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**Impact Assessment on the Thematic Strategy on the prevention and recycling of waste
and the immediate implementing measures**

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Impact Assessment on the Thematic Strategy on the prevention and recycling of waste and the immediate implementing measures

Lead DG: DG Environment

Other departments involved: ADMIN, AGRI, COMP, DEV, ECFIN, EMPL, ENTR, ESTAT, FISH, JAI, JLS, JRC, OIL, REGIO, RELEX, RTD, SG, TAXUD, TRADE, TREN

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EXECUTIVE SUMMARY

Waste is a growing issue for all modern expanding economies. The amount of waste generated is keeping pace with or in some cases outpacing the growth of recycling and is resulting in increased landfill. Waste management is currently responsible for 2% of greenhouse gas emissions. Other important aspects of the waste problem include dioxin emissions from incinerators, soil and groundwater pollution due to uncontrolled landfills, and exports of hazardous waste to developing countries. Waste is also an economic burden. Management of hazardous and municipal waste alone is estimated to cost industry and citizens up to €75 billion a year. In addition, the regulatory environment sometimes discourages waste recycling.

Recycling saves a lot of energy, resulting in reduced greenhouse gas emissions, reduces the production costs of materials such as cement, paper, glass and metals, reduces the energy demand and related pressure to increase oil prices and contributes to improving the competitiveness of EU industry. Trade between Member States in waste for recovery increased by 130% between 1995 and 1999 and close to 50% of European paper, metals and glass is made out of recycled materials. The waste sector has a turnover of over €95 billion for EU-25 and provides 1 200 000 to 1 500 000 jobs.

The EU legislation on waste developed over the last few decades has set a regulatory framework addressing the most acute negative environmental impacts of waste management. Important parts of this legislation remain to be implemented by the Member States in the years ahead and will result, *inter alia*, in cleaner incinerators and landfills and increased recycling of packaging, cars and electronic equipment. This policy is delivering significant environmental benefits but a continued focus on specific waste flows would do little to improve the environment further and would be increasingly costly.

The overall objective of waste policy is to reduce the environmental impact of waste generation and management and, in this way, contribute to reducing the overall environmental impact of resource use. Against this background, a set of preferred options has emerged from this IA that will increase the environmental efficiency and the cost-effectiveness of EU waste policy. This will involve:

- linking waste policy to product and resource policies (i.e. introducing life-cycle thinking in waste policy), national waste prevention programmes and increasing recycling and recovery of waste through framework approaches;

- moving to a European recycling society (i.e. a society that uses wastes as resources rather than discarding them in landfills) by developing common environmental requirements for recycling and allowing waste to circulate more freely across the EU;
- modernising the legislative framework by revising the waste framework legislation, adopting interpretative guidelines and repealing the priority given to regeneration of waste oils.

Overall, this new policy will increase the focus on important environmental issues and deliver improvements in the regulatory environment. It will entail negligible costs for industry and in the longer run could generate economic benefits for the EU. Given the framework character of this policy, Member States will shoulder much of the responsibility for delivering the benefits.

Key short-term benefits will be:

- Waste policy will become more focused on environmental impact, thereby becoming more efficient and cost-effective;
- The regulatory environment for waste management activities will be improved and lead to lower costs and reduced barriers for waste recycling and recovery activities. For example, using quality benchmarks to determine when recycled materials cease to be waste will reduce the administrative costs borne by businesses as a result of waste legislation. This measure has enormous potential. One recycling sector estimates that this measure could affect costs corresponding to roughly 1% of turnover. In addition, the quality benchmarks will improve markets by reducing market failures related to uncertainty about waste quality;
- Waste prevention policies will be implemented at the appropriate national, regional or local level, avoiding the introduction of economically inefficient measures at EU level. This will promote action closest to the point of generation of the waste and focus on the most environmentally relevant wastes;
- Increasing the amounts of waste recovered will result in lower emissions from waste disposal and environmental benefits such as reduction of greenhouse gas emissions.

This will lay the foundation to achieve further benefits in the longer term:

- With common standards in place the EU will be in a position to simplify the rules governing shipments of waste within the EU. This would result in lower costs for recycling activities and promote recycling, thereby contributing to reducing the associated environmental impact;

- More environmental benefits could be reaped by increased recycling at lower cost. For example, moderate increases in recycling of a given material instead of large increases in specific products could deliver more environmental benefits while cutting costs. In the case of plastics, cost savings of 16 to 37% could be obtained from a 10% increase in mechanical recycling.

The communication on “*A Thematic Strategy on the prevention and recycling of waste*” outlines the strategic approach and indicates how to proceed with its implementation. The proposal for revision of the Waste Framework Directive and other pieces of legislation proposed together with the communication are the first measures implementing the strategy.

1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

This Impact Assessment (IA) aims to analyse the impact of the Thematic Strategy on the prevention and recycling of waste (2004/ENV/001). It provides the European institutions and the public with information on the impact of waste generation and management and on policies addressing the issues of waste generation and management.

This impact assessment is built on a review of some 160 existing reference documents, additional research on recycling policies and the environmental performance of waste management facilities¹, input from stakeholders and Member States, and five expert meetings.

Stakeholders and Member States have been consulted throughout the development of the Thematic Strategy on the prevention and recycling of waste and its Impact Assessment (IA) in accordance with the Commission's minimum standards for consultation. The various stages of consultation have been documented on the Commission's website²:

1. A six-month Internet consultation was organised from May to November 2003 on the basis of communication COM(2003) 301 final "*Towards a Thematic Strategy on the prevention and recycling of waste*". This consultation invited general opinions and comments on the assessment of waste policies and the review of policy options contained in the communication. This included a request to provide data and information on environmental, economic and social impacts. 205 contributions were received and made available on the Commission's website;
2. A three-month Internet consultation was organised from the end of June to the end of September 2004 on the basis of a questionnaire presenting a list of options considered for inclusion in the strategy. This consultation focused on gathering data and information on the environmental, economic and social impacts of the options listed. 89 contributions were received. The main results of this stakeholder consultation on the IA on the strategy are summed up in tables available on the Commission's website³;

¹ See "Support in the drafting of an ExIA on the Thematic Strategy on the Prevention and Recycling of Waste", final report submitted by EPEC, available on the Commission's website at:

<http://europa.eu.int/comm/environment/waste/strategy.htm>.

² <http://europa.eu.int/comm/environment/waste/strategy.htm>.

³ See "Support in the drafting of an ExIA on the Thematic Strategy on the Prevention and Recycling of Waste", pp. 153-202, final report submitted by EPEC, available on the Commission's website at:

<http://europa.eu.int/comm/environment/waste/strategy.htm>.

3. These Internet consultations were accompanied by meetings with Member States and stakeholders to address specific issues emerging from the consultations. Five one-day meetings of experts, each focusing on specific issues, two general stakeholder information meetings and two meetings with Member States were organised and the agenda and outcome of these were made available on the Commission's website;
4. Several of the preferred options emerging pointed to a review of Directive 75/442/EEC (the Waste Framework Directive – WFD). A focused consultation was organised in early 2005 on aspects and options to be included in the review of the WFD. This included consultation of the Member States through a questionnaire followed by a meeting and a stakeholder workshop. The outcome of these meetings is available on the Commission's website;
5. A specific consultation was held on the implementation and environmental justification of Directive 75/439/EEC on the disposal of waste oils. Member States were asked to respond to a questionnaire in August 2004 and an eight-week Internet stakeholder consultation was held in early 2005. 49 contributions were received and posted on the Commission's website⁴;
6. A specific consultation was also held on integration of Directive 91/689/EEC on hazardous waste into Directive 75/442/EEC with a view to simplifying the existing waste framework legislation. Member States were asked to respond to a questionnaire in September 2004 and another eight-week Internet stakeholder consultation was also held in early 2005. 44 contributions were received and posted on the Commission's website⁵.

As stated above, the outcomes of these stakeholder consultations are available on the Commission's website and the main stakeholder input to the IA on the strategy is summarised in tables that are also accessible on the Commission's website. This has been taken into account and, in particular, used to construct the impact assessment tables in section 5 of this report.

An Inter-Service Steering Group (ISSG) was established for the IA. The ISSG met a total of four times, starting in February 2004. The following Directorates-General and departments participated in the ISSG: ADMIN, AGRI, COMP, DEV, ECFIN, EMPL, ENTR, ESTAT, FISH, JAI, JLS, JRC, OIL, REGIO, RELEX, RTD, SG, TAXUD, TRADE and TREN.

⁴ See specific webpage on the Waste Oils Directive at:
http://europa.eu.int/comm/environment/waste/oil_index.htm.

⁵ See specific webpage on hazardous waste at:
http://europa.eu.int/comm/environment/waste/hazardous_index.htm.

This IA follows the structure specified in the Commission's Impact Assessment Guidelines (SEC(2005)791). It considers the environmental, economic and social dimensions of waste policies in an integrated and balanced manner. This IA is very wide-ranging, as it aims at informing the institutions about the impact of different types of initiative:

1. The Thematic Strategy itself, a Commission communication which provides the strategic framework for the development of EU waste policy and future Commission proposals;
2. Revision of the waste framework legislation for immediate implementation of aspects of the strategy, both on issues of substance and to improve the regulatory framework in line with the better regulation approach to simplification;
3. Revision of specific legislation for immediate implementation of aspects of the strategy. This includes, in particular, revision of the existing legislation on waste oils management.

These three types of initiatives vary in nature. They range from general strategic policy guidelines to specific and practical proposals. This IA applies the principle of proportionate assessment by adapting the level of detail of the assessment to the needs of the various categories:

1. Generic impacts are assessed mainly in general qualitative terms to inform strategy development. Future Commission proposals implementing specific aspects of the strategy will be subject to a detailed impact assessment on their own;
2. Similarly, impacts related to framework measures are assessed mainly in general qualitative terms. However, for a number of issues addressed in the proposals to review legislation, the types of impact that can be expected are illustrated by worked examples of implementing measures;
3. The proposal to repeal the legislation concerning management of waste oils would have a more direct impact and is subject to a more detailed impact assessment. The full assessment is given in Annex I to this report.

In addition, this IA will need to be supplemented by assessments by the other European institutions, in particular concerning amendments of Commission proposals having a significant impact, and by Member States, from the point of view of major national measures implementing the strategy.

2. PROBLEM DEFINITION

Waste represents both an environmental threat and an economic challenge and opportunity for European society.

The EU legislation on waste developed over the last few decades has set a regulatory framework that addresses the most acute environmental impacts of waste management, such as high levels of dioxin emissions from waste incineration, leaching of pollutants into soil and groundwater from uncontrolled landfills, and export of hazardous wastes to developing countries.

However, the amounts of waste are growing and the EU needs to address important issues:

1. Hazardous waste generation increased by 13% between 1998 and 2002 to 58.4 million tonnes, i.e. 129 kg per capita, whilst gross value added grew by 10%⁶, demonstrating the strong link between economic activity and hazardous waste generation. Management of this waste costs €10 billion to €25 billion per year;
2. Municipal waste generation and wealth creation are also strongly linked, as shown by the 19% increase in both GDP and municipal waste generation between 1995 and 2003. This means an increase from 204 million tonnes (457 kg per person) to 241 million tonnes (534 kg per person). Municipal waste generation in the new EU-10 Member States is 312 kg per person and has stabilised after a decline⁷. Municipal waste generation is predicted to grow substantially as wealth grows in the EU, especially in EU-10. The potential cost of managing this waste is €30 billion to €50 billion a year⁸;
3. Controlled waste management is the source of 170 Mt CO₂ equivalent of greenhouse gas emissions – essentially methane – representing in 1995 4% of EU-15 greenhouse gas emissions⁹ and an annual externality of €1.7 billion to €6.8 billion¹⁰.

⁶ Waste Generation and Treatment in Europe, Eurostat, 2005 (pending publication).

⁷ Waste Generation and Treatment in Europe, Eurostat, 2005 (pending publication).

⁸ Calculated on the basis of costs for management of municipal waste ranging from €120 to €200 per tonne.

⁹ Waste management options and climate change, AEA Technology, Final Report to DG Environment, 2001, available at <http://europa.eu.int/comm/environment/waste/studies/index.htm>.

¹⁰ Calculated taking a valuation factor ranging from €10 to €40 per tonne CO₂ equivalent. Most of the valuation factors used in literature as well as the market value of carbon trading fall within this range. However, some methodologies documented in the literature use higher values, for example the EPS method uses 108.

The problem posed to European society by waste generation and management has to be seen as part of the wider issue of how increasing amounts of resources are used. On the one hand, waste generation is one consequence of the pattern of resource use while, on the other, waste that is generated constitutes largely untapped potential for substituting for use of virgin resources.

The increases observed in waste generation concern total waste and municipal solid waste (MSW) as well as materials and specific waste flows. In addition, despite an increasing trend towards recycling and incineration, the growth in waste generation means that the absolute amounts of waste landfilled are decreasing only slowly and, in some cases, are even increasing.

A separate IA attached to the Thematic Strategy on sustainable use of natural resources discusses the environmental problems related to resource use and the potential policy options to address these problems. Although that analysis is not duplicated in this report, it must be noted that the links between waste policy and resource policy are very strong. While the resource strategy looks at the fundamentals of resource policy and considers the basic patterns of the economy, the waste strategy takes waste as the starting point and seeks to shape a specific policy area. The waste strategy takes account of the important message delivered by the resource strategy that resource-related policies need to focus on environmental impact and aim at reducing the overall environmental impact of resource use.

Waste policies have the potential to contribute to reducing the impact of waste generation and management and in this way contribute to reducing the overall environmental impact of resource use. Waste prevention can influence the way in which resources are used while waste recovery and recycling can reduce the need to use virgin resources: from the 16 tonnes per capita of materials used in the EU every year, some 4 tonnes of waste are generated, i.e. about 25% of material input. However, although the potential of waste policies to reduce environmental impact is by no means insignificant, it is clear that waste policy is no substitute for a resource policy.

In addition, there are a number of implementation problems, ranging from dumping of waste at mismanaged landfills to shipments of hazardous waste in violation of international conventions. This can cause unacceptable environmental impacts in developing countries and in Member States. Therefore a focus on full implementation of existing EU legislation, in particular of the landfill directive and the waste shipment regulation on waste will be the foundation on which any new Strategy will be built.

Within waste policy five main issues have been identified that play an important role in determining the present patterns of waste generation and management and related failures of waste policies:

1. Waste policies are based on poor knowledge. The statistics on waste generation and management are of poor quality. Even more important is the lack of information on the impact of specific waste streams or processes. In some cases this has resulted in high regulatory pressure in some areas while others which could be of more importance remain untouched by waste policy.
2. **The potential of waste prevention to reduce environmental impact is underexploited.** The amounts of total waste and household waste are growing. Production, design and consumption choices are failing to reduce the amounts of waste generated and are putting an environmental and financial burden on the shoulders of European citizens and businesses. There is also a lack of effective Member State policies encouraging the prevention of waste.
3. **The potential of waste recycling and recovery to reduce environmental impact is underexploited.** Despite progress in recycling and recovery, landfill remains dominant and waste is only partly used to substitute for virgin resources. This is largely because the economic costs of waste disposal, recovery and recycling do not reflect externalities. This results, in particular, in low disposal costs that do not include negative externalities and high recycling costs that do not include the external benefits associated with substituting virgin resources. Issue 4 also contributes to discouraging recycling and recovery but calls for different types of policy responses. Therefore, issues 3 and 4 are considered separately.
4. **The complexity of EU and Member State legislation tends to discourage recycling and recovery activities.** Micro-management of waste-related activities and a degree of complexity in parts of EU and Member State waste legislation contribute to discouraging recycling and recovery activities. Diverging national legislation on waste recycling and recovery and extensive control procedures applied to shipments of waste for recovery are significant components of this problem. This approach is partly due to the perception that waste management operations can be polluting. However, this negative perception seems to persist, despite the recent progress made with the regulation and control of waste management processes which has significantly reduced the environmental impact of waste recovery.
5. EU waste law often remains unclear despite Court jurisprudence and has given rise to considerable litigation on its interpretation. This results in regulatory overlaps and uncertainty for competent authorities and the waste industry and could impede necessary investments.

