3.7. Waste generation and management

Main findings

- Reported total waste generation within the EU and the European Free Trade Area increased by nearly 10% between 1990 and 1995, while economic growth was about 6.5% in constant prices. Half the waste comes from the manufacturing industry and construction and demolition activities, while municipal waste, mining waste and waste from other sources each contribute about one sixth of the total. In the Accession Countries, amounts of industrial waste per capita are higher, while volumes of municipal waste are currently lower than the EU average.

- Limited current systematic and consistent data hinder the development of projections for future waste trends. Nevertheless, most waste streams will probably increase over the next decade. In 2010 the generation of paper and cardboard, glass and plastic waste will increase by around 40% to 60% compared with 1990 levels. The number of scrapped cars should increase less, by around 35% compared with 1995 levels.

- Today waste is also produced as a result of society's attempt to solve other environmental problems such as water and air pollution. Some of these increasing amounts of waste give rise to new problems, such as sewage sludge and residues from cleaning of flue gases.

- In most EU countries landfilling is still the most common treatment route for waste and a major change is needed in order to implement the EU strategy on waste. Furthermore, as illustrated by municipal waste, there has been no general improvement in this trend in the 1990s.

- Paper and glass are some of the waste fractions where Member States have followed the Community waste strategy of increasing recycling instead of energy recovery and landfilling. However, the development has been only a partial success, because the total amount of waste paper and waste glass (container glass) generation has also increased in the same period.

- Sewage sludge and end-of-life vehicles are other waste streams where substantial increases in quantities can be expected, calling for more efficient waste management practices.

- The quantities of waste are now so big that transport of waste represents a significant part of total transport: in France, for instance, waste accounts for 15% of total weight of freight. The environmental impact of this remains to be assessed.

1. The main problems related to waste generation and management

1.1. The sheer quantity of waste is a problem

Waste represents an enormous loss of resources both in the form of materials and energy. Indeed, quantities of waste can be seen as an indicator of the material efficiency of society.

Excessive quantities of waste result from:

- inefficient production processes;
- low durability of goods;
- unsustainable consumption patterns.

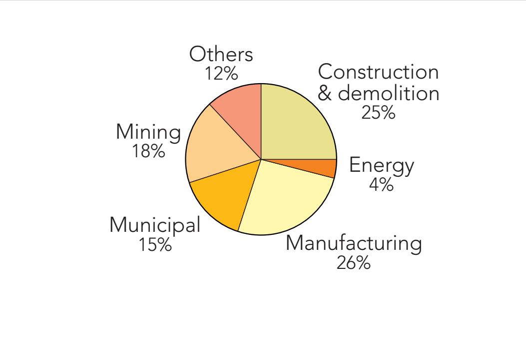
Waste generation is increasing in the EU, and amounted to about 3.5 tonnes of solid waste per person in 1995 (excluding agricultural waste), mainly from manufacturing, construction & demolition and mining (Figure 3.7.1).

Solid waste is also increasingly produced as an attempt to solve other environmental problems such as water and air pollution. Some of these wastes give rise to new problems – examples include sewage sludge and residues from cleaning of flue gases. Moreover, managing waste causes a number of pressures on the environment:

Figure 3.7.1 **Waste generation by sector**

The figure shows the distribution of total waste by sector. Since data from most countries is incomplete and lacks harmonisation, these and other data in the chapter should be regarded as best available approximations.

Sources: OECD, 1997; NRCs, 1998a



- leaching of nutrients, heavy metals and other toxic compounds from landfills;
- use of land for landfills;
- emission of greenhouse gases from landfills and treatment of organic waste;
- air pollution and toxic by-products from incinerators;
- air and water pollution and secondary waste streams from recycling plants;
- increased transport with heavy lorries.

While total waste quantities are a measure of resource loss, the environmental impact of waste can not be analysed by looking at quantity alone. Hazardous substances in waste, even in small quantities, can have a very negative impact on the environment (Figure 3.7.2). However, the following discussion is mainly based on amounts because the content of hazardous substances in waste is poorly described at EU level (see also Chapter 3.3).

An increasing part of resources contained in waste is recovered as materials or as energy in incinerator or biogas plants, but more than half is still permanently lost in landfills. Recycling of materials may reduce the environmental impact of waste but is not necessarily without environmental impact. For example, plants processing scrapped cars produce large amounts of shredder waste contaminated with oil and heavy metals and smelting of the metals give rise to emissions of heavy metals, dioxins etc. from secondary steel works and aluminium smelters.

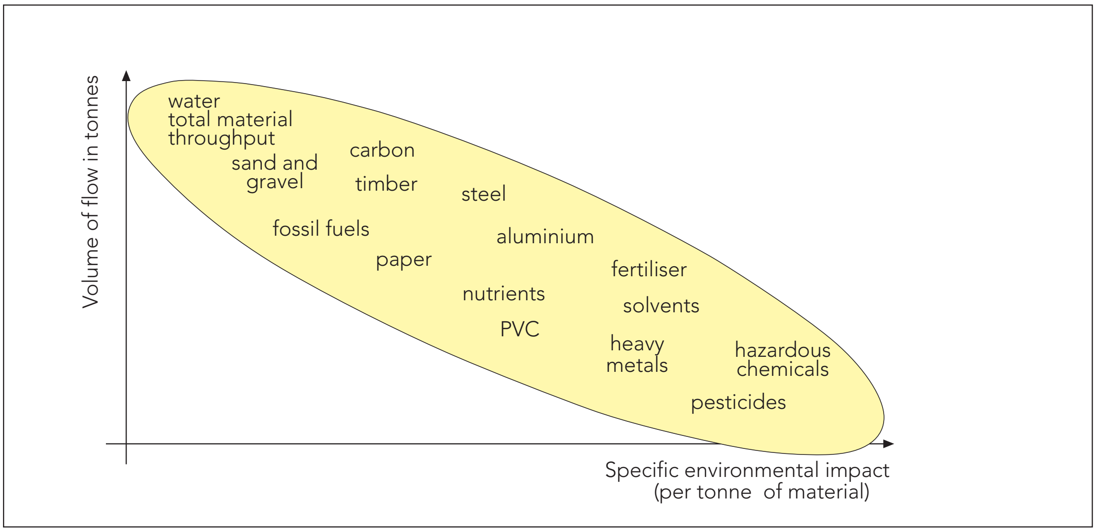
Few resources can be retrieved completely from waste. In most cases recycled material will be of a somewhat lower quality than the virgin material due to contamination or the nature of the recycling material. Even high-quality recycled materials represent a net loss of resources because the energy used for initial production is lost and some material is always lost during collection and treatment.

The quantities of waste are now so big that transport of waste is a significant part of total transport. A French study indicates that about 15% of the total weight of freight transported in France in 1993 was waste and that waste transport accounts for 5% of the total transport sector energy consumption (Ripert, 1997). Rough estimates from Denmark indicate a lower but still significant energy consumption for transport of waste. The French study also shows that transport distances are much higher for waste for recycling than for disposal. This implies that

Figure 3.7.2 **Material flow and specific environmental impact – qualitative and quantitative aspects of waste**

The relative environmental impact of waste is related to both the quantity and the degree of hazard associated with it. There are therefore two aspects to waste generation: quantitative, i.e. how much is generated, and qualitative, i.e. the degree of hazard. This is shown here for a selection of materials. Waste with a high specific environmental impact per tonne is normally found in minor volumes and is therefore more difficult to separate and collect. Until now waste management has mainly concentrated on waste streams in the middle of the area marked.

Source: Steurer, 1996



efficient planning tools are needed to control transport resulting from separation of the waste into more and more fractions for advanced treatment – although higher transport distances for recycled materials may in some cases be compensated by reduced need for long-range transport of raw materials.

1.2. Can waste generation be de-linked from economic growth?

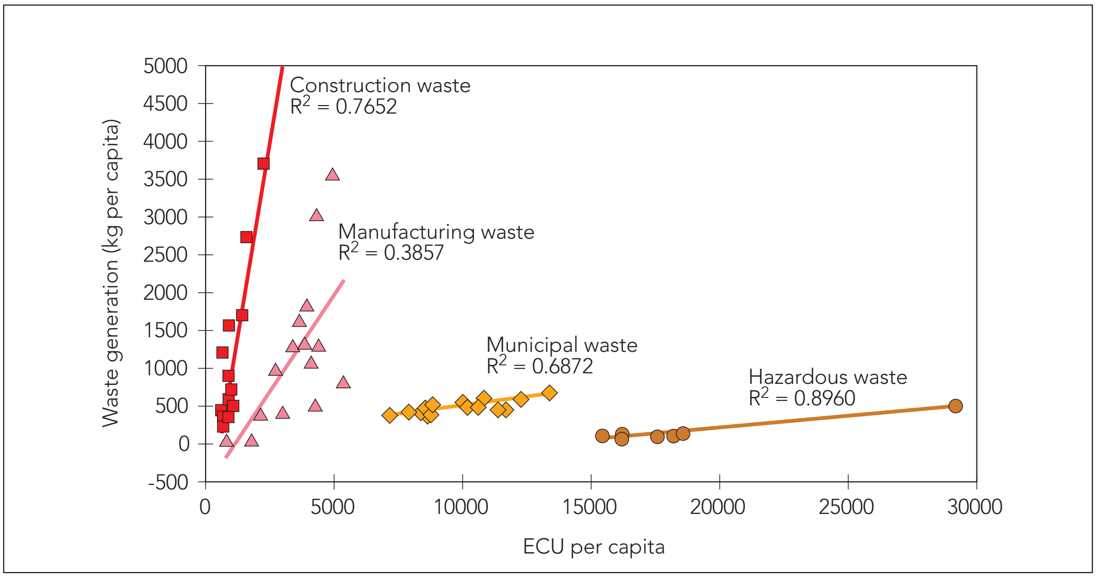
Reported total waste generation in OECD Europe increased by nearly 10% between 1990 and 1995 (EEA, 1998a) while GDP growth was about 6.5% in constant prices. This relation is also noted in the waste strategy for England and Wales which states that 'for every ton of useful products made in UK, we consume about 10 tons of other resources – raw materials and energy. ... They go to landfill, or are emitted to the atmosphere or into water. And ...a high proportion of the useful goods we produce join the waste stream quite quickly too.' (DETR, 1998).

The main challenge is to de-link waste generation from economic growth (Figure 3.7.3). A closer analysis of the relationship between economic growth and waste generation reveals several different trends. For instance, country comparisons show no general correlation between GDP and waste from energy production, which probably reflects national differences in energy supply systems. Coal-fired power plants generate large amounts of fly ash, while hardly any waste is produced from hydroelectric power stations, and nuclear power plants generate a small but extremely hazardous amount of waste.

For hazardous waste a correlation between GDP and waste quantities can be demonstrated for data from 1995, but not from 1990. In this period large changes took place in both awareness of hazardous waste and in definitions and classification procedures. Thus the apparent correlation in 1995 may be spurious.

For municipal waste and construction and demolition waste a very close link between economic activity and waste generation can be demonstrated. For manufacturing waste, however, there are significant variations between Member States; in some countries (notably Germany and Denmark) the ratio of waste generation to manufacturing GDP is much lower than in others. This may be an indicator of the use of the cleaner technology (including internal recycling) in produc-

Total waste/GDP Figure 3.7.3



For each Member State, waste quantity/capita has been plotted against economic activity related to selected waste streams. The figure shows that the generation of municipal, construction and hazardous waste seems to relate to the economic activity behind waste generation whereas such a relation does not seem to exist for manufacturing waste. A good correlation is assumed if R^2 values are above 0.7. In relation to municipal waste the economy is stated as final consumption from house-holds in Purchasing Power Standard (PPS). Hazardous waste is related to GDP stated in PPS. Construction and manufacturing waste are related to the part of the GDP originating from construction and manufacturing activties.

