The baths are changed only every 15 weeks.

Financial aspects

The **investment costs** amounted to approximately 30,678 EURO. From those costs, investment dependent costs amount to 11,453 EURO (pay-off period of three years; medium interest rate of 8 % on 50 % of the investments).

Due to the measures taken, the quantity of cooling lubricant spent baths for the emulsion splitting plant dropped from originally 450 t per year to 90 t per year. Thus, 360 t of cooling lubricants baths (80 %) per year are saved. The **cost savings** resulting from the less necessary quantities of cooling lubricants concentrates amount to 39,942 EURO per year (at a price of 1.59 EURO per kg of concentrate). Due to the fewer quantities of spent baths to be treated through emulsion splitting a further cost reduction amounting to 9,203 EURO per year can be made. Originally, the 360 t of spent baths per year led to an amount of about 36 t of waste per year. The disposal costs amounted to 153 EURO per t. Thus, 5,522 EURO disposal costs are saved

annually. Moreover, costs are reduced due to saved bath changes as well as to reduced machine times of exposure.

Taking the daily costs for the plant and the cost savings resulting from the measure into consideration, 30,678 EURO original investment is **paid off** in less than one year.

Ecological relief

Due to the measure, the amount of 360 t of cooling lubricant spent baths per year can be saved in the test plant. Thus, 36 t of waste (80 %) from the emulsion splitting plant is preventable. Furthermore, fresh water consumption is reduced by 360 cubic metres per year. Due to the fewer quantities used in the emulsion splitting plant, considerable amounts of energy and therefore of fossil fuel energy carriers are saved.

Conclusion

The use of a mobile bath maintenance installation leads to considerable financial and ecological advantages. Generally, this measure is of interest for plants without the possibility of a central supply of cooling lubricants. A decision to use this measure is facilitated through the fact that some suppliers offer mobile bath maintenance installations for testing.

3 Spain

The table below illustrates the waste produced in Catalonia in 1997.

Table VIII.4 Industrial waste production in Catalonia in tonnes (1997) (Memòria d'activitats 1997, Junta de Residus, Barcelona, 1998)

Waste type	Special	Inert	Non-special	Total	%
Solvents and fluids with solvents	103,150	0	0	103,150	2.2
Oily (oil, grease and hc)	30,510	0	297	30,807	0.7
Chemical and phytochemical products	109	0	488	597	0.0
Residual fluid and bath with metals	20,473	0	9,582	30,055	0.6
Residual fluid and bath without metals	20,541	0	571	21,112	0.5
Organic fluid waste	99,872	0	3,718	103,590	2.2
Paints, varnish, dyes and adhesive	3,728	0	9,924	13,652	0.3
Saline waste	14,450	7,639	29,520	51,609	1.1
Decontamination waste	28,975	11,863	298,699	339,537	7.3
Combustion waste	59,838	360,662	210,563	631,063	13.6
Cleansing plants sludges	13,586	5,832	793,548	812,966	17.5
Expired products and rests of organic production	0	6,847	93,393	100,240	2.2
Animal waste	0	0	337,297	337,297	7.3
Sanitary waste	3,612	0	0	3,612	0.1
Vegetables waste	0	0	596,280	596,280	12.8
Plastics	0	71,628	9,709	81,337	1.7
Metals	0	470,152	1,349	471,501	10.1
Mineral and ceramic waste	1,268	165,392	5,510	172,170	3.7
Industrial package	52,300	0	136	52,436	1.1
Contaminated soils and sediments	0	0	4,813	4,813	0.1
Others	18,743	36,577	636,582	691,902	14.9
Total	471,155	1,136,592	3,041,979	4,649,726	100.0