In addition, the more specific issue of management of waste oils is also considered in the strategy and this IA. This issue is included in this IA because it more explicitly illustrates the problems arising from knowledge gaps, unclearness despite jurisprudence and the complexity of EU and Member State waste legislation. Furthermore, it is an example of taking a life-cycle approach to waste policy and can be dealt with at the same time as other issues addressed in the strategy.

1. **Implementation of the Waste Oils Directive has proved difficult.** The Member States have been failing to implement the priority given by the Waste Oils Directive (WOD) to processing waste oils by regeneration. Litigation over issues such as whether Member States have implemented appropriate measures for complying or whether national constraints for not complying with the priority provision could be lawfully claimed have led to a plethora of infringement cases. Several cases have been taken to the European Court of Justice, which has ruled against five Member States. Recent information has cast doubt over the environmental justification of giving regeneration of waste oils priority over use as a fuel. In addition, waste oil collection rates remain too low.

EU waste policy is well established and includes a substantial body of legislation based on Article 175 of the Treaty. EU action to address the identified issues is necessary to solve issues related to transboundary transport of pollution and to trade in recyclable materials on the internal market.

2.1. Background for the problem definition: the waste sector

The waste sector has been steadily developing in the EU for over a decade with high growth rates driven by the implementation of EU and national waste policies. It includes two sub-sectors: specialised waste management companies (collection, incineration, landfill, composting, etc.) and businesses recovering and recycling materials (paper, glass, metals, etc.).

The specialised waste management sub-sector has an estimated turnover of over €75 billion for EU-25. It provides 500 000 jobs¹¹. The sector is estimated to be growing by around 11% per annum¹². The number of known installations disposing of waste, recovering hazardous waste and incinerating waste in EU-15 is reported to exceed 14 500¹³. The number of specialised installations recovering non-hazardous waste must be added to this but is not documented.

¹¹ Extrapolation based on figures from the waste management sector.

¹² Analysis of the EU Eco-Industries, their Employment and Export Potential, Ecotech, available at: http://europa.eu.int/comm/environment/enveco/industry_employment/main_report.pdf.

¹³ Figures reported in the second drafts of the BREFs on waste incineration and waste treatment.

The waste recycling sector consists of a number of sub-sectors of industry that produce materials. Employment levels are estimated to be high but it is difficult to find accurate and comparable data on national employment in recycling. Extrapolation of published figures¹⁴ suggests that waste recycling provides 500 000 to 1 000 000 jobs in EU-25. This is estimated to include over 35 000 jobs in social economy organisations in EU-15¹⁵.

The ferrous and non-ferrous metals recovery and recycling sector in EU-25¹⁶ (excluding steelworks, smelters, refiners and foundries) comprises over 60 000 enterprises, of which 3% are large companies (handling 50 000 to 100 000 tonnes per year), 28% medium-sized companies (5 000 to 50 000 tonnes per year) and 69% small enterprises (collecting up to 5 000 tonnes per year). Some 500 000 persons are employed in this sector across EU-25.

The amount of materials that the recycling industry provides to manufacturing industry is increasing¹⁷. The statistics show that at least 50% of the paper and steel, 43% of the glass and 40% of the non-ferrous metal produced in the EU are currently derived from recycled materials. Just under 100 million tonnes of ferrous metal scrap with a value of between €15 billion and €20 billion is consumed in EU-25 per year. Consumption of major non-ferrous metals scraps within EU-25 stands at around 5 million tonnes with a value of over €4.5 billion a year.

Trade in recyclable waste between Member States is increasing rapidly. No information is available about trade in wastes that are not subject to control procedures. Information on controlled waste reported to the Basel Convention Secretariat¹⁸ shows that trade in such wastes between industrialised countries increased from around 2 million tonnes in 1995 to approximately 4.5 million tonnes in 1999. EU-15 is involved in some 75% of this trade, of which two thirds consists of trade between EU Member States; intra EU-15 trade has been increasing faster than global trade. Trade between Member States in controlled wastes for disposal is stable at around 500 000 tonnes per annum. By contrast, trade in controlled waste for recovery grew

¹⁴ Recycling Social Enterprises: Sustainable Businesses for Environmental and Social Regeneration, CECOP, 2000, gives some estimates of the number of jobs in the sector: 250 000 in Germany, 14 000 in Belgium and 6 000 in France. The extrapolation to EU-15 is consistent with information provided by the recycling sector.

¹⁵ La place de l'économie sociale dans les métiers de la récupération et du recyclage, CWESAR for IBGE, 1999.

¹⁶ Figures reported by the waste recycling sector.

¹⁷ Figures reported by the waste recycling sector.

¹⁸ Global trends in generation and transboundary movement of hazardous wastes and other wastes, Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, UNEP, 2002.

from around 1 500 000 tonnes in 1995 to 3 500 000 tonnes in 1999. It is dominated by trade in wastes containing metals and solvents.

2.2. Waste policies are based on poor knowledge

The available statistics on waste are recognised as being of poor quality partly because of consistency and comparability problems regarding statistics from different Member States, regions or cities. Progress is being made on this issue as the Waste Statistics Regulation¹⁹ is being implemented. Improved weight-based statistics on waste generation and treatment will be published by Eurostat, starting in 2006 for the reference year 2004.

However, statistics on waste generation and management alone do not give an accurate picture of the environmental impact. The balance of environmental and economic costs and benefits of waste recycling and recovery can be dramatically influenced by specific attributes of given wastes, such as their complexity and their level of contamination, by characteristics of recovery techniques, such as process efficiency, as well as by life-cycle aspects such as the nature of the primary resources saved.

Therefore, it is important to have data and information of acceptable quality covering the life cycle of the waste materials in order to assess both the needs for policy action and the achievements of policies. Such information must cover waste in general and not focus only on specific waste flows. This is growing in importance as issues of increasing complexity need to be addressed by waste policies.

Such overall information on the life-cycle environmental impact of waste generation and management is not currently available and where information is available concerning specific waste flows it suffers from lack of consensus on methodology and data.

Furthermore, in some cases the environmental justification of certain regulatory provisions that made environmental sense at the time of their adoption could be questioned in the light of changes in practices and techniques and of improved knowledge on environmental impacts. This is the case, for example, with the priority given in European waste law to the regeneration of waste oils over other recovery techniques (see also section 2.5).

Clearly, the unavailability of data and information of appropriate quality can be a major factor leading to sub-optimal waste management practices and policies and also makes policy assessment difficult.

¹⁹ Regulation (EC) No 2150/2002 of the European Parliament and of the Council on waste statistics, OJ L 332, 9.12.2003, p. 1.

2.3. The potential of waste prevention to reduce environmental impact is underexploited

As discussed in the previous section, statistics on environmental impact are not available. Therefore the data in this section are based on statistics expressed by weight. It should be noted that environmental impact per tonne generated will vary dramatically depending on the waste considered.

Waste generation in the EU is estimated at more than 1.3 billion tonnes per year²⁰. This includes waste from manufacturing (427 million tonnes), from energy production and water supply (127 million tonnes), from the construction sector (510 million tonnes), and municipal waste (241 million tonnes). In addition significant amounts of waste for which good estimate are not available are produced by agriculture, forestry, fishery, mining, quarrying, and the service and public sectors.

. Generally, information and projections point to waste generation increasing faster than GDP²¹, in particular municipal waste, construction and demolition waste and industrial waste. However, in a limited number of Member States there are signs of breaking the link between total waste generation and economic growth. This relative decoupling is probably partly linked to a change in the structure of national industries and trade in semi-finished and finished goods with EU Member States or third countries, implying that waste is generated outside the national borders.

The current pattern of use of resources is resulting in increasing waste generation. This trend is well documented in the literature reviewed although the general quality of waste statistics is poor and patchy:

- Between 1990 and 1995 total waste generation in the EU and EFTA increased by 10% whilst GDP increased by 6.5%²². With anticipated higher levels of economic growth, this trend is predicted to continue and will concern most wastes. For example, paper/board, glass and plastic waste are expected to increase by 40% by 2020 compared to 1990 levels²²;
- Hazardous waste generation increased by 13% between 1998 and 2002 to 58.4 million tonnes, i.e. 129 kg per capita, whilst gross value added grew by 10%;

²⁰ Eurostat, pending publication

²¹ Environmental Signals 2000, EEA, 2000.

²² Environment in the EU at the turn of the century, EEA, 1999.

- End-of-life cars will increase by 35% by 2010 compared to 1995 levels²³;
- Electrical and electronic waste is expected to grow by 3 to 5% a year²⁴;
- Construction and demolition waste almost doubled between the late 1980s and the late 1990s²⁵ in EU-15 and a similar trend is emerging in EU-10;
- Municipal waste in EU-25 grew by 19% from 204 million tonnes (457 kg per person) in 1995 to 534 million tonnes (534 kg per person) in 2003 whilst GDP also grew by 19%. Municipal waste generation in the new EU-10 Member States has stabilised at 312 kg per person after a decline²⁶. The OECD predicts that MSW generation will increase by 43% between 1995 and 2020²⁷. The IPTS projected an increase in MSW generation of 42.5% by 2020 compared to 1995 levels²⁸. The EEA predicts a 20% increase in MSW²⁹. MSW growth in the new EU-10 Member States is expected to be even faster;
- Every year 10 tonnes per capita are added to the material stock of the European economy³⁰. This addition mainly consists of materials with a long life span, many of which would remain in the material stock for very long periods, but is bound to result in an increase in waste generation at some stage. In some cases this could cause major changes in waste arisings, as illustrated by the generation of plastics waste from the construction and demolition sector which is forecast to increase by over 120% by 2010 compared to 1995 levels³¹. Unfortunately, no reliable models of waste arisings that look at this effect are currently available.

Waste generation is, in many cases, a waste of resources and waste prevention can make substantial contributions to reducing the overall impact of use of resources. This could include

²³ Baseline projections for selected waste streams: Development of a methodology, European Topic Centre on Waste, 1999.

²⁴ COM (2000) 347.

²⁵ Inventory of existing information on recycling of selected waste materials, EEA, 2004.

²⁶ Waste Generation and Treatment in Europe, Eurostat, 2005 (pending publication).

²⁷ OECD Environmental Outlook, OECD, 2001.

²⁸ Scenarios of household waste generation in 2020, Final Report. JRC/IPTS-ESTO, 2003.

²⁹ Environment in the EU at the turn of the century, EEA, 1999.

³⁰ Resource use in European countries, European Topic Centre on Waste and Material Flows, 2002.

³¹ Plastics - a Material of Choice in Building and Construction: Plastic consumption and recovery in Western Europe, APME, 1998.

reducing the quantities of waste generated as well as the hazardousness of wastes or extending the life span of products through repair or re-use.

Although clearly very large, it is difficult to quantify the potential of waste prevention to reduce resource use and the associated environmental impact because the benefits of waste prevention concern the whole life cycle of resources and would depend on the type of resource saved. For example, saving use of metals, food or polymers would in general yield more environmental benefits per tonne than saving the use of a tonne of sand. One exploratory study estimates the potential environmental benefits of municipal waste prevention in the range of €258–€380 per tonne of municipal waste prevented³².

2.4. The potential of waste recycling and recovery to reduce environmental impact is underexploited

Recovering the materials and energy contained in waste could make substantial contributions to reducing the overall impact of use of resources in three ways:

- Avoiding environmental impact from the extraction of primary raw materials. For example, recycling of metals avoids hazardous by-products of ore-processing and reduces CO₂ emissions, due to energy savings if less mining waste needs to be moved;
- Avoiding environmental impact, such as air pollution or energy use, from the conversion of primary raw materials in production processes, e.g. emissions of aerosols and particulate matter from production of virgin polymers;
- Reducing emissions from waste disposal installations, e.g. methane emissions from landfills.

Current waste management practices contribute to the overall environmental impact of use of resources, as illustrated by the following points:

- Despite an increasing trend towards recycling and incineration, the growth in waste generation means that the absolute amounts of waste landfilled are decreasing only slowly or are still increasing:
 - Between 1995 and 2003 the proportion of MSW landfilled in EU-15 dropped from about 64% to 48.8%. In the same period MSW generation increased by

³² Technical report on waste management, RIVM, prepared for the European Commission, 2000, available at: http://europa.eu.int/comm/environment/enveco/priority_study/waste.pdf.

approximately 19% and the absolute amounts of waste landfilled dropped only slightly³³;

- The absolute amounts of plastic waste going to landfill increased by 21.7% between 1990 and 2002 despite a drop in the relative share of plastics landfilled from 77% to 62%³⁴;
- The absolute amounts of paper landfilled or incinerated in waste incinerators remained stable between 1990 and 2002 despite a substantial increase in recycling³⁴;
- A limited number of EU-15 Member States report high recovery and recycling rates for manufacturing waste, with landfill rates close to 10%. Others have not reported statistics or landfill up to 40% and in EU-10 most of this waste is landfilled³⁵;
- Waste management activities accounted for 97 million tonnes CO₂ equivalent in 2003, i.e. 2% of greenhouse gas emissions in EU-15³⁶, three quarters of which are methane emissions from landfills. This was down from 140 million tonnes CO₂ equivalent in 1990 and will decrease further with the implementation of the Landfill Directive. Achievement of the objective set in the Landfill Directive of reducing landfill of biodegradable MSW to 35% of its 1995 levels by 2016 should result in an overall reduction in greenhouse gas emissions from a positive flux of 50kg of CO₂ eq/tonne MSW in 2000 to a negative flux (benefit) of up to 200 kg CO₂ eq/tonne in 2016. This equals a saving of some 40 Mt CO₂ equivalent per year³⁷, i.e. about 1% of total EU-15 GHG emissions;
- Estimates for the UK attribute some 2.5% of total quantifiable emissions, 30% of methane emissions and 10% of cadmium emissions to MSW management³⁸;

³³ Waste Generation and Management in Europe, Eurostat, 2005 (pending publication).

³⁴ Inventory of existing information on recycling of selected waste materials, EEA, 2004.

³⁵ Waste Generation and Management in Europe, Eurostat, 2005 (pending publication).

³⁶ Annual European Community greenhouse gas inventory 1990-2003 and inventory report 2005, submission to the UNFCCC Secretariat, European Environment Agency, Technical Report 4/2005, 2005.

³⁷ Waste management options and climate change, AEA Technology, Final Report to DG Environment, 2001, available at: <http://europa.eu.int/comm/environment/waste/studies/index.htm>.

³⁸ Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes, Enviro Consulting Ltd and University of Birmingham with Risk and Policy Analysts Ltd, Open University and Thurgood, M., 2004, commissioned by DEFRA, London.

- Landfill of 100 000 tonnes of construction and demolition waste is estimated to take up a surface area of 13 square kilometres.

The main potential of waste policy to reduce environmental impact stems from avoiding upstream externalities associated with the use of the substituted resources. For example, 7% of crude oils are used for the production of plastics, of which 4% are incorporated in the material and 3% are used to provide the energy necessary for their production. Recycling combined with energy recovery and other recovery processes can therefore reduce use of crude oil for producing plastics and reduce the associated environmental impact.