Source: OECD, 1997a; OECD, 1997b; NRCs, 1998a+b; Eurostat, 1999 tion, but it can also be a result of differences in industrial structure. As an example much of the heavy industry in western Europe has been closed in the last decades due to competition from Eastern Europe and Asia.

It is however significant that where the rate of waste generation from production has declined – supposedly due to better use of cleaner technology – this has not been sufficient to neutralise the increase in total waste amounts due to the growth in the quantity of goods produced and consumed.

1.3. The need for an integrated approach

The challenge of increasing waste quantities cannot be solved in a sustainable way by efficient waste management and recycling alone. There is an urgent need for integration of waste management into a strategy for sustainable development, where waste prevention, reduction of resource depletion and energy consumption and minimisation of emissions at the source is given high priority. Waste must be analysed and handled as an integrated part of total material flow through the society.

For instance, problems like heavy metals in incinerator ash and residues from flue-gas cleaning should be met with a concentrated effort to phase out the use of heavy metals wherever feasible together with separate collection and treatment of products still containing heavy metals. Further input of resources for treatment and stabilisation should be avoided. In the same way, problems such as contamination of sewage sludge should not lead to an increased use of energy in incineration plants or advanced treatment, but to a decrease in the use of chemicals and heavy metals in industry and products creating the problems. Otherwise, these substances end up in the sewer.

To stabilise or even reduce the waste amounts there is a need for many varied initiatives besides cleaner technology, such as product development based on life cycle analysis, design for disassembly, environmental management systems in manufacturing industries, re-use of products and packages, improvement of product quality with regard to for instance lifetime, better possibility for repair, increased re-use of components from discarded products and, not least, increased consumer awareness of the need for changing lifestyles.

If a product or the components of a product are re-used directly it will contribute to waste minimisation. Recycling of waste is a process which takes material from the waste stream and produces a useful material or product, but it cannot be regarded as waste minimisation as such. In fact it is already technically possible to systematically re-use components from discarded products when producing new products. For example, a photocopier can be produced with a content of re-used components valued at 10% to 50% of the total cost, with an average of 35% (Erhvervsbladet, 1997).

As stated in the book 'Beyond the Limits': 'If the average lifetime of each product floating through the human economy could be doubled, if twice as many materials could be recycled, if half as much material needed to be mobilised to make each product in the first place, that would reduce the throughput of materials by a factor eight' (Meadows *et al.,* 1991)

1.4. Main EU policies

The policies adopted at Community level are guided by the Community Waste Management Strategy which aims to establish an integrated waste management policy (see section 6). Thus, the Strategy sets up a hierarchy of principles, giving top priority to the prevention of waste generation, followed by re-use and recycling of waste materials, energy recovery, and final disposal of waste.

The legal response to the Strategy is in particular the Waste Framework Directive, the Directive on Hazardous Waste and the Regulation in the Supervision and Control of Transfrontier Waste Shipments.

2. Analysis of selected waste streams

Detailed analysis of developments in waste generation, waste management and waste minimisation is hampered by the lack of comparable definitions and statistical information across Europe. The gaps in information are analysed in Chapter 4.2.

2.1 Hazardous waste

The EEA member countries generate about 36 million tonnes of hazardous waste per year (OECD, 1997). Statistical data on hazardous waste is particularly difficult to interpret. Analysis of the data shows large changes in reported amounts over time, as illustrated in Table 3.7.1. Countries and regions with figures for both 1990 and 1995 show an apparent increase (on average 65%) in hazardous waste quantities, but this is mainly due to changed definitions and new legislation. The introduction in late 1994 of the hazardous waste list in the European Waste Catalogue is the first attempt to establish a common classification for hazardous waste in EU. In general the new list includes more waste types than previous national lists.

Germany and UK with figures for 1990 and 1993/1994 show a decline by an average of 21% before the introduction of the hazardous waste list. This decline can possibly be explained by the introduction of cleaner technology or closing of heavy industry factories/moving production outside EU for example to Asia.

2.2. Paper and cardboard

In the case of paper and cardboard (Figures 3.7.4 and 3.7.5), consumption is a reasonable proxy measure for waste generation. Consumption in the EU rose from approximately 41 million tonnes in 1983 to 64 million tonnes in 1996, an increase of 46% or 3.5% per annum (CEPI, 1997), although in the period 1992-1996 the rate of increase slowed to 1.5% per annum. There is appreciable variation between Member States: annual rates of increase between 1983 and 1996 range from 0.4% (Sweden and the Netherlands) to 11.1% (Greece).

There is a remarkably wide range in per capita consumption of paper and cardboard over the period (1982-1996) ranging from as low as 49 kg/person/year in Portugal, 1983, to as high as 260 kg/person/year in Belgium, 1996.

Growth in consumption averages 1.8%, 3.5% and 5.5% per annum for the high, medium and low range groups respectively, over a 13-year period. While this grouping system obscures differences between countries within groups, it is a useful indicator for planning at European level as countries in the lower to middle ranges might be expected to have capacity for increased consumption which has been reached in countries in the middle to higher range. On the other hand, it could also be used to set realistic targets for reducing consumption levels.

The historical trend suggests that the move towards the information age is not resulting in reduced generation of paper.

Paper waste is a high-volume waste with a middle range environmental impact (see

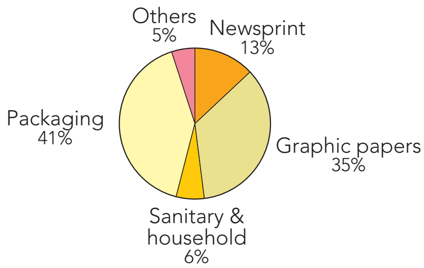
Reported quantities of hazardous waste in selected countries and regions, 1990-95 — Table 3.7.1.

Country	Year	Tonnes	Country/region	Year	Tonnes
Austria	1990	317 000	**Luxembourg**	1994	36 312
	1995	577 000		1995	180 596
Denmark	1990	116 000	**Netherlands**	1994	895 000
	1995	252 000		1995	955 000
Germany	1990	13 079 000	**UK**	1990	2 310 000
	1993	9 093 000		1994	2 080 000
Ireland	1992	143 600	**Catalonia**	1990	674 400
	1995	273 637		1995	831 439

Existing data for hazardous waste shows for many countries and regions an increase in generation of hazardous waste in the first half of the 1990s. However, the increase is primarily due to changed definitions and new EU legislation for hazardous waste.

Source: OECD, 1997a; NRCs, 1998a; Junta de Residus

Paper composition — Figure 3.7.4

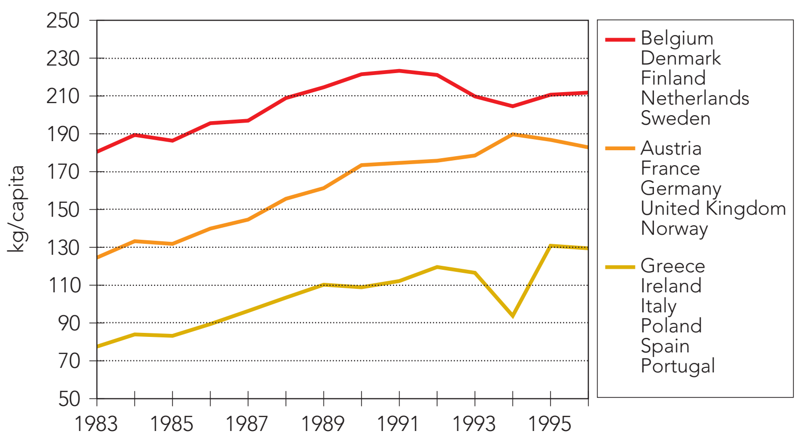


Total paper consumption in 1996, 64 million tonnes

The composition of paper and cardboard consumed has changed very little during the 1990s. Packaging and graphic papers account for the major part of consumption.

Source: CEPI, 1997

Paper consumption/capita — Figure 3.7.5



Countries grouped according to general paper and cardboard consumption in the period 1983-96:
low consumption, 40-140 kg/person/year (Greece, Ireland, Italy, Portugal and Spain);
medium consumption, 110-200 kg/person/year (Austria, France, Germany, UK, Norway);
high consumption, 150-260 kg/person/year (Belgium, Denmark, Finland, Netherlands, Sweden).
All three groups show an increase per capita from 1983-96, with the highest increase among countries with low consumption.

Source: CEPI, 1997

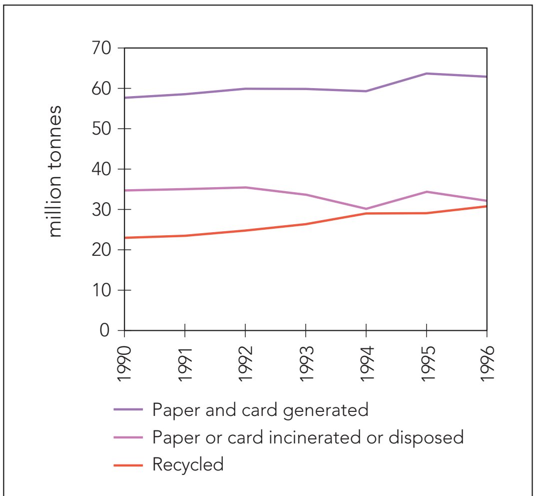
Figure 3.7.2). Paper is one of the waste fractions where Member States have followed the Community strategy of increasing recycling instead of energy recovery and landfilling. The recycling rate has increased for EU+Norway from 36% in 1985 to 40% in 1990 and 49% in 1996. However, the total amount of waste incinerated or landfilled has increased due to the growth in consumption of paper and cardboard (Figure 3.7.6).

As shown in Table 3.7.2 energy consumption and emissions for paper production based on virgin materials and recycling paper are comparable. Although recycling of waste paper in general is more environmentally friendly than production based on virgin material, it has to be underlined that recycling also gives a pressure on the environment.

Figure 3.7.6 **Paper treatment**

Despite the success of recycling the problem remains that waste paper generation has also increased in the same period. In 1996, 32.5 millions of tonnes of waste paper and cardboard were incinerated or landfilled compared with 32.5 million in 1990 and 28.3 million tonnes in 1985.

Source: CEPI, 1997 and NRCs, 1998a



2.3. Container glass

Consumption of container glass has, like paper, augmented during the 1990s. For the EU and Norway the average increase in the consumption of glass over the period 1990 to 1996 has been 13.6% or 2% per annum. In absolute figures the increase is from 11.7 million tonnes to 13.3 million tonnes. Average glass consumption per capita differs by 400-500% from the country with the lowest consumption to the country with the highest consumption (Figure 3.7.7).

About 75% of container glass production is used for the packaging of beverages. The rest is used for food, pharmaceuticals, cosmetics and chemical products. The consumption of container glass depends on national consumption patterns and on the materials used for containers (e.g. glass, one-way systems, plastic bottles). It is reasonable to assume that the consumption of container glass gives a relatively good measure of waste production.

As with waste paper, glass is one of the waste fractions where Member States have succeeded in the Community strategy to increase recycling (Figure 3.7.8), from 43% in 1990 to 55% in 1996 for the EU+Norway. This does not include refillable bottles on deposit, which are not regarded as waste until the bottle is discarded.