From the 16 tonnes per capita of materials used in the EU every year, some 4 tonnes of waste are generated, i.e. about 25% of material input, of which much has recycling or recovery potential. This can lead to substantial benefits:

- One example of monetisation, expressed in €, of the external benefits per tonne recycled, from a UK study undertaken in 1999, is 435 to 1363 for metals, 287 for glass, 101 for paper, 97 for textiles and -24 to 70 for plastics³⁹;
- Recycling reduces CO₂ emissions⁴⁰ by 9100 kg CO₂ eq/tonne for aluminium, 3200 for textiles, 1500 for ferrous metals, 500 for plastics and 1800 for PET. This largely reflects the energy savings from recycling, for example energy savings from recycling metals are 95% for aluminium, 85% for copper, 74% for steel and 65% for lead. This is mainly a result of lower energy needs for recycling compared to production of virgin materials. Recycling of many materials is driven by these benefits but remains limited because of the limited availability of collected wastes at an acceptable cost. The simplified model in Annex III calculates that the current level of recycling of metals, glass, paper and plastics already saves over 200 million tonnes CO₂ equivalent and further increases in recycling have the potential to deliver at least another 20 to 50 million tonnes CO₂ equivalent, i.e. up to 1% of total EU greenhouse gas emissions;
- Combining diversion away from landfill with recycling or highly energy-efficient recovery of MSW can reduce greenhouse gas emissions beyond the values given above for landfill diversion to a total negative flux (benefit) of 450-500 Mt CO₂ eq/tonne,

³⁹ Values updated by DETR on the basis of Cost-Benefit Analysis of Different Municipal Waste Management Systems: Objectives and Instruments for the Year 2000, Coopers and Lybrand/CSERGE, Luxembourg, Office for Official Publications of the European Communities.

⁴⁰ Waste management options and climate change, AEA Technology, Final Report to DG Environment, 2001, available at <http://europa.eu.int/comm/environment/waste/studies/index.htm>.

saving over 100 Mt CO₂ equivalent per year, i.e. about 2% of total EU-15 GHG emissions.

2.5. The complexity of EU and Member State legislation tends to discourage recycling and recovery activities

Much progress has been made in the waste field since 1975 when the first Waste Directive was adopted by the Community, notably thanks to EU legislation on waste disposal methods (landfill, incineration and recovery of hazardous waste) and on key waste flows (e.g. PCBs, packaging, electronic waste, end-of-life vehicles, POPs, etc.). In addition, a substantial body of environmental legislation has been built up which ensures that industrial activities are conducted in a way compatible with the environment (e.g. IPPC Directive).

Some limited gaps remain in this body of legislation, in particular as regards certain major waste management operations, such as bio-treatment of waste and preparation of waste for recycling and recovery, that are covered neither by specific directives nor by the IPPC Directive. Also, there are no EU quality standards for recycled wastes, such as compost and recycled aggregates. This results in differences in the regulatory standards applied to waste treatment in the Member States which could impede the development of markets and stimulate transboundary movements by attracting waste to the Member States with the least stringent regulations, i.e. eco-dumping of waste within the EU.

However, some of the existing body of EU legislation on waste and, especially, national/regional approaches to implementing it remain based on the assumption that micro-management is in general necessary as a safeguard against improper waste management. There is a risk that this approach will be exacerbated by current trends towards increasing controls and restrictions on shipments of waste on the internal market, as can be observed in the common position on the review of the Regulation on shipment of waste which gives Member States the power to object to shipments on the grounds that treatment standards are lower in the Member State of destination. National authorities are already developing many national regulations on how wastes should be treated and are using these rules to restrict shipments. For example, there are cases where Member States consider that the end-product would be safer or of better quality if the waste were to be processed under their national standards.

Such restrictions do not solve the environmental problem from an EU perspective. For example, a recycling activity restricted in one Member State on grounds of the health risks posed by the recycled material may continue in another Member State. Such recycled materials may also be freely imported as end-products by the Member State restricting their recycling.

Furthermore, restricting shipments of waste for recycling could potentially reduce the availability of recyclable waste for EU industry, especially in small Member States. This could have a negative effect on the competitiveness of recycling activities conducted in an environmentally sound manner and could impede their current growth. Access to the internal market is important for the recycling industry given that many recycling activities need large quantities of material if they are to be competitive.

In addition, EU waste legislation has evolved over a quarter of century and layers of requirements have been regularly added by enacting new legislation. This has resulted in minor regulatory overlaps, for example the permit requirements for waste facilities under the waste legislation and under the IPPC Directive are not streamlined. Furthermore, a number of definitions contained in EU waste law have been the subject of litigation and their interpretation often remains unclear despite Court rulings. Examples include the definition of recovery and the point at which waste ceases to be waste. The resultant uncertainty for competent authorities and for the waste industry could impede necessary investments.

2.6. Implementation of the Waste Oils Directive has proved difficult

The Waste Oils Directive (Directive 75/439/EEC) is designed to create a harmonised system for the collection, storage, recovery and disposal of waste oils, such as lubricant oils for vehicles, turbines, gearboxes and engines, hydraulic oils, etc. but does not cover edible oils and oils harvested for biofuel production. The Directive aims at protecting the environment against the harmful effects of illegal dumping and treatment operations. In 1987 the Directive was amended to give priority to processing waste oils by regeneration where no technical, economic and organisational constraints exist. The total quantity of waste oils is estimated at 2.3 million tonnes (2003), which is equivalent to a share of about 7% of the hazardous waste generated in EU-15⁴¹. Oil use has become more efficient and from 1995 to 2003 consumption decreased by 9%.

The Waste Oils Directive suffers from implementation problems with both collection and regeneration^{42 43}:

- The collection rate (percentage of volume of collectable waste oils which is collected) is increasing but still not perfect. It was 75% in 1994/95 and 81% in 2003. In addition, the

⁴¹ The forthcoming implementation report will not yet include reliable figures on waste oils for EU-10.

⁴² Economics of Waste Oils Regeneration, Final report, commissioned by European Commission, Coopers & Lybrand, 1996.

⁴³ COM(2003) 250 final/3, see http://europa.eu.int/eur-lex/en/com/rpt/2003/com2003_0250en03.pdf.

collection rate differs very much between Member States. For instance, Luxembourg attains the highest rates (99%) while Greece reported the lowest figure (41%).

- Regeneration is not being given priority over incineration. The rate was 36% in 1994/5 and in 2003. The remaining amounts of waste oils collected are mainly used as fuel.
- Recent information⁴⁴ has cast doubt over the environmental justification of giving regeneration of waste oils priority over use as fuel. The wide range of existing regeneration technologies differ significantly in terms of their environmental impact. In parallel, incineration technologies have also substantially improved. Hence a generic priority for any kind of regeneration is not necessarily compatible with the objective of giving priority to the environmentally preferable technologies. In addition, the Waste Incineration Directive will repeal the more lenient emission limit values laid down in the Waste Oils Directive by the end of 2005. This will further narrow the impact of waste oils regeneration and incineration.
- The scope of the priority given to regeneration is not clearly defined in the Directive. Priority has to be given to processing waste oils by regeneration. However, the definition of processing excludes recycling operations other than regeneration, for instance processing waste oils into flux oils or converting them into methanol.
- The regeneration priority leaves much room for interpretation. Given that only 50 to 65%⁴⁵ of the total waste oils are fit for regeneration, verification of the regeneration obligation causes problems. Despite Germany having the third highest regeneration rate in EU-15 in 1998, the European Court of Justice ruled against the country for failing to take measures to give priority to regeneration of waste oils. The lawfulness of the measures subsequently taken by Germany is still subject to complaints. On the other hand, small Member States have argued that the small quantity of waste oils generated on their territory would exempt them from taking measures to give priority to waste oils regeneration. However, the European Court of Justice has rejected this view in recent court cases. Altogether five judgments on this issue have been handed down⁴⁶ and several other infringement cases are still pending⁴⁷.

⁴⁴ Critical Review of Existing Studies and Life-Cycle Analysis on the Regeneration and Incineration of Waste Oils, Taylor Nelson Sofres Consulting, 2001, commissioned by the European Commission, available at http://europa.eu.int/comm/environment/waste/studies/oil/waste_oil.pdf.

⁴⁵ Taylor, Nelson, Sofres.

⁴⁶ Cases C-102/97 (Germany), C-201/03 (Sweden), C-424/02 (UK), C-15/03 (Austria) and C-92/03 (Portugal).

⁴⁷ The Commission has decided to suspend pursuing all the cases relating to this provision due to this Commission proposal.

- The available statistics on waste oils are inexact. The quantities reported by the Member States differ widely; for instance, in 2003, 17.1 kg/capita was put on the market in Sweden, yet Ireland and the Netherlands reported only 5.8 and 7.1 kg/capita respectively. This allows only general conclusions to be drawn on the collection and regeneration rates actually achieved.

3. OBJECTIVES FOR FUTURE WASTE POLICY

The overall objective of waste policy is to reduce the environmental impact of waste generation and management and in this way contribute to reducing the overall environmental impact of resource use.

Waste prevention, recycling and recovery measures need to result in a net benefit and reduce the accumulated impact throughout the life-cycle of a resource. Because of the complexities of the environmental impact of waste generation and management, life-cycle thinking is needed to ensure that the various relevant environmental impacts are taken into account, and that impacts are not simply displaced within the life cycle.

The general objectives relating to the five issues identified are to:

1. ensure that sound knowledge on the environmental impact of waste generation and management is taken as the basis for developing waste policy;
2. harness the potential of waste prevention to contribute to reducing the environmental impact of resource use;
3. harness the potential of waste recovery and recycling to contribute to reducing the environmental impact of resource use;
4. improve the regulatory environment for recycling and recovery activities;
5. reduce the environmental impact of waste oils.

These objectives contribute to the sustainable use of natural resources which is one of the principal objectives of the Sustainable Development Strategy. These objectives will also contribute to developing a cost-effective waste policy and to promoting recycling activities by improving and simplifying the legal framework. This in turn will facilitate the use of recycled materials in manufacturing industry in the EU and make them more competitive.

4. POLICY OPTIONS

4.1. Ensure that sound knowledge on the environmental impact of waste generation and management is taken as the basis for developing waste policy

A first necessary step is to develop a new type of knowledge base taking into account life-cycle information. This knowledge should be used to design environmentally and cost-effective waste prevention and recycling policies. It should help to define what information on waste is relevant to policymaking and to ensure that such information is taken into consideration as an integrated part of policymaking.

The main options available are:

- **No policy change:** Limit information-gathering to implementation of the Waste Statistics Regulation by Member States and use these statistics as indicators of environmental degradation/improvement;
- **Maximum use of life-cycle assessment (LCA):** Undertake a full life-cycle assessment at EU level in accordance with ISO standards on waste generation and management and introduce mandatory LCA for waste management planning;
- **Move to life-cycle thinking (LCT):** LCT is a mindset for policymakers to make every effort to take into account relevant life-cycle aspects. In many cases this means using common sense to look at the wider picture while in others it could mean using assessment tools such as LCAs. To spread LCT in waste policy it is necessary to formulate an environmental objective for EU waste policy and legislation and set a framework for the assessment of waste policies at EU and national levels. This would be supplemented by a knowledge-gathering function at EU level that would inform further developments in EU waste policy.

4.2. Harness the potential of waste prevention to contribute to reducing the environmental impact of resource use

The potential for waste prevention will vary locally as it depends on economic growth and the industrial structure. Furthermore, specific information and instruments are needed to influence decisions taken at production process, management, design and consumer levels. Therefore, options based on stringent regulatory approaches, such as binding waste prevention targets or mandatory waste prevention measures, were discarded at an early stage because such options do not fit the need for waste prevention policies to be flexible and adapted to local circumstances. In addition, it is important that whatever policy option is considered for promoting waste prevention

encourages a focus on a selection of waste prevention measures that have the highest potential to reduce the environmental impact of use of resources. Therefore, the selected options take a general approach to prevention and do not focus on any single specific instrument or practice as a mix of actions or instruments would be needed to address this complex issue.

This assessment considers the following options which allow the necessary flexibility for developing national and local solutions to reap the environmental benefits of waste prevention:

- **No policy change:** Member States would remain free to decide to what extent their national waste policies tackle the issues of increased waste generation. EU policies such as eco-labelling, EMAS, IPPC and ETAP would contribute to preventing waste;
- **Set indicative prevention targets:** Targets would be set at EU level for reducing waste arisings. The targets would be weight-based as there is no other indicator available for the general impact of waste generation. This would trigger national policies limiting waste generation through measures affecting production and consumption;
- **Adopt a framework for prevention policies:** The Waste Framework Directive makes it clear that waste policies must include prevention programmes and gives guidance to Member States for the development of their policies. A reporting cycle would provide a means of spreading good practices.

4.3. Harness the potential of waste recovery and recycling to contribute to reducing the environmental impact of resource use

The main policy options as regards harnessing the potential of waste recycling and recovery to reduce the environmental impact of resource use are:

- **No policy change:** The recycling and recovery targets in the existing end-of-life product Directives (on packaging, ELVs and WEEE) would be regularly updated and increased. New end-of-life wastes would be selected such as furniture, toys, etc, and directives on producer liability would be adopted. Other waste flows would remain unaffected by these policies;
- **Environmental agreements:** Existing voluntary commitments by industry, such as the Recovered Paper Declaration and the Vinyl 2010 commitment, would be taken as a basis for developing environmental agreements within an appropriate framework. If successful the approach would be extended to other materials/wastes;
- **Economic instruments:** The EU would strive to coordinate Member States' action on landfill taxes. This would affect waste management in general and accelerate diversion

of wastes from landfill when economic alternatives exist. The level of taxation would determine the range of viable alternatives. In the longer run other economic instruments would be considered, such as tradable certificates;

- **Mandatory management options:** Wastes for which there are preferred treatment techniques or techniques which should be avoided would be identified. This could include a number of individual measures, such as recycling targets for waste products or waste materials, landfill restrictions, etc.

Taxation of virgin resources could also address waste management problems but is not included on this list because it would address the wider issue of sustainable use of natural resources. This option is considered in the Thematic Strategy on sustainable use of natural resources, taking account of the limited chances of reaching agreement on such an option at EU level.

Tradable certificates are not taken into consideration for the short term because the European Parliament, Council and many stakeholders signalled the need for further study of the potential of such instruments in the waste sector. Therefore tradable certificates are a longer term option as one of the economic instruments described above.

4.4. Improve the regulatory environment for recycling and recovery activities

The revision of the Waste Shipment Regulation currently being considered under the co-decision procedure could potentially dramatically change the regulatory environment for recovery activities. In the ongoing revision of the Regulation on shipment of waste, both Parliament and the Council have inserted provisions that increase the powers of Member States to object to shipments of waste. In particular, one amendment in the common position agreed by the Council on 24 June 2005 enables Member States to object to shipments of waste if waste treatment standards are lower in the Member State of destination.

In addition, despite the quite significant jurisprudence of the European Court of Justice already existing, waste management law is still subject to litigation and further cases are, or are likely to be brought, before the Court. Experience shows that given the large grey areas in waste legislation, Court judgments are likely to cause significant changes to the way EU waste legislation must be interpreted and implemented.

“No policy change” is therefore not an option, and the main policy options available to improve the regulatory environment are:

- **National standards:** Rely on national standards and empower Member States to block shipments of waste if the treatment standards are lower in the Member State of destination. Member States would increasingly develop national requirements on how

wastes must be treated and shipments of wastes would be restricted if the Member State of destination does not apply the same requirements. In addition, the jurisprudence of the European Court of Justice would guide implementation of the Community waste law, leading to some clarification;

- **EU recycling society:** Develop common EU waste treatment standards and maintain an EU market for waste bound for recovery. This would not prevent Member States from taking more stringent national measures. However, the likelihood of Member States adopting national measures restricting the internal market would be significantly reduced where common EU standards exist. Common standards would have to address three areas:
 - Determine preferable methods of treatment for a given waste. Depending on the specifics of each case, this would include either EU guidelines (e.g. to combat sham recovery) or treatment requirements developed in the framework of objective 3;
 - Emissions from and the efficiency of waste management processes. This would entail clarifying the definition of recovery and requiring BAT for certain waste management operations by extending the scope of the IPPC Directive and setting minimum standards for permits for other waste management facilities, where appropriate;
 - The quality of the recovered materials. This would entail the adoption of criteria for particular wastes determining when the waste has been fully recycled;
- **Adopt guidelines interpreting waste legislation:** Guidelines would be adopted to interpret the concepts of “waste” and “recovery” and to facilitate application of permit requirements;
- **Revise the waste framework legislation:** This would mainly involve revision of the WFD to clarify aspects such as the meaning of “recovery” and “disposal”, the point at which particular wastes cease to be waste, the link between waste legislation and the IPPC Directive, etc. It would not include a fundamental review of the definition of “waste” as this option has been discarded following discussions with the European Parliament and the Council and extensive consultation of stakeholders. In addition, the Waste Framework Directive and the Hazardous Waste Directive would be merged into a single legal instrument.

4.5. Reduce the environmental impact of waste oils

Analysis of the provisions of the Waste Oils Directive and of the extent to which they overlap with other existing EU environmental legislation has showed that the only substantial value added by the Waste Oils Directive are the collection and regeneration requirements.

In principle several options could be considered to deal with the issues of collection and treatment. These include, in particular, two extreme options that were discarded. The option of a full repeal of all obligations related to waste oil management was considered to pose big risks of greater mismanagement of waste oils. The option of giving priority to specific environmentally favourable processes would not be practicable given the fast pace of technological development and the additional level of complexity, which would risk adding new implementation problems to the existing ones.

The remaining policy options taken into consideration in this IA are:

- **No policy change:** Enforcement of the existing collection requirement and regeneration priority. Member States would have to take practical measures to implement this priority, e.g. through regulations directing waste oils towards regeneration or by the use of economic instruments;
- **Focus on collection:** The Waste Oils Directive would be revised or repealed to put the focus on ensuring full collection of waste oils. Regeneration would no longer be given priority and the choice of treatment method would be left to the operators.

5. ANALYSIS OF THE IMPACT OF THE OPTIONS

This section contains tables summarising the most important impacts of the options considered. These tables use information from the final report submitted by EPEC entitled “Support in the drafting of an ExIA on the Thematic Strategy on the prevention and recycling of waste”, available on the Commission’s website at:

<http://europa.eu.int/comm/environment/waste/strategy.htm>.

The report contains specific and targeted information and data of relevance to the Impact Assessment. The report includes:

- A series of tables summing up the information found in 167 reference documents and in stakeholder contributions on the impact of waste generation and management and identification of the data/information gaps and an assessment of the potential and the work to be done to fill the gaps;

- A comparative assessment of material-based and product-based recycling policies for paper (qualitative assessment) and for plastics (quantitative assessment);
- A qualitative assessment of the impact of extending the IPPC Directive to additional waste management activities.

The tables in this section use the following coding, taking today's situation as the reference point: (-) means the impact is negative (e.g. increase in costs or emissions, decrease in employment), (+) means there is a positive impact (e.g. decrease in costs or emissions, increase in employment), (=) means negligible impact. In some cases the impacts are also ranked as lowest or highest.

5.1. Ensure that sound knowledge on the environmental impact of waste generation and management is taken as the basis for developing waste policy

One common concern highlighted in most of the literature analysed is that failure to adopt a life-cycle approach could potentially “overlook” or “undervalue” environmental and social externalities of waste management (e.g. net climatic impact, net energy balance, amenity impact, house prices, etc.). The significance of failing to take account of the overall life-cycle impact lies in the potential for persisting with economically, environmentally and socially unsustainable waste management options. The main benefits of adopting a life-cycle approach illustrated in the information sources are twofold: firstly, the economic, environmental and social impacts of different waste management options can be considered and, secondly, these impacts are assessed throughout all the phases of the process (i.e. from production to disposal). Conventional approaches often fail to consider the impact of the environmental impacts that take place at production or use phases, which is particularly useful for identifying the environmental pressures of products with fast innovation cycles or of using recycled rather than virgin materials.

This supports taking a life-cycle approach to waste policy. Table 1 sums up the impact of the selected options and is followed by a worked example illustrating application of life-cycle thinking to management of biowaste.

Table 1: Impact of options for developing a knowledge base

OPTION	No policy change	Maximum use of LCA	Move to LCT
IMPACT			
Environmental			
Environmental effectiveness of measures adopted on the basis of the information	(-) as complexity of waste issues grows measures fail to address the environmental issues and become complex and costly	(+/-) LCA gives a sound basis for adoption of measures but the process could be lengthy. However, there is a risk of non-quantifiable impacts being ignored	(+) gives a sound basis for adoption of measures
Economic			
Costs for businesses (manufacturing industry)	(=) neutral	(-) highest costs but overall magnitude small	(-) low costs
Innovation and research	(=) neutral in general (-) because no clear signal is given, innovation is not encouraged in this area	(+) for improving LCA tools and potentially to promote good practice and techniques (-) could impede innovation if policymakers adopt fixed solutions on the basis of LCA which give a static picture	(+) for improving assessment tools and to promote good practice and techniques
Implementation costs (EU, national and local authorities)	(=) neutral	(-) highest costs	(-) moderate costs
Social	No direct impact is identified apart from the greater potential of policies taking life-cycle approaches to integrate more impact categories.		

Worked example: applying life-cycle thinking to management of biowaste

The greatest environmental impact of biodegradable waste (biowaste) occurs when it is landfilled and concerns climate change. Biowaste breaks down in landfills and produces methane, only part of which is captured and flared even in modern landfills. Methane is an important greenhouse gas – it is 21 times more potent than CO₂. About

1 300 kg CO₂ equivalent is generated per tonne of biowaste⁴⁸ landfilled, equivalent to 1.5% of total EU-15 emissions of greenhouse gases, i.e. three quarters of all greenhouse gases emitted by waste management activities. Therefore any alternative process for the management of biodegradable waste that avoids emission of methane has significant environmental advantages.

In addition to the large positive climate impact of diverting biowaste from landfills, further more modest reductions in greenhouse gas emissions in the range of 60-100 kg CO₂ eq per tonne of biowaste are achievable if the biowaste diverted from landfills is used to produce compost or energy.

Although environmental assessments such as LCAs comparing the various options for the management of biowaste unanimously show that landfill is by far the worst option, they often reach varying conclusions concerning the ranking of the alternative management options⁴⁹. This is because the differences in the environmental advantages and disadvantages of a given option are relatively small and depend on local conditions. For example, in the climate change impact category, energy efficiency of incinerators, the type of displaced energy source and soil benefits are key factors. In cases where the incineration facilities have high energy efficiency or the energy source displaced is highly polluting (e.g. coal), incineration tends to compare rather well to composting or anaerobic digestion. Where soil benefits are large and the energy efficiency of incinerators is modest, composting has advantages. In addition, because greenhouse gas emissions from non-landfill options are limited, other categories of impact (e.g. acidification, eutrophication, photooxidant formation, toxicity, etc.) and soil benefits become equally relevant. However, no single process performs best for all categories over a wide range of local conditions.

Applying life-cycle thinking to the management of biodegradable waste therefore suggests that (1) the priority at EU level should be to divert biodegradable waste from landfills and (2) environmental assessments should be undertaken at the appropriate level to determine the best local waste management option other than landfill.

5.2. Harness the potential of waste prevention to contribute to reducing the environmental impact of resource use

The information reviewed during the IA demonstrates that waste generation has a wide range of negative economic, social and environmental impacts which is why waste prevention is desirable.

⁴⁸ “Waste management options and climate change”, Final report submitted by AEA Technology, 2001, available at <http://europa.eu.int/comm/environment/waste/studies/index.htm>.

⁴⁹ See for example meta-study “Evaluating waste incineration as treatment and energy recovery method from an environmental point of view”, report by PROFU commissioned by CEWEP, 2004, available at <http://www.cewep.com/studies/art131.46.html>; “How shall energy in waste be utilised – a system study of incineration, material recycling, anaerobic digestion and composting” in IVL Report B 1547(2004), Jan-Olov Sundqvist, 2004, or “Compost credits – the carbon balance of biowaste composting”, report by Grontmij Nederland commissioned by Essent Milieu, 2005.

One exploratory study estimates the potential environmental benefits of municipal waste prevention within the range of €258–€380 per tonne of municipal waste prevented⁵⁰. However, this is a general assessment and the environmental balance of waste prevention will vary dramatically depending on the waste concerned. Therefore, to be environmentally effective and efficient, waste prevention policy must take account of the potential of waste prevention to reduce the overall environmental load of use of resources by taking a life-cycle approach.

Experience demonstrates that when waste generation and waste management form the basis of decision-making, if no account is taken of the “use” phase, an incomplete picture of the product life cycle and its main environmental impacts is created.

Two alternative options are considered: indicative prevention targets or national waste prevention programmes which allow the necessary flexibility for developing national and local solutions to reap the benefits of waste prevention. Table 2 sums up the impacts of these options and is followed by a worked example illustrating the potential impact of waste prevention activities, taking food waste as an example.

⁵⁰ Technical report on waste management, RIVM, prepared for the European Commission, 2000, available at http://europa.eu.int/comm/environment/enveco/priority_study/waste.pdf.

Table 2: Impact of options for preventing waste

Option			
Impact	No policy change	Indicative prevention targets	A framework for prevention policies
Environmental	(-) observed waste generation trends would continue with an increase in major associated impacts	(+) depending on the implementing measures, waste generation would be curbed. This tends to put the focus on heavy wastes which do not necessarily have the highest potential to reduce environmental impact. If misunderstood, this could lead to negative impacts in extreme cases	(+) Depending on the implementing measures, waste generation would be mitigated. The flexible approach to waste prevention policies would encourage assessment of the environmental benefits of action, looking at all impact categories in a balanced manner. This has the potential to focus waste prevention efforts on waste with a high environmental impact
Economic			
Costs for businesses generating waste	(=) no change in observed trends	(-) potentially the highest as prevention targets are likely to promote inflexible approaches	(-) lowest cost of prevention measures thanks to a flexible approach (+) the flexible focus on prevention would encourage businesses to identify prevention measures that have positive economic outcomes
Innovation and research	(=) neutral in general (-) because no clear signal is given, innovation is not encouraged in this area	(+) strong signal in favour of products and technology with low waste weight	(+) moderately strong signal in favour of products and technology with low environmental impact
Implementation costs for EU, national and local authorities	(=) no implementation costs	(-) probably the highest because of the difficult monitoring and enforcement tasks	(-) moderate to high. Implementation costs mainly related to assessing options for action and monitoring results

Social			
Employment	(=) no change in observed trends	(+), (-) or (=) depending on the implementing measures	(+), (-) or (=) depending on the implementing measures. However, the flexible approach to waste prevention policies would encourage taking potential employment impacts into consideration
Health	(=) no change in observed trends	(=) likely to be neutral	(=) likely to be neutral, but the flexible approach to waste prevention policies would encourage taking potential health impacts into consideration

Worked example: impact of food waste

Ongoing Commission studies⁵¹ show that food accounts for a significant fraction (20 to 30%) of the environmental impact of products. Large amounts of food worth £424 per adult are wasted by final consumers in the UK⁵². Australians threw away a total of A\$5.3 billion worth of food in 2004⁵³. In the USA food loss costs a family of four at least \$589.76 annually and adds up to a total cost in the US of US\$ 43 052 million⁵⁴. Improved consumer education at national and local level could reduce this wastage of financial resources and the associated environmental impact and make additional revenue available for other goods and services.

5.3. Harness the potential of waste recovery and recycling to contribute to reducing the environmental impact of resource use

The available literature shows that air, water and soil quality issues are significant in the overall environmental balances of recycling, recovery and landfill of waste only in cases of sub-standard

⁵¹ Environmental impact of products (EIPRO), analysis of the life-cycle environmental impact of total final consumption in EU-25, IPTS/ESPO, draft report, April 2005.

⁵² The Soggy Lettuce Report, Waste and Resources Action Programme – WRAP, 2004.

⁵³ Wasteful Consumption in Australia, The Australia Institute, Discussion Paper Number 77, March 2005.

⁵⁴ Using Contemporary Archaeology and Applied Anthropology to Understand Food Loss in the American Food System, Timothy W. Jones. PhD, Bureau of Applied Research in Anthropology, University of Arizona, 2005.

installations. For state-of-the-art installations the main environmental impact of increasing recovery of waste is savings in greenhouse gas emissions which are on a larger scale than other emissions. This means that energy efficiency is a key parameter for energy recovery operations.

Landfills and incinerators are regulated by recent Community legislation which imposes stringent controls and pollution reduction requirements on incinerators and landfills. Existing incineration installations must comply with Directive 2000/76/EC by the end of 2005, existing hazardous waste landfills have had to comply with Directive 1999/31/EC since 2004 and municipal landfills will have to by 2009. Therefore this assessment takes climate change as the main category of environmental impact⁵⁵.

Table 3 sums up the impacts of the options considered. It is followed by a worked example comparing the impact of recycling specific end-of-life products to recycling materials in the case of plastics and paper.

⁵⁵ It should, however, be noted that this assessment is valid only in general terms and that environmental assessments of specific wastes or processes could identify other key parameters. This is the case, for example, with POPs where recycling would have a major impact on health and the environment because of their toxicity.

Table 3: Impacts of options for recycling and recovering waste

Option	No policy change	Environmental agreements	Economic instruments	Mandatory management options
Environmental				
Climate change	<ul style="list-style-type: none"> Recycling reduces CO₂ emissions by 9100 kg CO₂ eq/tonne for aluminium, 3200 for textiles, 1500 for ferrous metals, 500 for plastics and 1800 for PET Diversion of MSW into combinations of recycling, bio-treatment and high-efficiency energy recovery has the potential to deliver greenhouse gas emission savings of 450 to 500 kg CO₂ per tonne, i.e. some 100 million tonnes CO₂ eq per year The simplified model in Annex III calculates that further increases in recycling have the potential to deliver at least another 20 to 50 million tonnes CO₂ equivalent, i.e. up to 1% of total EU greenhouse gas emissions 			
	(+) to (-) depending on waste flows subjected to recycling obligations and producer liability. Favourable if this concerns products whose environmental impacts are mainly at the waste phase of their life cycle. Could be negative if this is not the case	(=) to (+) current voluntary action concerns waste flows where recycling delivers reduction of GHG emissions. However, it is open to question whether this would deliver more than business as usual, especially for difficult issues	(+) economic instruments such as landfill taxes would divert waste from landfills with corresponding reductions of GHG emissions (-) certain instruments, for example landfill taxes, can result in increased illegal dumping of waste	(+) mandatory management options would either divert waste from landfills or encourage recovery techniques saving GHG emissions
Economic				
Recycling markets	(+) costs of collection of waste to be recycled would be borne to a certain extent by producers making recycling viable. The intensity of this impact would depend on the magnitude of the regulated waste flows	(+) to (-) the flexibility of the instrument would allow concentration on wastes with the greatest marketing potential	(+) as landfill costs would increase, recycling and recovery would become more attractive	(+) costs of collection of waste to be recycled would be borne by the holder of the waste making recycling viable. The intensity of this impact would depend on the magnitude of the regulated waste flows
Energy markets	<p>Recycling of materials results in energy savings and thus in decreased energy demand from the industries concerned. Use of waste as a fuel in manufacturing industries has the same effect. Use of waste for power/heat production increases the EU's domestic energy supply</p> <p>This can contribute to reducing the demand for energy and contribute mitigating the effects of increasing oil prices</p>			