2.4. The challenge of plastic waste

The EU is facing an increasing quantity of post-use plastic waste which has been increasing by about 4% per year (SOFRES, 1996) (Figure 3.7.9). In 1990, 13.6 million tonnes of post-use plastics waste was generated in

Table 3.7.2. **Energy consumption from production of newspaper and emissions from unbleached paper pulp with and without use of recycled paper for different materials in Sweden 1994-95**

The table shows that recycling of paper in general is better than using new pulp, but even recycling gives rise to considerable energy consumption and emission of phosphorous and nitrogen.

Consumption of energy				Emissions			
Raw material	Consumption of heat GJ/tonne	Consumption of electricity GJ/tonne	Total energy consumption GJ/tonne	Raw material	CO_2 kg/tonne	Phosphorus g/tonne	Nitrogen g/tonne
Newspaper with 100% recycled paper	5.7	3.2	8.9	Unbleached paper pulp with recycled paper	14-21	10-17	80-220
Newspaper without recycled paper	5.5	10.6	16.1	Unbleached paper pulp without recycled paper	12-37	18-40	230-420

Source: Naturvårdsverket, 1996

the EU, Norway and Switzerland and in 1994 the quantity peaked at 17.5 million tonnes (APME, 1995; APME, 1996).

Municipal Waste
Municipal waste is by far the largest 'source' of plastic waste with 61% of the total in 1996 (Figure 3.7.10).

Several problems are related to municipal waste, for example:

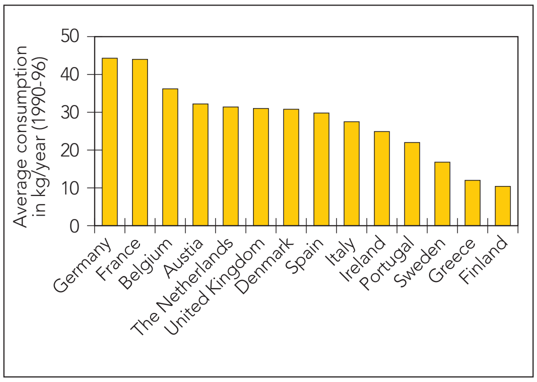
- it is difficult to handle as it consists typically of a number of fractions of waste and several plastic types; the bottleneck to more recycling is sorting the different plastics both in relation to available techniques and to health and safety problems related to sorting;
- it contains plastic types with a high degree of contamination from foodstuffs resulting in very labour- and energy-intensive recycling.

As shown in Figure 3.7.9 it is obvious that plastics waste has to be dealt with in a more innovative way in order to implement the Community Waste Management Strategy. Only 20% of plastic waste is subjected to material recovery or energy recovery while an average of 80% is disposed of. Disposal can be either incineration without energy recovery or landfilling. The figure also shows that despite increasing quantities of post-user plastic waste the fractions dealt with by material recovery and energy recovery are more or less constant at levels of about 7% and 15% respectively (APME, 1995; APME, 1996).

PVC waste
Polyvinylchloride waste (PVC waste) accounts for a total of 12% of all plastics waste in the EU, Norway and Switzerland, or 2.1 million tonnes PVC waste in 1994 (SOFRES, 1996). In comparison, PVC production in 1994 was 4.8 million tonnes (Allsopp, 1992) and is still increasing, confronting future generations with rising amounts of PVC waste. Recovery of PVC waste is lower than recovery of other kinds of plastic waste. A study in eight western European countries has shown recycling rates from 1% to 3% (DEPA, 1996). Material recovery of PVC requires sorting waste into generic materials; this is not done today.

PVC requires special attention due to its high content of dangerous substances which are used as plasticisers (phthalates), stabilisers (lead, cadmium and organotin com-

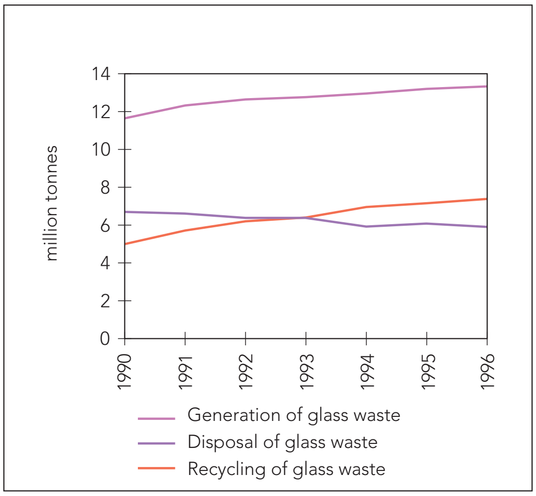
Average glass consumption in different countries, 1990-95 (in kilo per capita/year) — Figure 3.7.7



The yearly consumption of container glass per capita (and hereby the glass waste generation) is 4 times as high in countries with a high consumption compared to countries with a low consumption.

Source: FEVE, 1997 and NRCs, 1998a

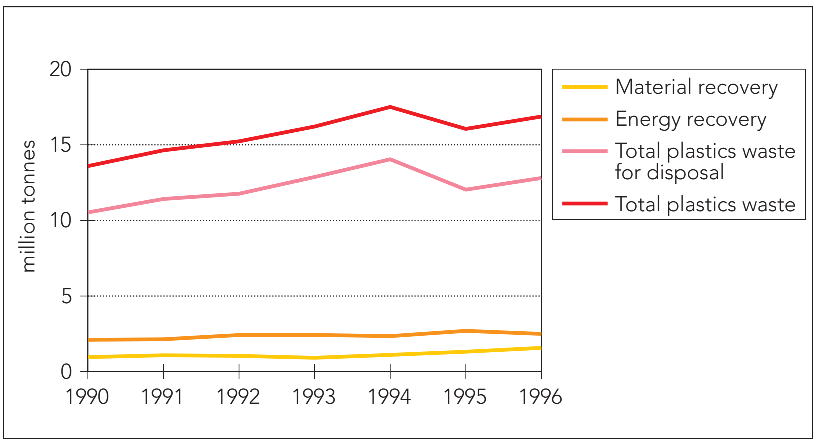
Glass generation and management — Figure 3.7.8



While recycling has increased by almost 50% from 5 million to 7.4 million tonnes per year, the amount of waste glass for disposal has decreased by only 12% (6.7 million to 5.9 million tonnes) due to the simultaneous increase in waste glass.

Source: FEVE, 1997; NRCs

Total plastic — Figure 3.7.9

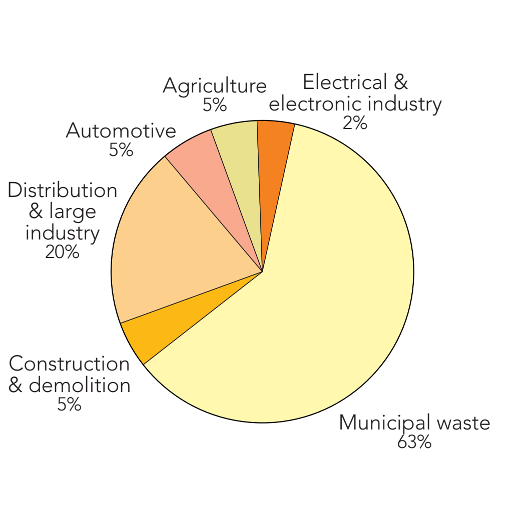


The fraction of total plastic waste dealt with by disposal is more or less constant at about 75%.

Source: APME, 1995; APME, 1996.

Figure 3.7.10 **Plastic sources**

Source: APME, 1996



pounds) and pigments (cadmium compounds). In addition, the chlorine content in PVC is very high (about 57% by weight). The dangerous substances create problems when PVC waste is landfilled, recovered or incinerated (with or without energy recovery). When PVC is landfilled, there are different problems related to the disposal of hard and soft types of PVC. In the leachate from landfill accepting soft PVC, phthalates have been identified in different concentrations. On the other hand, degradation of hard PVC in a landfill procees much slower than for other types of plastic.

With incineration of PVC large amounts of hydrochloric acid are generated making it necessary to neutralise the acidic fumes. In the dry and semi-dry gas cleaning processes 1-2 kg residues are formed per kg PVC incinerated. The high chlorine content of PVC further constitutes a risk of dioxin production during incineration. Uncontrolled burning will release dioxin and other toxic substances. A Danish study has shown that 67% of the chlorine in waste for incineration comes from PVC (DEPA, 1996). It is also worth noting that the calorific value of PVC is 22 MJ per kg – the lowest value among plastic polymers. In comparison, Low Density Polyethylene has for example a calorific value of 45 MJ per kg (SOFRES, 1996).

Under the Basel Convention on the control of transboundary movements of hazardous wastes and their disposal, it has been discussed whether PVC should be classified as hazardous or non-hazardous waste. For the time being no common position has been reached. The normal content of lead in PVC is typically 0.6% (DEPA, 1996). Waste contaminated with lead compounds higher than 0.5% or cadmium higher than 0.1% by weight is, according to the classification rules in the hazardous waste directive (91/689/EEC), classified as hazardous. Hard PVC will normally have a cadmium level of 0.25%.

2.5. Scrapped cars

As the number of cars in EU is increasing so is the number of scrapped cars (End of Life Vehicles) that need to be treated: at present, the quantity of waste from scrapped cars in the EU is estimated at 8 to 10 million tonnes.

Scrapped cars are usually, after dismantling of directly reusable parts, shredded into small pieces and then separated into three fractions – iron and steel, other metals and non-metallics (Figure 3.7.11). The metals are to a very high degree recycled and smelted down to new raw materials. Re-smelting of metals is less energy consuming than production of metals from ore, but creates new problems of air pollution and/or hazardous dust from the cleaning of the smoke. Secondary steelworks are estimated to be responsible for 28% of the chromium, 16% of the zinc and 3% of the dioxins emitted in Europe (UNECE, 1998). Secondary steel smelting typically results in 10-15 kg dust per tonne steel recycled. In 1996 about 700 000 tonnes of dust were generated in Western Europe. The dust is polluted with heavy metals and has to be treated at special treatment plants (Hoffmann, 1997). The amount and hazardous properties of the dust reflect the quality of the scrap received. The Danish Steel Works was able to reduce the load of heavy metals in scrap by 10% from 1992 to 1995 through stricter rules for pre-treatment of the scrap. After 1995 heavy metal content has increased due to the increasing use of zinc in cars (Danish Steel Works, 1997).

In relation to waste treatment the non-metal part, shredder waste, is the most problematic. The present amount of shredder waste from cars is in the range of 2 to 2.5 million tonnes in the EU. This waste is a mixture of foam, textiles, plastic, rubber, glass, oil and hazardous waste. It is generally highly contaminated with heavy metals, oil, brake fluids etc. and at present this waste is landfilled in most Member States. It cannot be recycled and incineration is problematic due to the often high content of heavy metals and PVC. Danish studies indicate that better sorting of shredder waste can reduce the heavy-metal content considerably and make incineration with energy recovery less problematic (Miljøstyrelsen, 1997).

3. Waste amounts and treatment in the Accession Countries

The 10 central and eastern European Accession Countries applying for membership of the Union will need to harmonise legislation and practices in the area of waste management to ensure compliance with EU legislative requirements. Total reported quantities of waste reported are three times the EU average. Although there are differences of definition and data coverage, the main explanation seems to be higher reported amounts of mining waste and waste from agriculture. Where a breakdown is available by source the average figures for manufacturing waste and waste from energy are about 50% above the EU average (Figure 3.7.12 & 3.7.13).

The generation of industrial waste depends on both the type of industry and the extent to which production processes make use of cleaner technology and waste minimisation procedures.