Innovation and research and Investment in new techniques	(+) limited to regulated flows	(+) limited to flows concerned by the agreements	(+) would benefit innovation in all areas of alternative waste management	(+) limited to regulated flows
Costs for businesses Note: this cost impact is typically dynamic. In the short term costs would be expected to increase. They would then decrease as a result of innovation. The pace of this decrease will depend on the strength and clarity of the signal for innovation and research	(-) costs increase for producers of the regulated products	(-) costs increase moderately for the players involved in agreements	(-) waste management costs increase for all waste generators who currently send waste to landfill	(-) costs increase for generators who currently send regulated waste flows to landfill
Implementation costs	(-) highest implementation costs. This option would concentrate on small waste flows and set up systems requiring complex and costly management	(-) high implementation costs. Monitoring by the public authorities of progress under environmental agreements is demanding in terms of resources	(-) lowest implementation costs. Implementation costs are linked with tax revenue mechanisms. In many cases, it is more a question of changing the level of taxes as landfill taxes already exist in most Member States	(-) high implementation costs as it is necessary to implement systems to monitor management of the restricted waste flow
Social				
Employment	(+) on a per tonne basis, recycling is more job-intensive than incineration or landfill. Estimates in the literature available give figures of 241 jobs for recycling 10 000 tonnes, 19 to 41 jobs for incineration and 8 to 12 for landfill. However, increased recycling means that jobs are not created for the production of virgin materials. Thus the net effect on employment will depend on the relative employment intensities of waste recycling and of production of virgin materials. This is thought to result in a neutral or slightly positive effect on employment.			
	(+) increased recycling of specific waste flows promotes more labour-intensive practices	(=) to (+) increased recycling of specific waste flows promotes more labour-intensive practices. However, it is open to question whether this would deliver	(+) increased recycling of specific waste flows promotes more labour-intensive practices. However, energy recovery options are usually less labour-intensive than	(+) increased recycling of specific waste flows promotes more labour-intensive practices. However, energy recovery options are usually less labour-intensive than recycling

		more than business as usual, especially for difficult issues	recycling	
Social inclusion	(+) increased employment in the recycling sector makes more low-skilled jobs available			
	(+) re-use and repair of discarded goods is typically a sector in which the social economy has developed. Therefore, the social economy would in general benefit from promoting re-use and recycling (-) organised systems tend to reduce the space for the social economy to develop	(=) industry-led initiatives would not necessarily favour the social economy. Moreover, current voluntary action concerns waste flows only moderately relevant to the social economy (-) organised systems tend to reduce the space for the social economy to develop	(+) re-use and repair of end-of-life goods is typically a sector in which the social economy has developed. The social economy would in general benefit from promoting re-use and recycling. This would not be the case for diversion from landfill to energy recovery	(+) re-use and repair of end-of-life goods is typically a sector in which the social economy has developed. The social economy would in general benefit from promoting re-use and recycling. This would not be the case for diversion from landfill to energy recovery (-) organised systems tend to reduce the space for the social economy to develop
Health	Low impacts of waste management in general as emissions are abated and levels are small compared to other sources. A number of case-specific studies report health effects of living close to a MSW incinerator or landfill. These studies are often related to uncontrolled sites and subject to significant controversy			

Worked example: impact of mandatory recycling of products or of materials⁵⁶

Current EU policy is based on mandatory waste management options for specific end-of-life products, i.e. packaging waste, waste electronic and electrical equipment and end-of-life vehicles. Recycling of these products is focused on the specific products rather than on the same materials coming from other products. This raises the question of whether policies imposing mandatory waste management options are more efficient if they are product- or material-based.

A modelling exercise has compared the impact of increasing by 10 percentage points the current recycling rates of paper and plastics by focusing on regulated products as opposed to taking a general approach to recycling materials, irrespective of the waste product recycled. It suggests that, for the existing regulated products, a materials approach

⁵⁶ Based on “Support in the drafting of an ExIA on the Thematic Strategy on the Prevention and Recycling of Waste”, final report submitted by EPEC, available on the Commission’s website at <http://europa.eu.int/comm/environment/waste/strategy.htm>.

is more cost-effective than a product-based approach, both for plastics and for paper. Although the analysis is constrained by the quality of the existing information, the results suggest that the materials-based approach would lead to the inclusion of cheaper recycling activities than would be possible through additional efforts focused on the presently regulated products.

In the case of plastics, the results suggest that the economic costs of material-based recycling policies would be 16 to 37% lower than product-based recycling policies would cost. However, given the large share of current and future recyclable volumes already covered by existing Directives, there is little scope to make a major difference in the costs of any given increases in the overall recycling rates for a given waste stream.

The relatively cheaper social and financial costs of a materials approach indicate that, at least as far as paper and plastics are concerned, there are economic benefits in a materials-based approach which arise from the lower costs per tonne recycled of some applications not currently included in any major recycling effort.

For paper, the environmental benefits of a materials- or a product-based approach to recycling would be the same. By contrast, for plastics a materials approach to recycling has environmental advantages over a product-based approach. This is because a materials-based approach would be more efficient in promoting recycling of homogeneous uncontaminated flows that delivers higher environmental benefits than recycling mixed plastics.

To the extent that the lower cost implies slightly lower labour intensity, this implies that the employment benefits could be smaller with a materials approach.

5.4. Improve the regulatory environment for recycling and recovery activities

The different options address, to a varying degree, the two types of issue raised by the current regulatory environment for waste activities, i.e. on the one hand the implementation problems caused by the complexity and lack of clarity of the waste legislation and, on the other, the functioning of the internal market for waste recycling and recovery.

Table 4 assesses the impacts of the selected options. In addition, this section includes worked examples illustrating the type of impacts which clarification of the basic definitions in the waste legislation could have.

Table 4: Impacts of options to improve the regulatory environment for recycling and recovery

Option	National standards	EU recycling society	Interpretative guidelines	Revision of Waste Framework Directive
Impact				
Environmental				
Climate change and Polluting emissions and Health impacts	(+) emissions would be reduced in Member States adopting national standards. However, this would not affect the risks related to recycled materials as such products circulate freely on the internal market	(+) emissions would be reduced across the EU and risk issues related to recycled materials would be tackled	(+) implementing informal guidelines would have the same types of impact as revision of the WFD. Although in some cases the greater flexibility provided by these guidelines would enhance impacts, in most cases non-uniform application could reduce the benefits	(+) clarifying the regulatory environment would have positive impacts on recycling and recovery activities, which would be encouraged. The benefits of this option would be limited as it would not solve internal market issues discouraging recycling and recovery activities
Economic				
Competitiveness and Costs for businesses Businesses concerned are typically those sectors and sub-sectors using controlled wastes as input. This could include sectors producing materials (metals, paper, plastics, cement, etc.) and producing energy.	(-) waste flows for recovery would increasingly be restricted and costs of reclaimed nationally regulated wastes for EU industry would rise. Industries using controlled waste as input would be more affected in smaller Member States (-) nationally regulated sectors would be protected from competition which would guarantee security to investors. This	(-) some recycling industries could be concerned by higher environmental standards and face a decrease in activity or a need to invest in BAT (+) an EU-wide level playing field would favour exchanges and specialisation with the accompanying benefits in terms of cost cutting. Also, the use of existing frameworks for implementation of best available techniques makes it possible to optimise cost-efficiency	(-) because of their non-binding nature, legal challenges would most probably continue to be the rule and related implementation costs would increase	(+) costs for obtaining shipment authorisations should decrease; recycling of materials to which waste legislation does not apply would benefit from lighter administrative burden

	would entail costs for the European economy but would benefit the protected businesses			
Implementation costs	(-) National authorities would have to engage individually in developing standards. Further divergence of national waste management systems is likely to raise more complex internal market issues which would need to be addressed by EU and national authorities	(-) The development and implementation of standards implies high initial costs. These would be lower than for national standards thanks to economies of scale. In addition, clarification of the rules on the internal market would reduce recurrent costs for dealing with conflicts related to different national standards and shipment controls	(-) less controversial issues could be solved. However, legal challenges would most probably continue for difficult issues which would continue to require high levels of resources at EU, national and local levels	(-) lowest long-term costs as the grey areas would be solved as far as possible. However, this option has the highest start-up costs (studies, legislative procedure, etc.) at EU and national levels
Social				
Employment	(+) small increase in employment on condition that national policies favour labour-intensive options. However, risks that EU recycling industry would suffer from more complicated waste shipment rules with corresponding decrease in employment	(+) This effect will be in two directions: 1. some recycling industries could face higher environmental standards leading to a decrease in activity. However, given the general rise in disposal costs caused by implementation of the Incineration and Landfill Directives this effect is likely to be marginal 2. reduced restrictions on shipments would increase recycling activities and result in more employment.	(+) very limited increase in employment as labour-intensive activities are likely to be favoured by clarification of legislation. However, this effect is expected to be slightly lower than for the revision of the FWD option because of non-uniform application across the EU	(+) very limited increase in employment as labour-intensive activities are likely to be favoured by clarification of legislation

		This second type of impact could be expected to predominate		
Health	(+) the reduction in polluting emissions would have slight positive impact on human health	(+) the reduction in polluting emissions would have slight positive impact on human health. In addition, risk issues related to recycled materials would be tackled which would have a positive impact on human health	(+) the reduction in polluting emissions would have slight positive impact on human health	(+) the reduction in polluting emissions would have slight positive impact on human health
Environmental, economic and social impact of clarifying when wastes cease to be waste (common to the three alternative options)		<p>Clarifying when wastes cease to be waste is expected to have largely positive economic, environmental and social impacts. For example, it should encourage clean recycling and the recycling of and trade in the related wastes through:</p> <ul style="list-style-type: none"> • A reduced administrative burden due to permits; • Increased confidence in the material, raising demand; • Reduction of costs and of potential distortions of competition caused by legal uncertainty, such as dealing with authorities that have different interpretations or that apply different standards. <p>Achieving this through informal guidelines would have the same type of impact as the technical criteria option. However, in some cases the greater flexibility provided by these guidelines enhances the impact, while in others non-uniform application could reduce the benefits.</p> <p>However, the implementation of technical criteria will entail compliance costs when it is necessary to demonstrate that materials are clean. Such criteria need to be adapted to the specific use of the material, which can be challenging.</p>		

The four worked examples which follow take a close-up look at the issues and types of impact relating to extending the IPPC Directive to a selection of waste management operations and clarifying the basic definitions contained in the Waste Framework Directive.

Worked example 1: extending IPPC as a component of common recycling standards⁵⁷

A qualitative model was developed to assess the effects of extending the scope of IPPC to additional waste treatment operations, using a combination of case studies, desk research and consultation of stakeholders.

General extension of IPPC to all waste management processes would generate no major environmental benefits and the positive environmental effects could be small in relation to the additional costs. However, targeted extension would be justified for activities for which the costs of extension of IPPC are limited compared to the environmental effects. For waste that is traded, IPPC can be part of a system of regulation ensuring treatment at optimum cost, improving environmental performance, preventing eco-dumping and encouraging trade and the associated incentives to lower recycling costs. The table set out below classifies waste operations into significant, low and unknown environmental impact.

Significant environmental impact:	Low environmental impact:	Unknown impact:
ELV dismantling		
Composting of organic waste		
Pre-treatment of combustible waste for co-incineration		
Sorting of construction and demolition waste		
WEEE dismantling		
Off-site treatment of slags and ashes for recycling		
Recycling of sludges		
Mechanical recycling of plastics		
Chemical recycling of plastics		
Sorting of packaging waste		
Preparation of paper for recycling until de-inking		
Off-site preparation of waste glass from a glass mill		
Recycling of textiles	Recycling of wood	
Recycling of rubber		
Recycling of minerals		
Scrap preparation		
Recycling of edible oils/fat		
Recycling of gypsum		

The case studies support extension of IPPC to biological treatment and to pre-treatment for co-incineration. Other likely candidates for IPPC extension are sorting of construction and demolition waste, off-site treatment of slags and ashes for recycling, recycling of sludges and chemical recycling of plastics. The relatively low environmental benefits from extension of IPPC to sorting of packaging waste, preparation of paper for recycling until de-inking, off-site preparation of waste glass from a glass mill and (preparation for) recycling of textiles suggest that these processes should not be covered by IPPC. The case studies suggest that the benefits of IPPC would be limited for dismantling operations covered by other EU legislation (ELV, WEEE).

In addition, the scope of the IPPC Directive is unclear. This “grey area” includes, *inter alia*, processes that are covered when they are performed on-site but not when they are performed off-site (e.g. treatment of slags and ashes from waste incinerators) and processes that are covered when they lead to disposal but not when they lead to recovery (e.g. biological treatment). Extension of IPPC coverage will be an opportunity to solve these issues and end the unequal treatment of technically identical processes.

Further work identifying more precisely the impact of such an extension of the scope of the Directive, in particular for smaller installations, should be part of the impact assessment on the review of the IPPC Directive.

⁵⁷ Based on “Support in the drafting of an ExIA on the Thematic Strategy on the Prevention and Recycling of Waste”, part three p. 87, final report submitted by EPEC, available on the Commission’s website at <http://europa.eu.int/comm/environment/waste/strategy.htm>.

Worked example 2: impact of clarifying when waste ceases to be waste in the case of recycling construction and demolition waste (C&DW)⁵⁸

Currently it is unclear in EU waste legislation at which stage processed C&DW ceases to be waste.

The cost of landfilling inert C&DW is currently €5-€15/tonne while recycling costs approximately €1-€6/tonne. Aggregates sell at €1-€6/tonne and in many countries prices are higher than the price of virgin materials. Consequently, this recycling activity is sensitive to small increases or decreases in operating costs. It should be noted that implementation of the Landfill Directive is likely to increase the costs of landfilling inert and mixed waste, which will be beneficial for this recycling activity.

In most countries there are no binding reference standards defining quality levels for recycled materials. Because of this, the quality of the recycled aggregates on the market is highly variable which reduces customer confidence in these materials thereby reducing market opportunities.

It is estimated that, where recycled aggregates are regarded as waste, at least one employee spends four working hours per week dealing with the administrative requirements imposed by the waste legislation. This is about 160 hours per year per site of average size and is estimated to cost some €9.6 million in a selection of eight Member States, i.e. 1% of turnover.

Environmental benefits of recycling inert and mixed C&DW include reduced use of virgin materials, reduced impact of extraction activities, reduced emissions of greenhouse gas (energy-related emissions of CO₂ and methane emissions caused by landfill of biodegradable materials present in mixed C&DW), reduced transport thanks to proximity of recycling centres, slight reduction of emissions to air and reduction of use of land for landfilling purposes. Environmental risks relate to leaching of substances from recycled materials.

Defining end-of-waste criteria for recycled aggregates would have many positive impacts, including a reduction of administrative costs for businesses, increased customer confidence in these materials and better market opportunities for recyclers, promoting recycling activities that deliver environmental benefits. However, there would be compliance costs and it is important that the criteria and compliance system are proportionate to the environmental issues.

⁵⁸ This case study is based on detailed input given by the FIR at the stakeholder meeting on 11 March 2005 which discussed various issues related to the review of the Waste Framework Directive and, in particular, defining when wastes cease to be waste. It is the most detailed submission made by trade associations. This contribution is based on a review of available literature concerning recycling of inert and mixed construction and demolition waste.

Worked example 3: impact of clarifying the definition of recycling in the case of plastics

Recycling is defined in several Directives regulating specific waste flows. The definitions in some of these Directives do not clearly state which processes count towards the recycling targets. This is particularly problematic for plastics. Plastics can be recycled into plastics (mechanical recycling), broken down to make new substances or play a useful role in production processes.

The literature suggests that when comparing mechanical recycling, feedstock recycling, energy recovery and landfill the major category of impact is greenhouse gas emissions. This can be expressed in terms of energy resources saved: the benefits of mechanical recycling of plastic waste lie within the 0 to 60 MJ range per kg of recycled plastic waste. 60MJ/kg can be achieved by using homogeneous plastic waste fractions to produce granulate and replace virgin plastic. Mechanical recycling of mixed plastic waste brings smaller benefits (producing roof tiles, palisades, etc.) because of the smaller amount of energy used in producing the product that is substituted (concrete, wood, etc.). In blast furnaces this is estimated to yield an energy saving of 42 to 47 MJ/kg. Currently mechanical recycling is slightly more costly than other processes and this difference is likely to increase over time.

There are therefore two main options for defining the scope of recycling: either recycling includes mechanical recycling only or it includes a range of processes other than energy recovery. Each of these interpretations can result in undesired effects:

- A narrow scope would mean that large amounts of mixed plastics would have to be mechanically recycled. This could produce low-quality plastics that can only be used to replace wood or concrete – which is both costly and not environmentally beneficial;
- A wide scope would mean that most plastic waste would go to the cheapest process. Mechanical recycling would therefore not be promoted for the fraction where it is the best option, i.e. uncontaminated homogeneous plastics.

It is clearly environmentally advantageous to ensure that policy does not inadvertently drive the resource-intensive recycling of contaminated and/or mixed plastics and neglect mechanical recycling of clean, easy-to-collect plastic waste.

Worked example 4: impact of using an energy efficiency threshold to define energy recovery in municipal waste incinerators

Current jurisprudence of the European Court of Justice classifies the overwhelming majority of municipal incinerators as disposal facilities.

It has been estimated that this could lead to degradation of the environment. For example, incineration with energy recovery is usually considered a means of diverting biodegradable municipal waste from landfills and helps the EU to comply with Directive 1999/31/EC. However, there are concerns that if incineration is defined in the same category as landfilling, some local authorities could be tempted to choose the cheapest option (landfilling), which will in turn degrade the environment. In addition, municipal incinerators with high energy efficiency are negatively discriminated against compared with some co-incineration operations with similar energy efficiencies but less stringent emission controls.

Economic costs for the municipal incineration sector due to this classification are estimated at some €260 million a year (between 2004 and 2008). It should be noted that these costs have to a large extent been reduced by an amendment to the Packaging Directive which allows municipal incinerators recovering energy to be counted towards the targets sets for management of packaging waste.

An objective definition that takes into account that energy produced by a municipal incinerator substitutes the use of resources in other power plants could better reflect the environmental benefits of incineration. However, the energy efficiency of municipal incinerators can vary dramatically. At low energy efficiencies incineration might not be more favourable than landfill. At high energy efficiency incineration could be as favourable as mechanical recycling or bio-treatment of certain waste flows. What is more, energy can be produced as heat, power or both. Therefore there is a need to compare heat and electricity generation which can be done using the weighting factor proposed in the BREF on waste incineration (1 kWh of power is equivalent to 2.6 kWh of heat).

In conclusion, using an energy efficiency threshold could generate both economic and environmental benefits in the case of classification of municipal incinerators as recovery or disposal operations. The threshold may be set at different levels, depending on the environmental objective that is considered most important. Setting the threshold at a moderate level, for instance by reference to the performance of a BAT plant producing electricity, would facilitate landfill diversion strategies but would mean that plants with moderate environmental performance would have the same status as efficient recovery operations. However, as BATs improve the threshold would progressively increase. On the other hand, setting the threshold at a high level, for example on the basis of life-cycle assessments comparing various recovery operations, would not encourage landfill diversion but would ensure that municipal incineration classified as recovery offers a high environmental performance.

5.5. Reduce the environmental impact of waste oils

Table 5 summarises the detailed information contained in Annex I. This Annex contains separate assessments of the environmental impact of collection of waste oils and of regeneration/combustion of waste oils.

Table 5: Impacts of options to reduce the environmental impact of waste oils

OPTION		No policy change	Focus on collection
IMPACT			
Environment		<p>(=) regeneration would increase. This would not lead to significant changes in the environmental impact. For instance, the most important indicator in favour of regeneration is the carcinogenic risk potential, which would decrease by 0.0039% (in EU-15) in comparison with waste oil incineration in cement kilns. Life-cycle assessments are also inconclusive on the advantage of regeneration; the relative advantages could be around 11-17% for the carcinogenic risk potential, but with disadvantages for the global warming indicator (up to 21%)</p> <p>(=) collection rates would remain at the current levels</p>	<p>(+) a renewed and strong focus on collection would have the effect of increasing collection rates. This would further reduce the severe risks for human health and the environment arising from illegal dumping in water or soil or uncontrolled incineration</p> <p>(=) in the long term decreased regeneration rates do not significantly change the environmental impact</p>
Economic	Direct costs	(=) combustion and regeneration have similar costs	<p>(-) collection is costly and could be estimated as in the same relative order of magnitude as the costs for regeneration. Consequently, complete collection would cost €144 million</p> <p>(=) combustion and regeneration have similar costs</p>
	Indirect costs	(-) giving regeneration priority favours the regeneration industry, but distorts competition and the free movement of goods	(=) enforcement will bring benefits for the collection sector but requires greater effort from the public administration and might require back-up measures (awareness-raising campaigns, take-back obligations, etc.)

Social	<p>(=) a possible increase in jobs, but a risky dependence on a few large regeneration installations</p> <p>(=) reduction of resource depletion and impact on security of petroleum supply is insignificant (<0.05%)</p>	<p>(+)increase in jobs and greater environmental awareness</p>
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6. COMPARISON OF THE OPTIONS

6.1. Improve knowledge on the environmental impact of waste generation and management

The literature review strongly supports integration of life-cycle aspects in environmental policy on waste. Such integration would benefit policies by making them more effective and cost-efficient.

The two alternative policy options have limited direct environmental, economic and social impact but have potential for improving the economic efficiency of waste policies. This would benefit the environment by promoting better allocation of resources within environmental policies and indirectly benefit the economy by avoiding disproportionately costly waste policies.

The main difference between the two options is their degree of flexibility. The “Maximum use of LCA” option guarantees that environmental issues will always be scrutinised in detail but this could in some cases come at a comparatively higher cost for regulators and businesses than with the “Move to LCT” option. Conversely, the “Move to LCT” option could be less costly and be a more pragmatic basis for policymaking but it does not guarantee that assessments go into the necessary depth, which could limit the impact of this option.

6.2. Harness the potential of waste prevention to contribute to reducing the environmental impact of waste generation

The information reviewed during the IA demonstrates that waste generation has a wide range of negative economic, social and environmental impacts which is why waste prevention is desirable. However, waste prevention policy must also take account of the potential of waste prevention to reduce the overall environmental load of use of resources by taking a life-cycle approach.

Neither of the two alternative options has major direct environmental, economic or social impacts but they would both increase the focus of policymakers at EU, national and sub-national levels on prevention, thereby triggering an increase in waste prevention policies. The environmental, social and economic impacts of the two options will largely be determined by the implementing measures taken by the Member States.

The “Targets” option has the advantage over the “Framework” option of giving a clear and unequivocal signal in favour of policies targeting weight reduction. It also allows simple measurement of progress.

The “Framework” option has the advantage over the “Targets” option of focusing on the environmental effectiveness and economic efficiency of prevention policies. Its greater flexibility also allows fuller consideration of economic and social issues.

6.3. Harness the potential of waste recovery and recycling to contribute to reducing the environmental impact of waste management

An increase in recycling and recovery generally results in positive environmental (mainly climate change) and social (mainly employment) impacts but these have an economic cost. Because of their complexity, the environmental and economic impacts of recycling or recovering a particular waste stream can have a range of cost-benefit ratios. In unfavourable cases recycling or recovery could be environmentally neutral but costly. In favourable cases the benefits of recycling or recovery outweigh the costs.

The “Environmental agreements” option has the lowest direct economic costs. It is, however, uncertain to what extent this option will generate environmental benefits.

The absolute costs of the “No policy change”, “Economic instruments” and “Mandatory management” options depend on the particular waste stream targeted and the nature of the economic instrument (e.g. level of landfill tax). Under the “No policy change” option costs would be borne by the producers of targeted products while the generators of waste would bear the costs under the other options. The “Economic instruments” option would result in the lowest unit cost for environmental improvement and lowest implementation costs, immediately followed by “Mandatory management”, in turn followed by “No policy change”.

However, the picture is different as regards innovation. The “No policy change” option gives a strong signal in favour of innovation that reduces the recycling/recovery costs but only for the regulated products. “Mandatory management” and “Environmental agreements” have similar effects as they target specific products or wastes but of lesser magnitude as they are either softer or have a wider scope. The “Economic instruments” option would benefit innovation in general as it allows maximum flexibility but this effect would probably not be as strong as that of the “No policy change” option.

The assessment also suggests that there are environmental and economic advantages from running material-based recycling policies rather than product-based policies.

6.4. Improve the regulatory environment for recycling and recovery activities

The different options address, to a varying degree, the two types of issue raised by the current regulatory environment for waste activities, i.e. on the one hand the implementation problems

caused by the complexity and lack of clarity of the waste legislation and, on the other, the functioning of the internal market for waste recycling and recovery.

All options lead to greater clarity in the EU waste legislation which has positive impacts in both environmental and economic terms and no significant social impact as regulatory burdens decrease and clarity enables complying operators to operate in a safe regulatory environment. As regards these aspects, the best options are “Revision of the Waste Framework Directive” and “Interpretative guidelines”, both of which are much more effective than “EU recycling society” and “National standards”. “Revision of the Waste Framework Directive” has the advantage of legal certainty which is very important for implementation of the waste legislation, in particular as regards when waste ceases to be waste or classifying operations as recovery or disposal. The advantage of “Interpretative guidelines” is the potential to deal with issues on a case-by-case basis when legislation is too rigid, for example as regards the issue of by-products.

“National standards” and “EU recycling society” are the only two options that address internal market issues significantly. They have very different potential impacts:

- “National standards” makes it possible for Member States to reduce emissions from waste management nationally. Locally this could lead to a very high level of protection of the environment. However, nationally regulated sectors would escape EU-wide competition. In addition, the costs of nationally regulated wastes for EU industry would rise and issues relating to the environmental performance of waste facilities in the EU would not be solved. This option would result in increasing divergence of national waste policies and make the functioning of the internal waste recycling and recovery market increasingly difficult in the future. Small Member States could be particularly affected by this. In the longer run, this could be detrimental to the waste sector as innovation and markets would be negatively affected which, in turn, would have negative environmental impacts because favourable activities would not be able to develop. With divergent policies in place nationally it would also be very difficult to develop common European solutions;
- “EU recycling society” has the potential to benefit both the environment and the economy after an initial adaptation phase. The development and implementation of standards implies high initial costs but these would be lower than for national standards thanks to economies of scale. In addition, clarification of the rules on the internal market would reduce recurrent costs for dealing with conflicts related to different national standards and shipment controls. European reference standards for waste treatment facilities and selected recycled substances would increase the level of environmental protection across the whole of the EU and solve the problem of operators who do not respect the environment and operate at a low level of quality. This would also increase the general level of confidence in the waste recycling and recovery market and, in particular, acceptance of recycled substances on the market.

6.5. Reduce the environmental impact of waste oils

The “Collection” option decreases the environmental impact, leads to no negative impact on the other criteria considered, and will possibly create more jobs in the collection sector.

The “No policy change” option leads to no advantages over the “Focus on collection” option for any of the criteria considered. While there is no clear-cut environmental benefit, it would create additional costs and distort the market.

6.6. Subsidiarity and proportionality of the identified policy options

Subsidiarity

Action at EU level is necessary to address the issues identified in this IA for the following reasons:

- Waste is produced in all the Member States of the EU and can have transboundary pollution effects. Only action at EU level can guarantee that the environment and human health are protected from the potentially deleterious effects of waste generation and management;
- Waste is moved throughout the EU and indeed internationally. An internal market in waste for recycling can only exist if there is a common definition of key concepts such as "waste", "recovery" and "disposal" and if there are common minimum standards for handling waste;
- Action by the Member States alone would render the internal market in waste for recycling inoperable and damage cooperation on other forms of waste treatment. This would lead to significant economic costs;
- Action at EU level to coordinate national waste prevention policies can significantly increase the environmental and economic efficiency of waste prevention policies through spreading good practices and synergies from similar approaches being developed in different Member States;
- A better understanding of the environmental impact of waste generation and management in the EU can only be achieved by improving and developing the knowledge base available at EU level.

Proportionality

The various policy options taken into consideration in this report have been selected taking into account the need for proportionality, in particular:

- The selected options for harnessing the potential of waste prevention to contribute to reducing the environmental impact of waste generation all take into account both the added value of EU coordination of national approaches and the fact that waste prevention measures need to be taken as close as possible to the point of generation of the waste;
- The options for harnessing the potential of waste recycling and recovery to contribute to reducing the environmental impact of waste management focus on the environmental issue in question. They were selected for their potential to address these issues only on points on which it is essential that there is a harmonised approach, allowing national decisions in other areas;
- The options for improving the regulatory environment for recycling and recovery activities introduce a number of innovations that will reduce the financial and administrative burden of waste regulation whilst preserving a high level of protection of the environment and human health;
- The alternative options considered for reducing the environmental impact of waste oils question the proportionality of the priority given to the regeneration of waste oils.

6.7. Preferred set of options

On the basis of this IA, the Commission considers that today the EU has a unique opportunity to make a paradigm shift in waste policy. It started from a situation where waste was mismanaged and needed close controls. With the recently adopted legislation in place, there is now a need to look at waste differently. This will involve:

1. Taking a resource approach to waste. This includes moving to life-cycle thinking, adopting a framework for waste prevention policies and increasing recycling and recovery of waste. For the latter, economic instruments have particular potential;
2. Moving to a European recycling society by developing common environmental requirements for waste recycling and allowing waste for recovery to move more freely between Member States;
3. Modernising the legislative framework by revising the waste framework legislation and adopting interpretative guidelines for issues needing case-by-case approaches.

As regards waste oils management, the Commission considers that the focus should be on the main environmental issue, i.e. full collection of waste oils, and that the priority given to regeneration should be repealed.

The communication “*A Thematic Strategy on the prevention and recycling of waste*” outlines the strategic approach and indicates how the Commission will proceed to implement it.

The proposal for revision of the Waste Framework Directive and other pieces of legislation proposed together with the communication are the first measures implementing the strategy. This proposal is based, *inter alia*, on application of life-cycle thinking to waste policy. It includes:

- definition of an environmental objective for waste policy;
- clarification of basic definitions of waste legislation;
- an obligation for Member States to develop national waste prevention programmes;
- provisions creating the framework for common waste treatment standards, notably by providing a means of clarifying when wastes cease to be waste and the definition of recovery, and allowing the adoption of minimum standards for low-risk waste recovery facilities;
- simplification of the waste legislation, notably by clarifying obsolete provisions and merging the Waste Framework Directive and the Hazardous Waste Directive;
- encouragement for Member States to use economic instruments to make progress towards the environmental objective of waste policy. This proposal is limited to political encouragement as a proposal for a common approach to waste disposal taxes would fall under the unanimity rule for adoption by the Council and there appears to be no unanimous consensus in the Council on the necessity for such action;
- provisions confirming the obligation on Member States to ensure the collection of waste oils and repealing Directive 75/439/EEC on the disposal of waste oils.

This proposal includes an energy efficiency threshold above which municipal incineration is considered a recovery operation. The threshold is set at the reference level that corresponds to BAT performance of an incinerator. The objective of this proposal is to promote diversion from landfills. Once progress has been made in diversion from landfills the threshold should be increased to ensure that competing recovery installations have comparable advantages over landfill.

Other initiatives which will be taken to implement the strategy include:

- ensuring appropriate implementation of existing legislation which will deliver substantial progress in terms of reducing the environmental impact of waste management and increasing recycling and recovery;

- developing a new knowledge base on the impact of waste generation and management;
- assessing the need for further EU measures to foster waste prevention and recycling;
- adopting interpretative guidelines concerning by-products;
- extending the scope of the IPPC Directive to cover additional important waste recovery activities.

7. MONITORING AND EVALUATION

The following elements will allow monitoring and evaluation of the strategy.

1. The **improved statistics on waste management and generation** will deliver good information for monitoring waste generation and management trends in the EU. These statistics will make it possible to define new categories of weight-based indicators covering more than just MSW, as is currently the case, including the potential for better monitoring of generation and management of hazardous waste;
2. The **new knowledge base on the environmental impact** of waste generation and management will allow better assessment of the environmental benefit of the waste policy. Ultimately, the work on this knowledge base will make it possible to define environmental indicators reflecting the environmental impact of waste management better than weight-based indicators;
3. **Assessments of national waste policies** will be required as part of the regular reports from the Member States on implementation of the EU waste legislation;
4. **Feedback will be required from relevant stakeholders** on the effect on the market of the adoption of end-of-waste criteria for specific waste flows;
5. **Implementation reports** will, *inter alia*, make it possible to monitor the collection rate for waste oils.