4. Environmental impacts of landfilling and incineration of waste

4.1. Landfilling

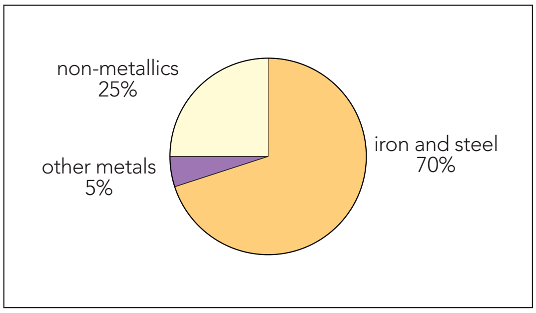
The main environmental pressures from landfilling of waste are:

- pollution of surface water and groundwater with toxic substances and nutrients leaching from the waste;
- contribution to the greenhouse effect by emission of methane;
- land use (including loss of natural areas).

Furthermore the landfills represent a permanent loss of resources and the need for controlling the pollution leads to increasing public expenditure for monitoring and clean-up operations.

The extent of these problems varies according to the type of waste landfilled, the construction of the landfill and the hydrogeological conditions. In relation to the risk of groundwater pollution studies have shown that the leachate may be a risk even after several centuries. Pollution of

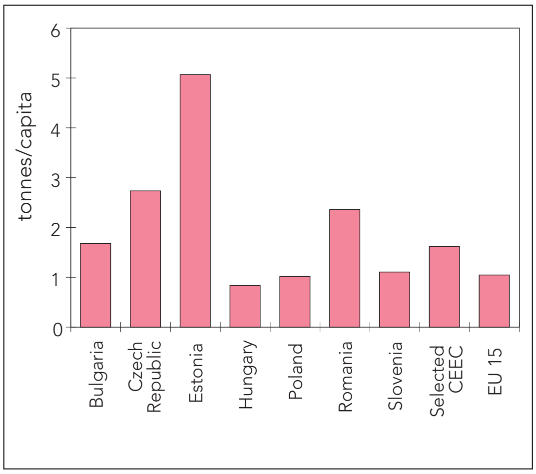
Car composition Figure 3.7.11



Major environmental problems are related to the treatment of the 25% non-metallic parts of scrapped cars.

Source: European Commission, 1997a; IPPE, 1996

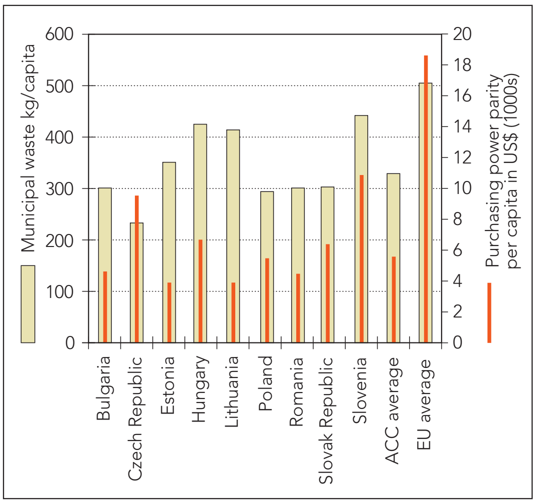
Manufacturing waste + Waste from energy/capita in selected Accession Countries Figure 3.7.12



The figure shows that the quantity of waste from manufacturing and energy production is in average about 50% higher in selected Accession Countries than in EU. The very high total for Estonia is mainly due to waste from oil-shale-based energy production.

Source: EEA, 1998b; OECD, 1997a

Manufacturing waste + Waste from energy/capita in selected Accession Countries Figure 3.7.13



The figure shows that the average generation of municipal waste is about 40% higher within EU (505 kilo/capita/year) than in the Accession Countries (AC) (311 kilo/capita/year). GDP expressed as average Purchasing Power Parity (PPP) in the AC is about 30% of the EU average. There is no trend in the connection between waste generation and PPP as there seems to be within the EU. Latvia is not included in the table because the data for Latvia is not clearly defined.

Source: EEA, 1998b; OECD, 1997a

groundwater will often give problems for decades even after the source of the pollution has been stopped because groundwater resources are generated only very slowly. Sorting and pre-treatment (e.g. incineration) of the waste can reduce the harmfulness of the leachate, but even leachate from incineration slag may exceed groundwater quality criteria for up to 100 years (Table 3.7.3).

Major gases emitted are methane and carbon dioxide from degrading organic substances in the waste. The greenhouse effect of methane is estimated to be 56 times that of carbon dioxide over a 20-year period and 21 times over a 100-year period (IPPC, 1996). Methane is estimated to be the cause of 20% of the global greenhouse effect (European Commission, 1997b) (see Chapter 3.1). From most landfills methane is released directly into the atmosphere where it contributes to the greenhouse effect. Methane from landfills was estimated to make up 28% of total methane emissions from the EU in 1995 (European Commission, 1998a). Before being released to the atmosphere methane may accumulate in buildings on or adjacent to landfills and present a very real danger of explosion.

The problems of methane emissions can be solved either by avoiding landfilling of organic matter or by collecting and utilising the gas at the landfill. A number of Member States have already issued or plan to issue general bans on landfilling of organic waste. The proposed Directive on the Landfilling of Waste (European Union, 1998) will demand gas collection from all new landfills receiving biodegradable waste and sets goals for the reduction of municipal organic waste to be landfilled. The first effects of this directive will appear seven years after implementation. Even after this date organic waste from industry and other activities can be landfilled providing gas collection systems are installed.

4.2. Incineration

The total quantity of waste incinerated in the EU is not available from official statistical sources. Data reported to the OECD indicates a total annual incineration of Municipal Solid Waste (MSW) of about 26 million tonnes (OECD, 1997a). This must be taken as the minimum quantity. In several countries reported quantities of incinerated waste are higher because other waste types are incinerated as well (industrial and commercial waste) (ISWA, 1997). Reported incineration capacities are also much higher for a number of countries (ETC/W, 1998).

It should also be noted that considerable quantities of waste are incinerated in cement kilns, steel ovens and industrial boilers. In Germany alone the following quantities of waste are incinerated in cement kilns: 170 000 - 200 000 tonnes waste oil, 60 000 tonnes hazardous waste (bleaching soil, solvents, paint sludge, contaminated wood) and 250 000 tonnes waste tyres (Johnke, 1998). To what extent these amounts are included in the OECD statistics is very unclear. The environmental impact of incineration outside incineration plants is only partially described.

Historically the primary aim of incinerating waste was to reduce the quantity of waste to be landfilled. In general incineration reduces municipal waste to about 30% of its original weight (generation of 300 kg of bottom ash per tonne of waste input). The remaining slag is much more stable than

Table 3.7.3. **Pollution from landfills can go on for centuries**

Rate of leachate production	Hazardous waste landfill	Municipal solid waste landfill	Non-hazardous low organic waste landfill	Inorganic waste
Medium: (200mm/annuum)	600 years	300 years	150 years	100 years
High: (400 mm/annuum)	300 years	150 years	75 years	50 years

Estimate of the time (in years) needed before leachate from different landfills can be released without risk to groundwater resources. The time needed to wash out the pollutants depends on the amount of rainwater washing through the waste (leachate production); two scenarios are presented. Calculations are based on a landfill with an average height of 12 m. Non-hazardous low organic waste landfills represent landfills receiving a mixture of commercial waste and non-hazardous industrial waste.

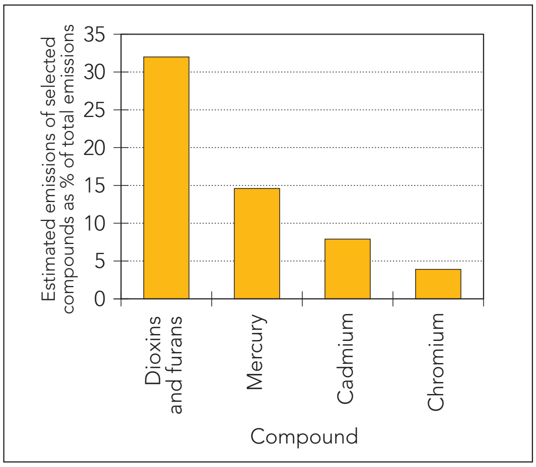
Source: Hjelmar et al., 1994

untreated waste and far easier to landfill or recycle (in road construction etc.). In many incinerator plants the energy obtained is utilised, and the focus on energy recovery has been increasing and is emphasised in the European Community Strategy on Waste.

Despite its positive aspects waste incineration also creates new problems through release of air pollutants and generation of secondary waste streams (slag and fly ash).

Air pollution
The main contaminants released in the combustion process are acid gases, polycyclic aromatic hydrocarbons (PAH), dioxins (PCDD) and furans (PCDF), dust and heavy metals.

Incinerator emissions Figure 3.7.14



The figure shows the relative share of emissions from incineration plants compared with total European emissions including natural sources. Based on estimates for a total of 38 European countries in 1990 (latest full data available).

Source: Umweltbundesamt, 1997

For some compounds waste incineration has contributed significantly to the total pressure on the environment (Figure 3.7.14).

Emissions from incinerators have undoubtedly been reduced considerably after 1990 due to the closing of many small installations and the introduction of cleaning systems. Estimates covering the EU, Norway and Switzerland show a marked decrease in dioxin emissions from 2 000 g dioxin equivalents (I-TEQ) in 1990 (Umweltbundesamt/ TNO, 1997) to 1 341 g in 1994 (Landesumweltamt Nordrhein-Westfalen, 1997). Similar decreases must be expected for heavy metals. In 1994-95 waste incineration's share of total emissions in Germany was estimated to be 12% of dioxins, 4% of mercury and 0.3% of cadmium.

Residues from air pollution control systems
Due to both EU and national legislation most large incineration plants and all plants established after 1990 are now equipped with advanced cleaning systems. No statistical data exists on the quantity of residues from flue-gas cleaning. As the quantity of waste generated depends on the process (Table 3.7.4), the composition of the waste incinerated and the design of the treatment system, estimates will be very uncertain.

Common to all residues is that they are highly contaminated and in most cases classified as hazardous waste. Unless treated further the pollutants are also very soluble and the waste is therefore difficult to store in landfills.

The problems of incinerator slag
Based on available information the total amount of slag from incinerator plants is estimated to be between 6 and 9 million tonnes per year in EEA countries. In a number of countries the slag is recycled and used for road construction, embankments and noise barriers and for concrete production. In Denmark and the Netherlands between 85 and 90% of the slag is recycled, while only 50% is recycled in Germany and hardly any slag is recycled in Sweden (DEPA, 1998 and International Ash Working Group, 1997).

When analyzing the chemical composition of incinerator slag a major concern is the heavy-metals content which is in many cases considerably higher than the concentrations occurring naturally in soil (Table 3.7.5).

This means that in many cases the use of slag for construction purposes may in the long term lead to contamination of surrounding areas with dust containing heavy metals if the surface is not sealed. On the other hand use under asphalt or concrete will reduce this problem.

Approximate quantities of residue in kg dry matter per tonne of waste incinerated using different methods of cleaning Table 3.7.4.

	Cleaning technology applied		
Residue Type	Dry	Semi-dry	Wet
Fly ash	(10-30)	(10-30)	10-30
Dry residue, including fly ash	20-50	15-40	
Sludge from wastewater			1-3

The table shows approximate quantities of residue per tonne waste from different flue-gas cleaning systems applied in Europe.

Source: International Ash Working Group, 1997

Table 3.7.5. **Heavy metals in slag and soils in mg/kilo**

The table compares concentrations of heavy metals and PAH in slag (mg/kilo) with natural variation in soil and Dutch target values for good soil quality. The table illustrates that for most heavy metals the content in incinerator slag may exceed even extreme natural conditions and in almost all cases exceed recommended standards.

Source: International Ash Working Group, 1997; Lamé and Leenaers,1998

	Range in slag	Range in natural soils	Dutch value for good soil quality
As	0.12 - 189	1 - 50	29
Hg	0.02 - 7.75	0.01 - 0.3	0.3
Cd	0.3 - 70.5	0.01 - 0.70	0.8
Cr	23 - 3.170	1 - 1000	100
Cu	190 - 8.240	2 - 100	36
Ni	5 - 500	7 - 4.280	35
Pb	98 - 13.700	2 - 200	85
Zn	613 - 7.770	10 - 300	140
PAH	13 - 19.000		1

In relation to contamination of water most of the heavy metals are present as very stable and insoluble chemical compounds (Table 3.7.6). Studies of leaching from slag show that the main risk of contamination of drinking water comes from lead and cadmium, but high contents of soluble chloride and sulphate also present a problem. The main risk when used for harbour construction is copper and lead. Copper is particularly toxic for marine organisms (Thygesen *et al.,* 1992).

Due to the potential for environmental pollution, recycling of slag calls for regulation and strict control of the amounts used, the conditions for use and possibly pre-treatment to reduce the amount of contaminants in the slag. The identified problems highlight the need for continuous reduction in the use of heavy metals and improved sorting of the waste before incineration.

Table 3.7.6. **Environmental risk factors from leaching from slag**

Compound	Drinking water	Sea water
Cadmium	128	13
Copper	21	1 586
Mercury	60	12
Lead	420	344
Chloride	160	0
Sulphate	126	0

The table shows how many times leachate from slag exceeds selected water-quality criteria or different compounds based on leaching tests. The quality criteria have been selected from national and EU criteria in order to represent 'worst case'. Chloride and sulphate do not present a problem in coastal areas due to the natural high concentration in sea water, while copper is particularly toxic to marine organisms but a minor problem in drinking water.
Seawater scenario is based on use of slag for harbour construction.

Source: Thygesen et al. 1992

5. Outlooks

Per-capita consumption is expected to significantly increase in the EU between 1995 and 2010. Based on assumptions that historical trends of waste generation will continue, this could more than counter gains from current policy initiatives to reduce waste generation linked to consumption, suggesting that new initiatives will be required to stem the growth in waste generation.

5.1. Outlook trends

The limited systematic and consistent data hinders the development of future waste trends. Nevertheless, if observed trends continue under the baseline scenario, most types of waste will most probably increase over the next decade. Household waste, for example, is likely to grow by around 20% to 2010 for the EU as a whole.

Projections suggest that paper and cardboard consumption in the EU could expand by 44-62% by the year 2010 (ETC/W, 1998). Thus, between 92 million and 105 million tonnes of waste paper and cardboard will probably be generated by 2010 under the projected rate of consumption.

Glass consumption could equally expand by 24-53% for the period 1995 to 2010 (ETC/W, 1998). This means that by 2010 between 16.2 million and 20 million tonnes of glass waste will probably be generated.

Within municipal waste, the amount of plastic waste is estimated to increase by 63% from 1993 to 2005 (APME, 1995; SOFRES, 1996).

Waste from scrapped vehicles could grow dramatically in the coming decades; the number of end-of-life vehicles is expected to increase by 21% between 1995 and 2010 for the EU (ETC/Waste, 1998). Another estimate suggests that the number of scrapped cars could even increase by 17% by 2000 and by almost 35% by 2010 compared with 1995 in the EU12 (Figure 3.7.15; excluding former East Germany) (Kilde and Larsen, 1998).

For total solid waste, no comprehensive projections of sectoral share are available for 2010, although currently manufacturing and construction/demolition each account for 25% of the total weight. The expected rapid expansion of the service and transportation sectors may have obvious implications for the amount of packaging and scrap vehicle waste during the outlook period.

To keep paper and cardboard waste disposal and incineration levels constant with those of 1996, about 68 millions tonnes would have to be recycled by 2010. Such a development would demand an increase in recycled amounts of more than 100% (more than 2 million tonnes per annum). Similarly, 10 to 14 million tonnes of waste glass (an increase of 35% to the 90% level) would require recycling by 2010 just to stabilize the amount of glass landfilled.

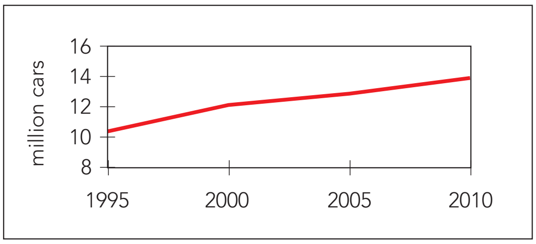
In general, landfilling is expected to decrease and recycling and incineration with energy recovery to increase during the outlook period. This will represent some progress in waste management in Europe, although hazardous waste and emissions of toxic compounds from incineration plants will continue to be produced and recycling plants will also keep generating secondary waste and emissions. Increasing efforts on waste avoidance, phasing out of toxic compounds in materials when feasible and separation at source could however mitigate these problems.

5.2 Policy implications

The expected waste trends during the outlook period suggest that existing policies, although providing some degree of success, will not be sufficient to stabilise waste arisings, meet policy objectives, or progress towards sustainability. Future product policy in EU will be of great importance for the possibilities to reduce the amounts of waste. The Commission (DG XI) has already taken the initiative to make a study in this area (Ernst &Young, 1998).

Efficient waste management and recycling must be supported by measures to reduce waste generation. This calls for consideration of the total lifecycle of products and services, emphasising preventive measures at source and re-use of products and components. Otherwise, the EU target of stabilizing municipal waste per capita by 2000, although somehow arbitrarily established by the Fifth Environmental Action Programme, is unlikely to be achieved.

Car projection Figure 3.7.15



The graph shows estimated numbers of scrapped cars in EU12 (excluding former East Germany) from 1995 to 2010. All figures are based on a model using historical data (until 1990) and projections of the car fleet combined with detailed information on age distribution of cars in the different Member States. The result should be seen as a trend more than a projection of exact numbers.

Source: Kilde & Larsen, 1998

Innovative initiatives already exist in several EU countries. Specific proposals by the European Commission include a directive on the treatment of scrapped vehicles with the aim of increasing the recycling of materials to reduce the problems associated with shredded waste. Important issues which would be addressed are the quantities of hazardous materials in cars and how to provide for more efficient disassembly and re-use/recycling of materials. Another possible initiative would be standardisation of container glass used for beverages to ensure re-use, thereby reducing the generation of glass waste.

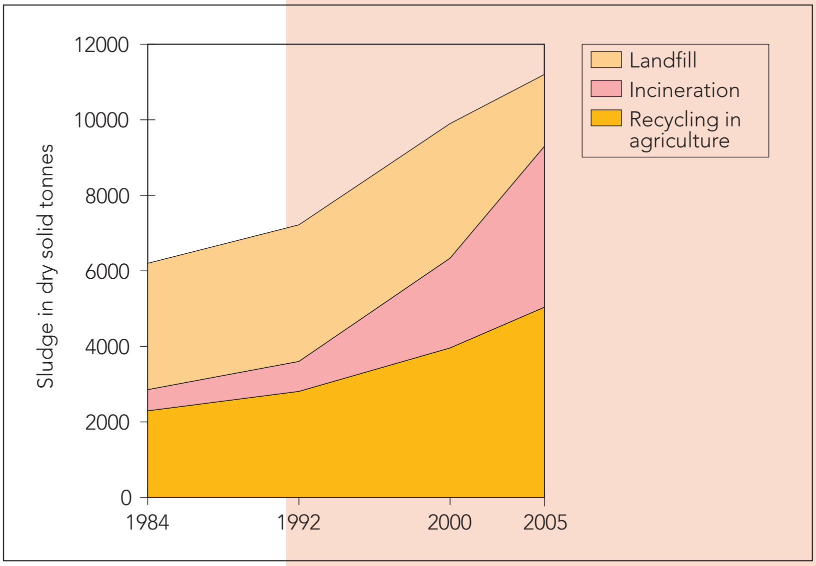
5.3. Accession countries

With strong economic growth anticipated for the outlook period in the Accession Countries, a substantial increase in the amount of municipal waste is to be expected. If quantities reach the average amount per capita for the EU, the total amount of municipal waste in the Accession Countries will increase by 50% from 34 million tonnes in 1995 to 53 million tonnes in 2010 (Figure 3.7.18). An increase of this order would cause enormous problems for waste management and demand efficient measures for collection and recycling.

Recycling plant capacity exists in eastern Europe based on the need to conserve due to the previous lack of imported products and raw materials. Previously re-use of containers and materials was an economic necessity and the governments subsidised recycling by paying small amount of money to small private companies for collecting the used material. The markets for recycling have in many cases been privatised and the subsidies removed, whereby re-use and recycling have decreased. Some of the plants, now privatized, are looking for

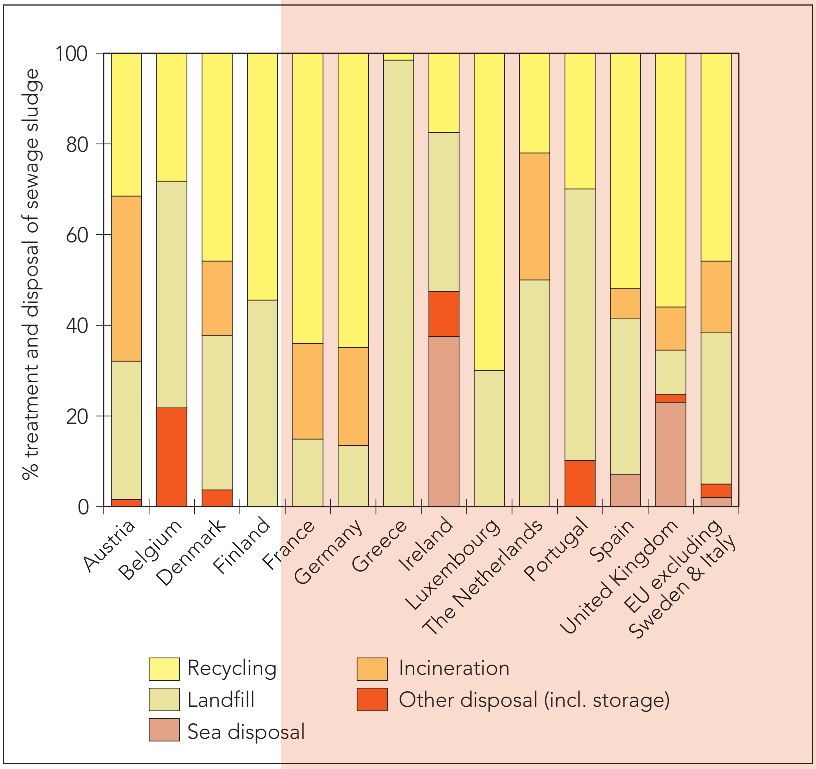
Box 3.7.1. Case study: Sewage sludge – a future waste problem?

Figure 3.7.16 **Sludge projection - EU, 1984-2005**



Source: Hall & Dalimier, 1994, *expanded to EU+3 by ETC/IW*

Figure 3.7.17 **Sludge treatment: variation in EU, 1995**



Source: European Commission, 1998c ; NRC the Netherlands (for Dutch figures), 1999

Thousands of treatment plants for urban waste water established over the last decades reduce the pollution of our lakes, rivers and coastal waters but are also the source of a rapidly growing waste problem: sewage sludge. The annual production of sewage sludge in the EU was an estimated 7.2 million tonnes dry solids in 1992. If the sludge is only mechanically dewatered the quantity of sludge to be managed is between 22 and 30 million tonnes.