Annex 1: Detailed information on the impact of waste oils management

Environmental impact

a) Regeneration versus incineration

Several comparisons of different waste oil treatment technologies have been conducted⁵⁹. They have raised reservations about their application and proper execution, which is not surprising, given the complexity of the issue. The criticisms relate, for instance, to the substituted fuels at incineration plants (marginal fuel), the base oil quality produced, the appropriate allocation method for calculating the impact, the failure to take account of future technologies and the chosen impact categories.

It is not feasible to provide a complete assessment of all technologies used to treat waste oil. Moreover, significant differences in impact are observed within the generic categories recycling and incineration, because very different technologies come under the same heading: older regeneration processes like acid/clay based technologies compete with a range of new and cleaner processes⁶⁰ and with recycling operations other than regeneration, like thermal cracking, gasification and others (i.e. flux oils). Incineration of waste oils takes place primarily in cement kilns⁶¹, road-stone works and power plants, but is complemented by a range of reprocessing facilities, for instance distillation to produce marine diesel oil.

Nevertheless the studies provide sufficient knowledge to draw generic conclusions on the impact of waste oils treatment. The equation set out below allows comparison of the environmental impact of energy recovery and regeneration from a life-cycle perspective. It takes account of the impact of the production and waste phases. The use phase is neglected because it has no

⁵⁹ See: Taylor Nelson Sofres S.A, IFEU: Ecological and energetic assessment of re-refining used oils to base oils: Substitution of primarily produced base oils including semi-synthetic and synthetic compounds; Heidelberg 2005; Australian Academy of Technological Sciences and Engineering: Independent Review of the transitional Assistance Element of the Product Stewardship for Oil (PSO) Programme; Australia, March 2004; Bob Boughton, Arpad Horvath: Environmental Assessment of Used Oil Management Methods; Environmental Science & Technology; Vol. 38 No 2, 2004; p. 353 – 358; ENVALYS: Life-cycle Assessment of Used Oil Recycling. Provisional Report.

⁶⁰ For instance, applied in the facilities in Aspropyrgo (Greece), Zeitz (Germany), Dollbergen (Germany), Ceccano and Pieve (Italy).

⁶¹ Incineration in cement kilns accounts for a volume of only approximately 400 000 Mt in EU-15, accounting for 1/6 of the total waste oils to be treated.

significant impact. The equation also includes the impact of the waste oils lost during the consumption process.

$$LC-I_{Inc}X + RegY = X \times I_{Vir} + Y \times [I_{Vir} - (I_{Vir} - I_{Reg})] + Z \times [I_{Vir} - (I_{PrimF} - I_{Inc})]$$

where:

$LC-I_{Reg}X + IncY$	= Life-cycle impact of mineral oils regenerated and incinerated
X	= Share of oils lost during consumption
I_{Vir}	= Impact of refining base oils from virgin mineral oils
Y	= Share of mineral oils regenerated
I_{Inc}	= Impact of combustion of waste oils
I_{PrimF}	= Impact of producing energy from primary fuels
Z	= Share of mineral oils incinerated.

One generic conclusion from the LCA studies on waste oils is that for almost all categories of environmental impact recovery (whether by incineration or by recycling) is less polluting than the process avoided (virgin oil production or primary fuel production). Therefore in the equation the terms in round brackets (the sum of the operations $I_{Vir} - I_{Reg}$ and $I_{PrimF} - I_{Inc}$) are almost always positive.

The table set out below applies the equation to compare the two options “maximum regeneration” and “maximum incineration”. Both options are based on an uncollected share of 50%. In the first option a share of 25% is considered realistic (roughly half of the collected waste oils are not fit for regeneration), while the second option is based on the extreme assumption of no regeneration. The impact data are based on a recently published life-cycle analysis conducted by IFEU and commissioned by the European waste oils regenerators GEIR⁶².

⁶² IFEU 2005.

Table: Comparison of environmental impact by maximising either use of waste oils in cement works or in modern regeneration installations (assumption: oil contains no poly alfa olefins and substitutes a primary fuel mix used in cement works in the EU)

Criterion	Global warming		Acidification		Nitrification		Carcinogenic risk potential	
	Maximum regeneration	Maximum incineration	Maximum regeneration	Maximum incineration	Maximum regeneration	Maximum incineration	Maximum regeneration	Maximum incineration
Share of unrecovered (uncollected) waste oils	50%							
Impact to produce one tonne of lubricant ⁶³	1160 kg CO ₂ -eq.		5.03 kg SO ₂ -eq.		0.1802 kg PO ₄ ³⁺ -eq.		0.282 g AS-eq.	
Share of regenerated waste oils (waste oils generated = 100%)	25%	0%	25%	0%	25%	0%	25%	0%
Overall avoided impact by the regeneration of one tonne of waste oils	484 kg CO ₂ -eq.		4.904 kg SO ₂ -eq.		0.1237 kg PO ₄ ³⁺ -eq.		0.264 g AS-eq.	
Share of combusted waste oils (waste oils generated = 100)	25%	50%	25%	50%	25%	50%	25%	50%
Impact to produce one tonne of fuel	4060 kg CO ₂ -eq.		3.09 kg SO ₂ -eq.		0.183 kg PO ₄ ³⁺ -eq.		0.145 g AS-eq.	
Overall avoided impact by the combustion of one tonne of waste oils	1120 kg CO ₂ -eq.		2.964 kg SO ₂ -eq.		0.182785 kg PO ₄ ³⁺ -eq.		0.144 g AS-eq.	
Sum of impacts	759 kg CO ₂ -eq.	600 kg CO ₂ -eq.	3.063 kg SO ₂ -eq.	3.548 kg SO ₂ -eq.	0.103579 kg PO ₄ ³⁺ -eq.	0.088808 kg PO ₄ ³⁺ -eq.	0.18 g AS-eq.	0.21 g AS-eq.
Impact difference (Regeneration =100%)	- 21%		16%		14%		17%	

⁶³ Approximate value; regeneration leads to average yields of only approximately 70% and is complemented by other output products.

According to the calculation above, regeneration has advantages over incineration in cement works in the environmental categories acidification, nitrification and carcinogenic risk potential. However, lower impacts are arising from the global warming potential. This is because the waste oils substitute fuels with a greater impact on global warming, such as pet-coke and coal. The study assigns different levels of environmental priority to each category. The highest priority is allocated to the criteria global warming and carcinogenic risk potential⁶⁴.

Following the same calculation method, the table below shows the different impacts arising from the three other main scenarios presented in the IFEU study. The results are similar. In the scenarios where waste oils substitute heavy fuels in cement works the global warming impact between regeneration and incineration in cement works differs to a lower extent.

The differences add up to 17 percent. It must be borne in mind that the figures compare extreme scenarios – almost complete regeneration of waste oils fit for regeneration against no regeneration at all – but in practice the shares regenerated and incinerated will lie between these margins.

Table: Environmental impact variation under three different waste oils LCA scenarios

Criterion/scenario	Global warming	Acidification	Nitrification	Carcinogenic risk potential
PAO 30%*, EU fuel mix**	12 %	-13%	-1%	-17%
PAO 0%*, 100% heavy fuel***	2%	-16%	4%	-11%
PAO 30%*, 100% heavy fuel***	-4%	-16%	-7%	-11%

* Poly alfa olefins share in the regenerated lubricant

** Waste oils substitute a fuel mix currently used in EU cement works

*** Waste oils substitute heavy fuel oil in cement works

⁶⁴ However, it has been argued that the methodology is not as robust for carcinogenic risk potential as it is for other impact categories; see Taylor Nelson Sofres S.A.

The IFEU study also provides a method to compare the normalised impact of regeneration and incineration. Here the different impacts are related to the total impact of pollutant releases in EU-15.

Table: Normalised environmental impacts of waste oils regenerated in modern plants compared with incineration in cement works (substitution of fuel mix, 100% base oils), expressed as person equivalent value and as share of total releases, based on 600 000 Mt (assumed waste oils potential in EU-15)

	Regeneration value in EU-15	Share of total pollutant release in EU-15)
Criteria of very high environmental priority		
Global warming	- 32 000	- 0.0084%
Carcinogenic risk potential	15 000	0.0039%
Criteria of high environmental priority		
Acidification	18 000	0.0047%
Nitrification	6 530	0.0017%
Fine particulates	400	0.0001%
Criteria of medium environmental priority		
Fossil resources	192 700	0.05%

The ranking corresponds to the results presented in the tables above. Incineration has the advantage over regeneration for the high-priority criterion “global warming”. It saves a global warming impact equivalent to 32 000 persons. However, this merely equals less than 0.01% of the greenhouse gases emitted in EU-15. The other criteria show favourable results for regeneration, but also result in only very small absolute differences. The impact on “fossil resources” shows the relatively strongest advantage for regeneration (but only 0.05% of the total fossil resources depletion). However, the focus of environmental policy has shifted away from considerations relating to the scarcity of fossil fuels towards reducing the environmental impact of use thereof⁶⁵. The depletion of fossil (fuel) resources is no longer seen as an environmental impact in itself, but rather the CO₂ and other pollutants arising from combustion of fossil fuels (see also section on social impact).

In the light of these considerations, the general comparison of regeneration and incineration (in cement works) leads to inconclusive results for the different criteria and insignificant absolute

⁶⁵ “Towards a Thematic Strategy on the sustainable use of natural resources” (COM(2003) 572 final).

environmental impacts. The precise benefits of regeneration over fuel substitution for waste oils will be case-dependent, from a life-cycle perspective.

b) Collection

Waste oils contains pollutants from the generation phase. In addition, waste oils sometimes carry organic pollutants produced during their use, e.g. in engines. Altogether this includes considerable concentrations of arsenic, chlorine, cadmium, chromium, nickel, lead, mercury, zinc, sulphur, polyaromatic hydrocarbons and polychlorinated biphenyls. Therefore waste oils dumped in sewers and rivers or tipped on soil pose a severe contamination risk for freshwater, with associated impacts on aquatic plants and fish, water treatment facilities and human health.

If waste oils are burned in heaters without air pollution capture systems almost all the contaminants are emitted into the air. An American Study⁶⁶ compared the direct combustion of waste oils with re-refining and distillation (into marine diesel oil fuel). It showed that heavy metal emissions into the air are the predominant difference between these three uses (see table).

This leads to a 150-fold higher impact in the category “terrestrial ecotoxicity potential” and over 5 times higher impact in the category “human toxicity potential” if waste oils are burned without air pollution control systems instead of re-refined or distilled.

Inventory of key heavy metal air emissions based on equivalent functional units*

Heavy metal	Waste oil as fuel and equivalent products	Re-refining and equivalent energy	Distillation and equivalent energy
Zn	729	1.2	1.2
Cu	35	0.017	0.015
Pb	29	1.6	1.6
Cr	1.2	0.48	0.48
Cd	0.89	0.011	0.010

* Tonnes of air emissions per litre of fuel. Assuming no air pollution control.

⁶⁶ Bob Boughton, Arpard Horvath: Environmental Assessment of Used Oil Management Methods; Environmental Science & Technology; Vol. 38 No 2, 2004; p. 353 – 358.

Ratio of impact characteristics for waste oil combustion compared to re-refining and distillation*

Environmental impact category	Ratio of waste oils fuel to re-refining	Ratio of waste oils fuel to distillation
Terrestrial ecotoxicity potential (kg DCB equivalent)	150	150
Human toxicity potential (kg DCB equiv.)	5.7	5.7
Nitrification potential (kg phosphate equiv.)	3.2	3.1
Aquatic ecotoxicity potential (kg phosphate equiv.)	2	2
Ozone depletion potential	1.1	1.1
Photochemical oxidant potential (kg ethane equiv.)	1.1	1.1
Global warming potential (kg CO ₂ equiv.)	0.9	0.9
Acidification potential (kg SO ₂ equiv.)	0.5	0.5

* Based on equivalent functional units of product and energy recovery assuming no air pollution control.

Besides this, the study shows that the difference in environmental impact between distillation to clean fuels and regeneration is not significant. Compared with the environmental benefits arising from the prevention of illegal dumping and burning of waste oils, it is therefore irrelevant, which – authorised - treatment method is used.

Economic impact – direct costs

Regeneration

The total costs (capital costs + operating costs, excluding waste oils purchase) of a regeneration plant are strongly influenced by the technology and the size of the plant. While the extra costs of modern technologies compared with the old acid/clay technology could be as high as 75%, the cost of a small plant (around 35 000 tonnes/year) could (depending on the technology) be 20 to 40% higher than the cost of a large plant (>80 000 tonnes/year). Total costs between €148 and €320/tonne have been calculated for grass-root installations⁶⁷.

⁶⁷ See Taylor/Nelson/Sofres.

The revenue (€295-€325/tonne, except for the old acid/clay process with lower revenue) is mainly influenced by the

- quality of the re-refined base oil,
- price of the virgin base oil (with which the re-refined base oil competes),
- perception of the users and the expectations of the market,
- any tax exemptions which exist for the lubricants sold, and
- distribution costs.

This results mostly in a gate fee of €10-€100/tonne (which the deliverer has to pay). A zero or negative gate fee (-€10 to -€50/tonne) could arise in the case of some large plants, but others assume positive gate fees of €40-€94/tonne waste oil⁶⁸.

Another aspect are the implications for the waste oils collection system. Contaminants could spoil whole waste oil batches and hence rule out regeneration (but not necessarily combustion) thereof; some countries have therefore set up more than one collection scheme giving rise to extra costs for separation, storage and subsequent transportation of the waste oils suitable for regeneration⁶⁹.

Italy grants a reduction on excise duties and steers waste oils to regeneration facilities via a consortium. The compensation granted for the collection of waste oils totals €53/tonne. In Spain compensation of up to €66.12/tonne is granted for regeneration activities. Germany has adopted a support guideline for subsidies to regenerators. The support would be degressive, depending on the quantities of oil regenerated in a given plant. The full amount of €25.56/tonne of base oils generated⁷⁰ was to be paid for a maximum of 3 000 tonnes per plant in 2001; in subsequent years this amount would be reduced by €2.50 each year. Finland would subsidise up to 30% of the investment in a regeneration plant and would make €4.4 million available for this purpose. However, no investor has shown interest yet.

Incineration of waste oils generates revenue for waste oils collectors. Such negative gate fees strongly depend on the prices of the substituted fuels (pet-coke, coal, heavy oils, etc.). In Germany in 2002 the cement industry paid €45-€55/tonne for waste oils⁷¹. However, this

⁶⁸ European Petroleum Industry Association: Recycling of used oils: Legal and Technical Considerations, Brussels, 2003.

⁶⁹ Fitzsimons.

⁷⁰ Modern regeneration plants can achieve a base oil yield of 54-77% as a share of the waste oils, see IFEU.

⁷¹ Communication from the Government of the Federal Republic of Germany to the Commission of 23. May 2003.

might have changed in the light of the petroleum price, which has been increasing ever since. A recent study conducted in Germany shows that both the cement and regeneration industry pay for the waste oils, whereas the reimbursement in regeneration plants (in the end of 2004 ca. € 70/tonne) was double as high as in cement kilns. In the regeneration industry the receiving price for the waste oils has increased by 120% between 2000 and 2004.⁷²

In France in 2004 the collectors sold black oils to cement kilns for 21,84 – 25,53 €/tonne, while the regeneration industry only paid € 16,36 €/tonne⁷³.

A further influencing factor is the intervention by Member States concerning the use of fuels. *Council Directive 2003/96/EC restructuring the Community framework for the taxation of energy products and electricity* exempts the use of energy products in mineralogical processes from the Directive. Member States are therefore free to decide whether waste oils used as a fuel in cement kilns are excluded from excise duties, which is also the case for other fuels like coal and heavy fuels. It should be noted that recycled oils (for instance used as lubricants) are outside the scope of this Directive. In parallel, Member States grant exemptions for the marketing of re-refined lubricants.

Thus, costs depend on many factors, such as the revenues for products of the regeneration process and no clear-cut conclusions on the cost differences between regeneration and incineration can be made.