Due to more stringent demands for treatment of urban waste water (Council Directive 91/271/EEC; see Chapter 3.5) many new treatment plants are due for completion by 2005. The amount of sewage sludge is thus expected to increase by 50% to at least 11.2 million tonnes dry solids by 2005 (Figure 3.7.16) (Hall & Dalimier 1994; updated to EU by ETC/IW). For some countries the quantity will increase by as much as 500%. This expected increase is in itself a challenge for waste management and the choices of treatment and disposal methods will have large economic and environmental implications.

Sludge can be a valuable fertilizer in agriculture. It is a good phosphorus source and also has a nitrogen content that can be valuable especially for crops with a long growing season (ISWA, 1998). The organic content of the sludge can help improve the soil structure and in general sludge stimulates beneficial biological activity in the soil (DEPA, 1997a). Phosphorus being a limited resource makes recycling of sludge for agricultural purposes an appealing solution for sustainable management of sludge.

However, sludge can also be contaminated with heavy metals, bacteria and viruses, and a number of organic substances, and both EU and national regulations set limits for contaminant concentrations to protect the soil and humans from pollution. Much of the sludge produced is already too contaminated and has to be incinerated or landfilled. Landfilling of sludge has hitherto been an inexpensive means of disposal, but both national restrictions and the proposed Landfill Directive will make landfilling more expensive. Several countries have introduced general restrictions on the landfilling of organic waste (Figure 3.7.17).

Incineration reduces the sludge to ash which can be landfilled. In most cases supplementary fuel is needed in order to burn the sludge and there is usually no net gain of energy (Johnke, 1998). Depending on the concentration of heavy metals and the incineration process the residual ash may be classified as hazardous waste.

The European Commission is considering tougher limit values for heavy metals and possibly limits values for some organic compounds which may further limit the potential for recycling. Several Member States have already established more stringent limit values for heavy metals and a number of Member States have also introduced limit values for a number of organic pollutants. A Danish survey indicates that up to 41% of the sludge may be in conflict with new limit values coming into force in year 2000 (Ingeniøren, 1998). In contrast availability of agricultural land in the vicinity of the waste water plant,rather than sludge quality, appears to be the primary factor determining disposal routes in the UK (Gendebien et al, 1999).

.../...

In addition, increased consumer awareness has led large supermarket chains in both France and Germany to reject products from farms using sewage sludge. Composting and other biological treatment options may to some extent solve the problem of pathogens and organic substances of concern but problems of heavy metals will still be a source of public concern.

The economic consequences of a restricted agricultural application of sewage sludge are considerable. Depending on the alternative chosen the cost may rise from EUR 75 per tonne for agricultural use to EUR 400 for incineration in some countries (ISWA, 1998). One German source even gives prices up to EUR 600 per tonne for thermal treatment (Johnke, 1998). Thus a thrust for phasing out the use of the problematic compounds may be an economically sound solution.

foreign sources of recyclable materials (Soil & Water Ltd., 1997). This course could hamper development of more efficient recycling systems for waste generated in the Accession Countries.

6. Responses – what is being done and is this sufficient to solve the problems?

6.1. Outline of community regulation and strategy

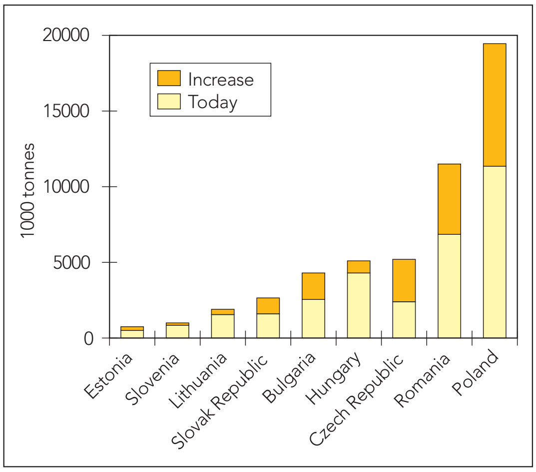
Early phases of Community waste legislation focused on clearly identified problems, including hazardous waste shipments, PCB disposal and waste from the titanium-dioxide industry. The legislation reflected the declared aim of the Treaty of approximation of national regulation directly affectingthe common market.

Later amendments of the Treaty, particularly the Single European Act (1987) and the Maastricht Treaty (1992) introduced a more general objective of protecting and improving the quality of the environment. These changes allow for a strengthening of the Community waste legislation aiming at establishing an integrated waste management policy in the Community. However this new focus may create new conflicts with the central policy of creating an internal market.

In line with the policy framework, a Community Strategy for Waste Management was initially adopted by the European Commission in 1989. The strategy sets out four strategic guidelines: Prevention, re-use and recovery, optimisation of final disposal and regulation of transport, together with a number of recommended actions.

The main strategic guidelines were maintained in the 1996 review of the Community Strategy, adding that preference should in general be given to the recovery of material over energy recovery. However, particular focus is further given to three main problem areas: i) scarcity of quantified and standardised information; ii) inadequate implementation of Community legislation at national level; and, iii) delays in adopting more sophisticated environmental measures, such as economic instruments and voluntary agreements, to encourage increased responsibility among producers and consumers.

Figure 3.7.18



The figure shows the increase in the amount of waste in the Accession Countries if economic growth leads to just the EU-average amount of municipal waste per capita. Latvia is not included in the table because data on municipal waste for Latvia is probably not comparable with that from the other countries.

Source: EEA, 1998

The following three pieces of legislation , as a response to the strategy, constitute the backbone of the Community waste management policy:

- The Waste Framework Directive which requires Member States to take all necessary steps to prevent waste generation, to encourage re-use and to ensure safe disposal. A fundamental principle of the Directive is the one on self-sufficiency and proximity requiring Member States to establish in cooperation an integrated and adequate network of disposal installations enabling the Community as a whole as well as eache Member State to become self-sufficient in waste disposal and to dispose of waste in one of the nearest appropriate installations. Member States are required to draw up waste management plans as a major tool to achieve this policy.
- The Directive on hazardous waste which sets more stringent requirements to the management of hazardous waste.

- The Regulation on the supervision and control of transfrontier waste shipments which sets out stringent requirements for the control of waste shipments, taking into account the principles of self-sufficiency and proximity of waste for disposal.

Based on the general legal framework, the Community policy on waste is supplemented by a number of more specific Directives. These may be divided into two groups:

- Directives on specific waste streams covering both measures of prevention and common rules for separate collection and treatment (in particular the Packaging Directive and the Directives on batteries and accumulators, waste oils, sewage sludge and PCBs/PCTs);
- Directives aimed at reducing the impact of treatment and disposal by setting common technical standards for operation of treatment facilities (i.e. the Directives on incineration of MSW and hazardous waste and the proposed Landfill Directive).

In Table 3.7.7 the main elements of the strategy are described and related to the present legal action in force, considered legal and political action to support the Strategy. From the table it is clear that a number of legal actions at present target the main elements of the strategy, i.e. the hierarchy of principles: prevention, material recovery, energy recovery and final disposal. However most of the legislation in force is directed towards specific problems (waste types or treatment activities), while few legal actions are directed towards the strategy in a broader sense (i.e. supporting the hierarchy of principles). In addition, these few legal actions are of a very general character, thus complicating monitoring and enforcement. This is in particular the case with the Framework Directive, which in Article 3 and 4 sets up the core elements of the Strategy, but without any concrete measures to be taken by Member States. The provisions are kept flexible due to the very different circumstances in the Member States, relying instead on waste management plans, which according to Article 7 of the Directive are to be drawn up by Member States. Except for the specific Directives, the strategy, at this stage, is therefore almost solely based on a legal framework focusing on administrative and notification procedures.

The Directive on packaging and packaging waste is the only existing directive addressing the hierarchy in more concrete terms by setting up concrete goals for recycling of material and recovery of energy.

In addition to the present legal framework, a number of new initiatives are under way, supporting the strategy in more concrete terms. This is in particular the case with the proposed Directive on the Landfilling of Waste establishing targets for the reduction of biodegradable municipal waste going to landfills. Also the current proposal for a Directive on end-of-life vehicles will provide a support to the strategy, setting up certain targets for the re-use, recycling and recovery of end-of-life vehicles. Other initiatives under way within the Commission focus on, for example, electrical and electronic waste, composting and hazardous municipal waste.

6.2. What progress has been made in implementing the EU waste strategy?

Under the EU Waste Strategy (see section 6.1 above) the general trend of increasing waste generation suggests that waste prevention initiatives have generally not been sufficient to reduce, or even to stabilise the quantity of waste.

For some countries it is possible to identify an increase in recycling and a reduction in landfilling for the period 1985-1995 (Table 3.7.8), but for many countries landfilling is still the most common treatment method (Figure 3.7.19).

For municipal waste it is possible to demonstrate trends in treatment in the EEA member countries. Even though there has been an increase in the level of recycling, landfilling remains the most common treatment and is in 1995 on the same level as in 1985-90. In the same period there has been an increase in the amount of municipal waste landfilled from 86 million tonnes to 104 million tonnes. Even if part of this increase may be due to better registration it is reasonable to conclude that in absolute figures, the EEA countries landfilled more municipal waste in 1995 than in the period 1985-90.

A breakdown of treatment routes for construction and demolition waste and manufacturing waste is provided for a number of countries. Table 3.7.9 demonstrates a shift away from landfilling towards recovery for these two selected waste streams.

However the overall conclusion regarding the treatment of waste in the EU is that landfilling is still the most common treat-

Main elements of the EU Waste Management Strategy Table 3.7.7.

Strategy	Legal action in force	Considered legal and political action
Prevent waste generation and reduce its hazardous content. Hierarchy of principles: prevention material recovery energy recovery safe disposal	Treaty, Art. 130R Member States required to: • encourage firstly, the prevention or reduction of waste, secondly the recovery of waste by means of recycling, re-use or the use of waste as a source of energy *(Framework Dir, Art. 3)*; • ensure that waste is recovered or disposed of safely, and prohibit the dumping or uncontrolled disposal of waste *(Framework Directive, Art. 4)*; • draw up waste management plans *(Framework Dir., Art. 7)*.	Possible proposals to set quantitative targets for reducing and recovering waste *(COM (96) 399)*
Prevention of waste generation	Community Regulations on eco-audit and eco-labels *(Regulation 1836/93 and 880/92)*. Member States required to take measures to prevent generation of packaging waste, limit the heavy metal content of packaging, and inform consumers *(Directive 94/62, Art. 4, 11 and 13)*.	In particular cases EU-wide rules to limit or ban the presence of heavy metals or specific substances in products to prevent hazardous waste to generate *(COM (96) 399)*. Integrate the principle of producer responsibility in all future measures on a case-by-case basis (COM (96) 399). Improve environmental dimensions of technical standards *(Council Resolution 97/C76/o1)*.
Prevention of impact on environment Prevent the negative impact on the environment	Member States required to take measures: • to reduce the heavy-metal content of batteries and accumulators, ensure separate collection, inform consumers, and prohibit marketing of certain batteries *(Directive 91/157);* • to collect and dispose of waste oils safely and prohibit any discharge of waste oils into inland surface waters, groundwaters etc. *(Directive 75/439, Art. 2 and 4);* • for the use of sewage sludge in agriculture in order to prevent harmful effects on soil, vegetation, animals and man *(Directive 86/278)*; • to implement common emission standards and operation criteria for incinerators for MSW and hazardous waste *(Directives 89/369 and 94/67)*.	Proposed specific requirements for Member States to ensure that measures aiming at reducing the negative impact on the environment from end-of-life vehicles are implemented *(COM (97) 358)*. Proposed directive on landfills setting minimum technical and administrative standards for landfills *(COM(97) 105)*.
Recovery Where generation of waste cannot be avoided, waste shall be re-used or recovered for its material or energy. Where environmentally sound, re-use shall be further encouraged in order to avoid generation. Preference to be given to recovery of materials over energy recovery operations.	Specific requirements for Member States to: • encourage re-use systems of packaging, to take the necessary measures in order to attain certain targets of recovery and recycling of packaging, and to ensure that systems are set up to provide for the return and/or collection of packaging waste *(Directive 94/62, Art. 5-7);* • to give priority to the processing of waste oils by regeneration *(Directive 75/439, Art. 3);*	Consider EU quality requirements to define when a given incineration operation is a recovery or a disposal operation *(COM (96) 399)*. Proposed specific targets of re-use, recycling and recovery for end-of-life vehicles, and demands for establishing systems for the collection of all ELVs. *(COM (97) 358)*. Development of a recycling industry based on modern technologies and methods and promote recyclability of materials and products *(COM(98)463)*.
Final disposal Avoidance of Iincineration without energy recovery and landfilling. Incineration with energy recovery to be promoted for all incineration installations, leaving landfilling in principle as the last solution. In the mid-term, only non-recoverable and inert waste to be accepted in landfills.	• Disposal costs must be borne by the producer of the waste (*Framework Directive, Art. 15*) • Member States required to take appropriate measures to: • establish an integrated and adequate network of disposal installations (*Framwork Dir., Art. 5*) • dispose of batteries and accumulators containing dangerous substances separately *(Directive 91/157, Art. 6).;* • ensure safe combustion of waste oils, and where neither regeneration nor combustion is feasible, to ensure safe destruction or controlled storage or tipping *(Dir. 75/439, Art. 4)*; • prohibit the uncontrolled discharge, dumping and tipping of PCBs/PCTs, making environmentally safe disposal compulsor*(Directive 96/59)*.	Proposed requirement for Member States to ensure that all costs are covered by the price to be charged by the operator for the disposal of any type of waste in that site and to set up a national strategy for reduction of biodegradable waste going to landfills ensuring certain targets to be met *(COM (97) 107)*. Encourage Member States to make serious efforts to prevent and to minimise quantities of waste that go to landfills, and in the long run to ensure that the price of disposal is made more transparent *(COM(96)399)*.

.../...

Strategy	Legal action in force	Considered legal and political action
Shipment of waste: the principle of self-sufficiency aims at avoiding shipments for disposal between Member States, while shipments for recovery are mainly submitted to the principles of the internal market.	Requirements on notifications procedures *(Regulation 259/93).*	Increase approximations ofl standards in order to establish common environmental standards for recovery operations *(COM (96) 399).* Concern of large-scale movements within the Community of waste for incineration with or without energy recovery *(Council Resolution 97/C76/01).*

Table 3.7.8. Total waste generation by disposal and treatment method in selected EU countries and regions (%)

Country/region	Year	Land-filling	Incineration	Recycling	Other treat-ment
Denmark	1985	39	26	35	.
Denmark	1994	23	20	56	1
Denmark	1995	17	20	62	1
Denmark	1996	20	19	60	1
Germany	1990	68	3	21	8
Germany	1993	55	4	25	21
Ireland	1995	73	1	14	13
Netherlands	1985	42	7	51	.
Netherlands	1990	31	8	61	.
Netherlands	1994	21	9	70	.
Netherlands	1995	18	9	73	.
Netherlands	1996	16	11	74	.
Sweden	1990	75	13	10	.
Catalonia	1994	56	10	34	.
Catalonia	1995	56	10	34	.

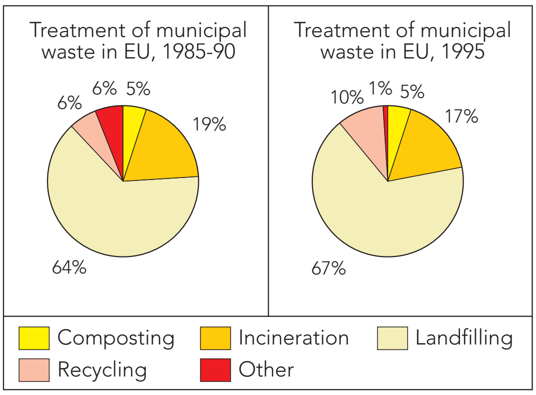
The table shows that progress has been made in some countries in increasing recycling and reducing landfilling

Source: NRCs , EEA 1998b; Junta de Residdus

Figure 3.7.19 Development in EU from 1985-90 to 1995 in treatment of municipal waste

The figure shows that despite increased recycling no progress has been made in reducing landfilling.

Source: EEA, 1998b; NRCs



ment route for waste and a major change is needed in order to implement the EU strategy on waste.

6.3. EU as a whole should treat its own hazardous waste

About 1.4 million of the 36 million tonnes of hazardous waste generated in EEA member countries (equivalent to 4%) is not treated in the country of origin but is exported, either to other EU countries, other OECD countries or to non-OECD countries.

According to the EU strategy, waste for disposal generated within the Community should be disposed in one of the nearest appropriate installations and should not be disposed outside the Community. For hazardous waste the EU has already banned export of all such waste for disposal to other countries except to EFTA countries. Export of hazardous waste for recovery to non-OECD countries is prohibited from 1998. This initiative follows a 1995 decision taken in the context of the Third Conference of the Parties of the Basel Convention on shipment of hazardous waste.

According to reports by the EU countries and Norway to the Basel Convention and the Commission very little hazardous waste was exported to non-OECD countries: 5802 tonnes out of a total of 1.47 million tonnes, corresponding to 0.4%, in particularly to India, New Caledonia and Kazachstan. If the figures reflect the actual situation, the export ban of hazardous waste for recovery to non-OECD countries therefore should be relatively easy for EU Member States to comply with.

EU exports to other OECD countries corresponds to 8% of the total, the destination mainly being the US, Norway and Switzerland. The remaining (91%) is exported among EU countries. The Community is thus also fulfilling the aim of treatment of hazardous waste within its borders. This conclusion does not however mean that sufficient treatment capacity for hazardous waste exists within the EU.

Development of disposal and treatment of waste from construction/demolition and manufacturing activities (%)

Table 3.7.9.

Country/ Region	Year	Construction & demolition				Manufacturing			
		Land-filling	Incine-ration	Recycling	Other	Land-filling and other disponal	Incine-ration	Recycling	Other
Denmark	1985	82	6	12	0	35	26	39	0
Denmark	1996	10	1	89	0	31	14	53	2
Germany	1990	32		10	58	38	8	49	4
Germany	1993	32		12	57	28	9	60	3
Ireland	1995	57	0	35	8	73		27	0
Luxembourg	1994	93	0	7	0				
Luxembourg	1997	93	0	7	0				
Netherlands	1985	50	1	49	0	34	2	64	0
Netherlands	1996	8	1	91	0	14	5	81	0
Sweden	1996					17	32	41	9
Catalonia	1995					37	1	52	10
Catalonia	1996					33	1	53	13

Source: NRCs; Junta de Residus

About 1 665 500 tonnes of hazardous waste was imported to EU Member States and Norway in 1995. Of this, 85% arose in other EU Member States, 8% came from other OECD countries, in particular Switzerland, US, Norway, Hungary and the Czech Republic, and 6% has unknown sources.

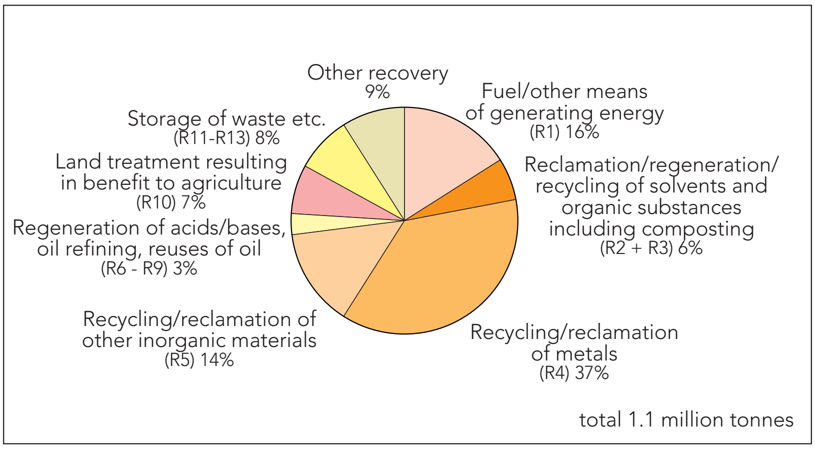
Many non-OECD countries do not have adequate facilities to treat their hazardous waste in a safe way. Until these countries are properly equipped, the EU could help by importing and treating this hazardous waste. However only 16 000 tonnes (1%) of imports to EU Member States and Norway was hazardous waste from non-OECD countries, in particular from South Africa, Brazil, Macedonia, and Slovenia.

Treatment of exported waste

About 75% of exported hazardous waste from the EU and Norway is exported for recovery and about 20% for disposal. Portugal, Spain, Luxembourg and the Netherlands export a large part for disposal. Figure 3.7.20 (according to the EU Framework Directive) shows which kind of treatment exported hazardous waste from the EU countries and Norway has received.

Treatment of exported hazardous waste according to the EU Framework Directive

Figure 3.7.20



The table does not include figures from Greece and Ireland. The figures for Sweden and France are 1994 figures.

Source: European Commission, 1998b; Norsas.

6.4. The importance of capacity, treatment prices and waste management

Waste management throughout Europe and above all the management of disposal and recovery is partly governed by the rules of market economy but is also strongly influenced by numerous EU and national regulations. Thus the success of the Community Strategy on Waste depends on a complex system governed by different national and regional regulations, the capacity of treatment facilities and the price structure between treatment forms and between nations.

Accordingly, knowledge of demand and supply of capacities for recovery, thermal treatment and landfilling and price relations is necessary to assess waste management comprehensively. Hardly any information is available on the capacity for re-use and recycling of different products and materials and an assessment is further complicated by the fact that many recyclable materials are traded on the world market. The following discussion will thus focus on capacities and prices for incineration and landfilling.

Incineration capacity in the EEA countries

Incineration plants for municipal non-hazardous waste are in operation in most EEA member countries, except Ireland, Portugal and Liechtenstein. In 14 countries a total of 533 incineration plants are reported in operation (nearly 280 of them in France). There is a very high degree of variation in the size of the plants. In addition to these, 239 incineration plants for hazardous waste are reported in operation.

By combining information on capacity where accessible with supplementary information on amounts of waste incinerated, the total incineration capacity for non-hazardous waste within the EEA is estimated to about be 33 million tonnes (NRCs, 1998b; OECD, 1997a). Incineration capacity is only available for about 17% of the total amount of municipal waste arising.

There is a very high degree of variation in available capacity for incineration (Figure 3.7.21). These differences may reflect both the level of development of waste management but also differences in strategies, climate, structure of energy supply systems and public acceptance of or opposition to incineration.

In some countries more than 90% of the capacity is reported to come from plants with energy recovery (NRCs, 1998b). While most countries have started to utilise the energy from waste there is a great deal of variation in the overall efficiency of energy utilisation (Figure 3.7.22). The variation may reflect differences in the composition of waste incinerated, but the main explanation is probably to which extent the incinerators operate only with electricity production, with heat production or a combination of the two. Optimal efficiency is obtained by combined systems where the heat is used in district heating systems.

Landfill capacities

Available data on landfill capacities is not complete and some confusion on the terminology for different types of landfills makes interpretation difficult. The following conclusions should therefore be taken only as a rough estimate.