Collection

The table set out below shows the costs of waste oils collection (mostly including transport costs). Due to the time that has passed since the data were compiled⁷⁴, the costs have probably changed considerably in the meantime.

⁷² Ökopol GmbH: Draft final report of the study „Stoffstrom- und Marktanalyse zur Sicherung der Altölentsorgung“; Hamburg Oktober 2005

⁷³ Ademe: Filière huiles usages; Rapport d'activité 2004 de la Commission nationale des Aides

⁷⁴ SOFRES/TAYLOR/NELSON have amended cost figures identified by Coopers & Lybrand: Economics of Waste Oils Regeneration; The Hague, 1994; therefore different years between 1993 and 2001 are taken as the basis.

Country	Collection costs in €/tonne ⁷⁵
Belgium	50
Denmark	41.8 – 56.4
Finland	44-110
France	72
Germany	57 – 96
Greece	47
Ireland	38
Italy	100
Netherlands	61
Spain	25-38
Sweden	28.9
United Kingdom	30.5 – 46

Nevertheless, the wide variation of collection costs could still be valid. The main reasons for this scatter are:

- Difference in population density in various regions and countries within Europe;
- Differences in geographic circumstances;
- Organisational structures of the collection;
- Separation of different oil qualities by collectors.

According to these factors, the rise in the marginal collection cost for higher collection rates will not be linear. Complete collection of waste oils will induce much higher specific costs than the average cost per tonne for the 80% of waste oils already collected.

Finland, France, Italy and Spain provide compensation for undertakings which collect waste oils. In Finland, producers and importers of lubricating and other specified oils are under an

⁷⁵ The actual charge for the waste oils holder may be very different from the collection costs. In many countries collection is directly or indirectly subsidised. In some countries, the take-back and collection obligation is by law free for the holder.

obligation to pay a waste oil charge of €42/tonne. In France too producers and importers are subject to a parafiscal tax. In 2003 the average compensation was €76.12/tonne. In Italy a contribution upon release onto the market of €53 was paid. Spain paid compensation of €42.08/tonne for collection, transport, storage, analysis and/or pre-treatment.

The subsidy required also depends strongly on the revenue obtained for the waste oils sold and, in particular, on the petroleum price. In Finland the average amount of compensation is about €1.5 to €2.5 million/year. Due to exceptionally high sales revenues from pre-treated products, the compensation paid in 2002 totalled only €0.9 million.

The countries subsidising waste oil collection achieve almost complete waste oils collection. Based on this assumption, the average costs for complete waste oils collection can be estimated at €50/tonne. If, in the longer run, the same quantity of waste oils per capita is assumed for EU-10, this would result in approximately €144 million in EU-25.

Other economic impacts

Regeneration

The intrinsic market forces are not sufficient to stimulate priority for regeneration. This failure is obvious from the infringement cases brought against 12 Member States. Therefore some form of subsidy is necessary to implement regeneration as a priority. In the past this could have supported the development of environmentally advanced technologies. However, it appears more appropriate to promote such operations under other existing instruments, such as the European Environmental Technology Action Plan⁷⁶ and the BREFs⁷⁷ under the IPPC Directive.

In addition Member States may supplement this action by fostering environmentally friendly regeneration technologies on a national basis. Member States may back up high regeneration national standards with the Waste Shipment Regulation (93/293/EEC). It allows Member States to object to the shipment of waste oils for incineration on environmental grounds (see ECJ case C-92/03).

⁷⁶ COM(2004) 38: Stimulating Technologies for Sustainable Development: An Environmental Technologies Action Plan for the European Union.

⁷⁷ See in particular BREF on waste treatment; <http://eippcb.jrc.es/pages/BActivities.cfm>.

Furthermore, measures giving priority to regeneration could support oligopolistic structures and market distortion. This can be induced by consortia structures or by state aids; it is also favoured by the trend to a few large scale re-refineries because operating costs decrease strongly as capacity increases (see also section on economic impact - direct costs).

On the other hand, a repeal of the regeneration priority will have a positive effect on industry co-incinerating waste oils. This might stimulate new techniques for more efficient use of waste oils as fuel. Also the repeal leads to a higher number and greater diversity of methods of treatment, which are currently excluded from priority (e.g. methanol production).

The public administration has encountered certain difficulties with enforcing the regeneration priority. One of the causes is the administrative burden required to verify whether or not derogations from the regeneration priority apply and to check the actual destination of the waste oils.

The conclusion is that the repeal of the regeneration priority will stimulate competition between different treatment technologies, which best meet the market needs. This will support innovation.

Collection

Collectors will benefit from stricter enforcement of the collection obligation. Waste oils are collected and transported predominantly by small and medium-sized enterprises and there is no indication that higher collection rates might change this.

On the other hand, full enforcement of the collection obligation requires public action. In particular, it is difficult to control the large number of small sources generating waste oils. The control and inspection obligation might require back-up measures (e.g. campaigns to raise public awareness, take-back obligations or other economic instruments).

Social impact

Regeneration

The regeneration industry has warned that disappearance of waste oils recycling would result in a loss of more than 1 000 jobs⁷⁸. However, this risk appears exaggerated. As explained

⁷⁸ C. Hartmann: The Future of Waste Oil Recycling? Workshop at the European Parliament on Recycling; Brussels, 1 March 2005.

above, Member States may continue their national schemes to promote regeneration and environmentally friendly technologies are also to be stimulated at EU level.

On the other hand, free competition between different treatment technologies could create jobs in other industries, like pre-treatment and processing of waste oils into higher quality fuels and other products. This shift has already taken place in some regeneration installations, which convert a considerable proportion of the waste oils input into fuels. This is favoured by the high oil price. However, regeneration of waste oils into base oils does not particularly benefit from the higher oil price, because production implies a high degree of value added⁷⁹.

Another aspect is the security of waste oils recovery and disposal. Competition between different types of installations will provide greater diversity, while the priority for regeneration implies dependence on a few large installations. These might not be able to react to changing market conditions in time.

In general the market reacts very sensitively to quality problems with recycled products. These have been alleged⁸⁰ and could put regeneration of waste oils at risk.

Resource depletion, including the impact on the security of supply of petroleum, could favour regeneration. However, this would be equivalent to a very marginal share of the total EU-15 population (< 0.05%, see also section on environmental impact).

Collection

Improved enforcement of the collection obligation is likely to increase jobs, because the additional volumes of waste oils must be stored, collected and transported professionally. Furthermore, the focus on collection will increase the environmental awareness of the population.

⁷⁹ See Fitzsimons.

⁸⁰ For instance, EUROPIA points out that re-refined base oils show a greater mutagenic activity than virgin base oil. In addition, the abovementioned study by the IFEU mentions a rather high PCB content in the waste oils input for regeneration, which will affect the PCB content in the re-refined lubricants.

Annex III: Current and potential climate change impact of waste policy – simplified model

Objective of this modelling exercise

This model has been developed to gain insight into the overall potential impact of waste policies on greenhouse gas (GHG) emissions taking a life cycle approach. The aim of this modelling exercise is to give the order of magnitude of the climate impact of waste policies and to identify major and minor contributors to the climate impact of waste policies. It is based on available information and the results of the calculations will need refining in the future on the basis of availability of new data.

Types of climate impact

Waste policy can have an impact on GHG emissions mainly by:

- reducing emissions from waste management facilities (e.g. methane emissions from landfills);
- saving energy by recycling materials instead of producing materials; and
- recovering energy from wastes.

Baseline

GHG emissions from waste management were estimated at about 4% of total EU-15 GHG emissions, as shown in Table 1⁸¹. Methane (CH₄) is the main contributor and originates from landfilling of biodegradable waste (paper, food and garden waste) which decays and releases methane.

Table 1: EU-15 GHG emissions from waste management in 1990 (million tonnes CO₂ equivalent)

Overall total emissions	Total emissions from waste sector	CH ₄ emissions from waste sector	CO ₂ emissions from waste sector	N ₂ O emissions from waste sector
4 252	170 (4.25%)	152	15	3

The latest information published by the European Environment Agency shows that GHG emissions from waste have fallen from a total of 141 to 97 MtCO₂eq which break down as

⁸¹ Waste management options and climate change, final report submitted by AEA Technology, 2001.

shown in Table 2⁸². This report shows that about 90% of the reduction in GHG emissions observed between 1990 and 2003 is due to reduction of methane emissions from landfills.

Table 2: Greenhouse gas emissions from waste management in 2003 (million tonnes CO₂ equivalent)

Overall total emissions	Total emissions from waste sector	Share of landfill	Share of incineration	Share of others ⁸³
4 180	97 (2.3%)	71	3	23

Methane emissions from landfill fell by 44 MtCO₂eq between 1990 and 2003.

Current levels of recycling and the related reductions in GHG emissions are shown in Table 3.

Table 3: Contribution of recycling to reducing GHG emissions in 2003

	Amounts recycled (Mt) ⁸⁴	GHG emission savings (MtCO ₂ eq) ⁸⁵
Aluminium	3.9	35.5
Ferrous metals	86	129
Glass	8.2	2.5
Paper	45.5	41
Plastics	2.5	3.6
Total		212

Scope of the model

The model explores the potential of waste policies to influence GHG emissions through lower emissions from landfills and energy savings achieved by increased recycling and composting.

⁸² Annual European Community greenhouse gas inventory 1990-2003 and inventory report 2005, Submission to the UNFCCC Secretariat, EEA, 2005.

⁸³ Waste water accounts for 6% of these 24%.

⁸⁴ Based on data made available by industrial organisations (BIR, CEPI, Plastics Europe) and on packaging recycling statistics published reported to the Commission.

⁸⁵ This is calculated using the emission factors given in table 4.

Energy recovery is not considered in this simplified model because of the complexity of modelling the climate effects of energy recovery from waste. GHG emissions from combustion and GHG emission savings due to energy recovery would have to be added to or subtracted from the results of the model and other parameters of the model would have to be corrected to take account of the distribution of the waste between the various recycling and recovery processes.

The model includes landfill and recycling/composting processes and covers, in particular, aluminium, ferrous metals, plastics, paper/board, glass and biowaste (food and garden waste). It does not cover other waste flows that may be recovered or disposed of in various ways nor does it cover support activities such as transport. The activities included within the scope of the model are assumed to be the major overall contributors to the climate change impact of waste policies.

The model is limited to EU-15 as no sufficiently robust information was found to enable the model to cover EU-25.

The model does not link the climate impact to a given time line. Its results are presented as absolute reductions of emissions.

Main assumptions

The most important assumptions that were made to conduct this modelling exercise are:

- (1) waste volumes remain unchanged;
- (2) international trade remains unchanged;
- (3) recycling and composting of waste result in the GHG emission factors indicated in Table 4:

Table 4: GHG emission factors for recycling and composting (million tonnes CO₂ equivalent per million tonnes waste)⁸⁶

Aluminium	Biowaste ⁸⁷	Ferrous metals	Glass	Paper	Plastics ⁸⁸
9.1	0.08	1.5	0.3	0.9	1.45

- (4) Implementation of the Landfill Directive will result in (1) reduction of the absolute amounts of biowaste landfilled to 35% of the absolute amounts of biowaste produced in 1995, and (2) in landfills being equipped with landfill gas collection and combustion systems. It is assumed that methane emissions are proportionate to the amounts of biodegradable waste landfilled and that the collection efficiency of landfill gases is 65%. It is also assumed that methane emissions from landfill for the reference year of the Landfill Directive equal methane emissions from landfill in 1990 which is a slight overestimate.

Scenario

The scenario is built by adding together the following bricks:

- (1) Implementation of the Landfill Directive⁸⁹. Methane emissions are reduced by 44%⁹⁰ through diversion from landfill. The remaining emissions are reduced through gas collection and combustion⁹¹ representing a 36% reduction of emission. This results in combined reduction through diversion of biowaste from landfills and combustion of

⁸⁶ Unless otherwise indicated, the factors are taken from “Waste management options and climate change”, final report submitted by AEA Technology, 2001.

⁸⁷ Taken from “Compost credits – the carbon balance of biowaste composting”, report by Grontmij Nederland commissioned by Essent Milieu, 2005. This report gives a saving factor in the 0.06 to 0.1 range.

⁸⁸ Taken from “Good practices guide on waste recycling”, ACRR, 2004. Saving factors vary from 1.0 to 3.4 depending on the type of plastic. The factor of 1.45 indicated is for a mix of recycling activities.

⁸⁹ This calculation is based on data contained in COM(2005) 105 final. Report from the Commission to the Council and the European Parliament on the national strategies for the reduction of biodegradable waste going to landfills pursuant to Article 5(1) of Directive 1999/31/EC on the landfill of waste.

⁹⁰ Total MSW in 1995 was 482 Mt of which 50% is estimated to be biowaste (241 Mt). In 1995, 62% of MSW was landfilled and it is assumed that 62% of the biowaste produced was landfilled (149 Mt). The final amounts of biowaste landfilled will be 35% of total biowaste produced in 1995 (84 Mt). This reduction from 149 Mt landfilled to 84 Mt represents a reduction by 44%.

⁹¹ After diversion of biowaste from landfill 56% of the amounts landfilled in 1995 remain landfilled. Under the assumption of the model this means that 56% of the methane produced in 1995 is still, Collection and combustion of this methane will imply and additional reduction of emissions by 65% of 56%, i.e. 36%.

landfill gases of 80%, i.e. reduction of emissions from 107 to 21 MtCO₂eq. As methane emissions from landfills had already been reduced by 40 MtCO₂eq by 2003, the remaining reduction to be delivered by implementation of the Landfill Directive is 42 MtCO₂eq.

- (2) Recycling of material can be increased and deliver additional savings of GHG emissions, as shown in Table 5.

Table 5: Contribution of recycling to reducing GHG emissions post-2003

	Assumption	Additional amounts recycled (Mt)	GHG emission savings (MtCO ₂ eq)
Aluminium	Increase from 3.9 to 4.7 million tonnes, i.e. 20% increase	0.8	7.3
Ferrous metals	Increase from 86 to 103.2 million tonnes, i.e. 20% increase	17.2	12.8
Glass	Recycling of glass packaging reaches 80%	3.2	1.1
Paper	Paper collection for recycling reaches 75%, i.e. all Member States achieve the results of the current best performers	12	10.8
Plastics	Increase by 2.8 Mt - roughly implementation of the existing targets for packaging, end-of-life vehicles and waste electrical and electronic equipment	2.8	4.1
Total			36

- (3) Full ban of biodegradable waste from landfills. This delivers additional reductions by reducing methane emissions, recycling paper and composting biowaste as shown in Table 6.

Table 6: Contribution of a total ban on landfill of biodegradable waste to reducing GHG emissions post-2003

	Assumption	Additional amounts recycled (Mt)	GHG emission savings (MtCO ₂ eq)
Methane from landfill	All biodegradable waste is diverted from landfill resulting in zero methane emissions from landfill		13
Paper	The remaining 25% (15.2 Mt) of paper/board that are landfilled or incinerated are split between incineration and recycling in proportion to the current split between municipal waste incineration (18%) and recycling/composting (27%)	9	8.1
Biowaste	The remaining 61 Mt of biowaste that are landfilled or incinerated are split between incineration and composting in proportion to the current split between municipal waste incineration (18%) and recycling/composting (27%)	37	3.0
Total			24.1

Results

The results of the model are shown in Table 7.

Table 7: Climate impact of waste policy

		GHG emission savings (MtCO ₂ eq)	As fraction of total EU-15 GHG emissions (%)
Reductions achieved by 2003	Reduction of methane from landfills	44	1.0
	Savings from recycling	212	5.0

	Total	256	6.0
Reduction achieved post-2003 by implementation of the Landfill Directive and increased recycling	Reduction of methane from landfills	42	1.0
	Savings from recycling	36	0.8
	Total	78	1.8
Reductions achievable through a total ban on landfill of biodegradable waste	Reduction of methane from landfills	21	0.5
	Savings from recycling paper	8.1	0.2
	Savings from composting	3.0	0.07
	Total	32.1	0.77