Landfill capacity for non-hazardous waste (excluding sites used solely for inert waste) in the EU is estimated for 1996 to be about 1.2 billion tonnes in more than 8 700 licensed landfills. In addition to the licensed landfills about 3 450 unlicensed landfills have been reported from Germany, Greece, Portugal and Spain, of which 3 430 are in Greece (NRCs, 1998b; OECD, 1997b). Earlier data indicates a further 10 000 unlicensed sites in other Member States (Italy, France, Spain) (Hjelmar, 1994).

For the countries where data on both capacity and total amount landfilled in 1996 is available it is possible to calculate the remaining capacity expressed in years – i.e. how many years will it take to fill up the existing landfills at the present rate of disposal (see Figure 3.7.23).

Not all licensed landfills are equipped with the membranes and leachate collection systems needed to protect the environment properly. A survey made for the European Commission (DG XI) in 1994 and data collected by ETC/W indicates the following rates of application of liners and leachate collection systems in landfills licensed for municipal waste: Ireland <40%; United Kingdom, the Netherlands, Germany and France 40-70%, Denmark and Finland 70-90%; Austria, Belgium, Portugal and Sweden >90% (NRCs, 1998b; Hjelmar, 1994).

Considering the time needed for finding suitable locations, getting public acceptance and constructing the landfill there is therefore an urgent need for either a dramatic reduction in the amounts of waste landfilled or rapid construction of new controlled landfills or alternative treatment facilities. Furthermore, as reflected below the available capacity differs very much from one country to another.

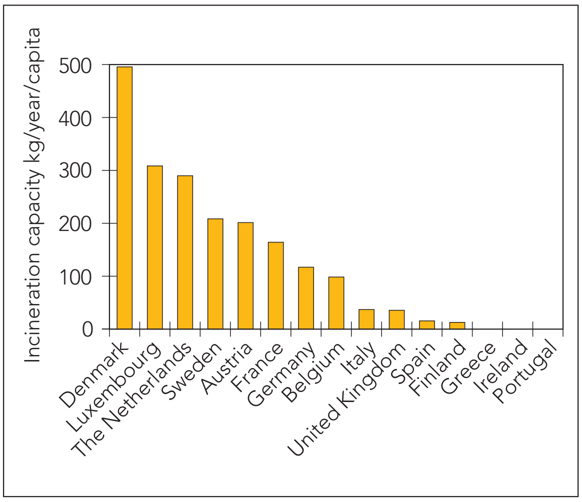
The effect of treatment prices on disposal patterns
In nearly all EEA member countries the average treatment prices for landfilling non-hazardous waste are far below those for incineration. This means that unless a new regulation is in place the market mechanism will direct waste to landfills instead of incineration with energy recovery. In other words the market mechanisms act in direct opposition to the official Community strategy. Of even greater concern is that landfills which have inadequate pollution control and make up about 67% of the landfills probably have prices below the average. Price mechanisms may thus also counteract the aim of reducing the impact of disposal (Figure 3.7.24).

The different treatment prices in EEA member countries are strongly influenced by national rules and regulations. A number of countries have issued detailed landfill regulations or guidelines which define the technical standard and the management of these waste management facilities. In particular, demands relating to the installation of liners, treatment of leachate and analysis of surrounding groundwater or surface water will increase the price of landfilling.

The difference in prices between member countries is in some cases due to very different environmental protection measures and reflects in this respect a conflict with the general community aim of environmentally safe disposal. Therefore, it is important for the Community to determine an obligatory state of the art for all kinds of waste management activities including rules for the implementation of post-treatment measures. This will lead to a gradual internalisation of external costs. This will however not change the fact that landfills are cheaper to construct and operate than incinerators.

Prices of incineration may vary according to the age of the installation, different interest rates, the income from the sale of energy or the cost of cooling towers, etc. The causes of current differences in treatment prices between incineration and landfilling have to be counteracted either by regulatory measures to harmonise environmental standards or other waste management measures supporting the general Waste Strategy or using economic instruments like waste taxes.

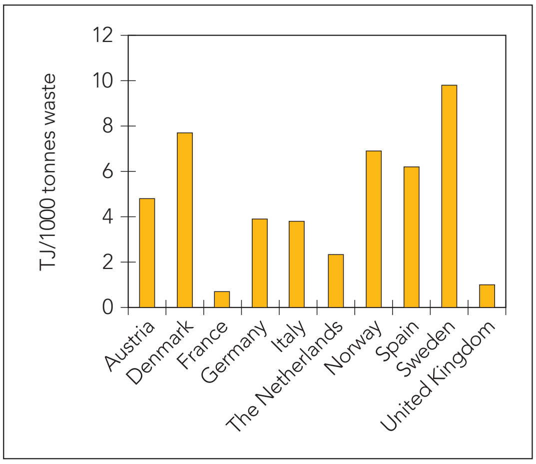
Incineration capacity in the EU Figure 3.7.21



The figure illustrates a large variation in available incineration capacity per capita within the EU. The figure covers municipal solid waste incineration plants with and without energy recovery and is based on information on capacity where available or actual incinerated quantity in 1996 or the latest reported year before.

Sources: NRCs 1998b; ISWA, 1997; OECD 1997a

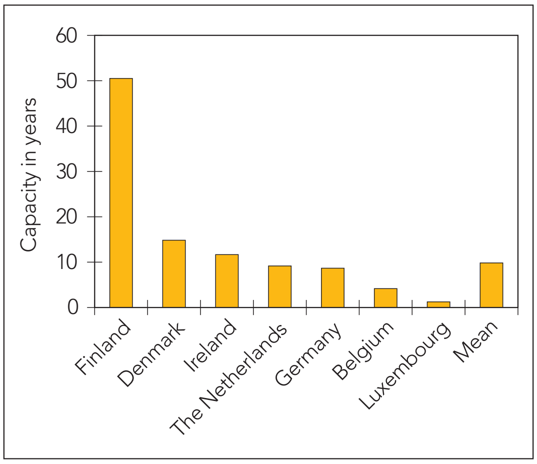
Energy recovery from incineration, selected countries Figure 3.7.22



The figure shows a large variation among the EEA countries in total energy recovery (heat+electricity)/ thousand tonne waste and is based on data obtained directly from the plants.

Source: ISWA, 1997; RIVM homepage

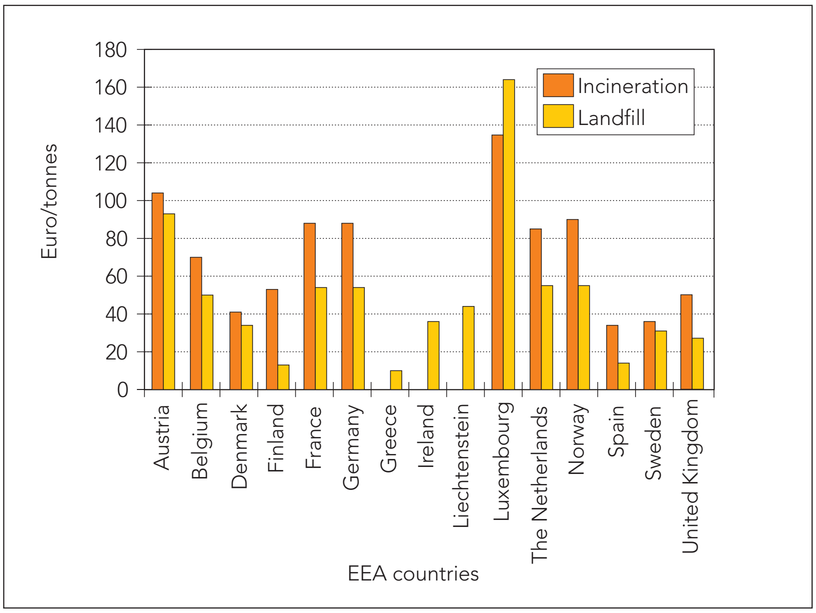
Available landfill capacity, selected countries Figure 3.7.23



The figure shows a very high degree of variation in the available landfill capacity expressed in years.
While the countries covered by the data as a total have sufficient capacity for 10 years, some only have capacity for a few years.

Source: NRCs, 1998b

Figure 3.7.24 **Avarage treatment prices for landfilling and incineration of non-hazardous waste**



Average treatment prices for landfilling and incineration of non-hazardous waste in selected EEA member countries (excl. waste tax and VAT). It should be noted that all prices are averages of observed prices and cover large variations between plants.

Source: NRCs, 1998b

Large differences in treatment prices between countries in an open market counteract the aim of treatment of the waste close to the source (the proximity principle). Large profits or savings can be obtained by finding a low-cost disposal solution. This may also directly influence the competitiveness of recycling industries where the cost of disposing of the residual waste can be considerable.

Waste taxes can be used to correct the price relation
As a consequence of the negative impact of the price relation a number of countries (Austria, Belgium, France, Denmark, the Netherlands and the UK) have introduced special landfill or general waste taxes which are levied in addition to the actual treatment price. Some German Länder also have imposed waste taxes but according to the Federal Court, they are in conflict with national legislation and have to be abolished.

Table 3.7.10. **Treatment prices in Denmark, 1997 (EUR)**

The table shows treatment prices in EUR in Denmark in 1997 with and without waste tax. The tax is acrually differentiated for incineration with only heat recovery and incineration with the more efficient combined heat/power production.

Source: DEPA, 1997b

	Landfilling	Incineration
Disposal fee before tax	20-34	14-40
Waste tax	45	28/35
Total	65-79	42-75

The rate of taxation varies among countries depending on the kind of waste (the UK, France, Austria), the kind of treatment and energy recovery (Denmark) and the technical standard of the landfill (Austria). The current rates per tonne are in Denmark between EUR 28 and 45, in AT between EUR 14 and 71 and in the UK between EUR 2.5 and 8.5. Despite differences in structure the general purpose of the taxes is to reduce landfilling and support a state-of-the-art treatment recovery and recycling of waste.

The Danish waste tax has been in operation long enough to assess the actual effect. Table 3.7.10 illustrates the effect of the waste tax on the relation between landfilling and incineration. A study of treatment patterns from 1987 to 1996 concludes that a 32% reduction of the waste landfilled or incinerated can to a large extent be explained by the effect of the waste tax. In the same period substantial increases in the recycling of building material, glass and paper have been obtained. The effect of the tax has been strongest in sectors with a high tonnage (i.e. building and construction) (Skou Andersen, 1998).

6.5. Integration into other policy areas

To support waste minimisation there is a need to integrate it into a number of related policy areas.

In relation to waste from industrial production the first steps have been taken with the Directive on Integrated Pollution Prevention and Control (IPPC) where waste is seen as an emission from production to be dealt with in the licensing process. In order to make this operational it is important to integrate the waste aspect into guidelines for best available technology.

The need for a closer focus on waste in a life-cycle perspective of products may be supported by special attention to waste generation when criteria for eco-labels are developed. Along the same line further focus on waste minimisation could be integrated in strategies for public procurement giving preference to products with minimised life-cycle generation of waste.

In some cases technical standards created by international standardisation organisations may present barriers to an increased direct re-use of components recycled material. Such barriers should only by accepted by the EU if crucial technical properties require it.

Finally it is evident that much waste generation can be seen as a product of an unfavourable relation between the prices of raw materials, production and maintenance costs (capital investment and labour) and the cost of disposal. A gradual substitution of taxes on labour with taxation on energy and raw materials is probably the most efficient way of obtaining sound resource management in a free-market economy. However this can only be done to a limited extent by individual Member States because their national industries will have higher costs than their international competitors, unless it is compensated by a reduction in labour costs.

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