1. Waste management

Prevention of waste

Our production and consumption lead to large quantities of waste. An important element in work on eco-cycles is therefore sustainable waste management. Articles that circulate in society contain large quantities of different materials. Many are energy-demanding to produce and contain substances that exist in limited quantities. It is therefore necessary that we manage joint resources in a long-term manner to achieve sustainable cycles in society. Many articles additionally contain substances that are toxic or hazardous and should not be released into the environment. This necessitates phasing out the most harmful substances and handling correctly those substances that continue to be used. There is a eco-cycle strategy in Sweden linked to the Swedish environmental objectives. The strategy is aimed at bringing about a society with non-toxic and resource-efficient cycles. This includes prevention of waste, changed patterns of consumption, more efficient production methods and waste management with a greater focus on recycling. The natural cycle strategy looks at materials and products throughout their lifecycle in order to provide as complete a picture as possible of their environmental impact. Consumption of energy for a product also has to be weighed into the assessment. Sweden considers it necessary for the volume of waste to decrease if we are to come close to sustainable management of waste. Producers must already take account of a product's environmental impact in a lifecycle perspective when it is manufactured. Design and material selection, as well as energy consumption in manufacturing and use must be taken into account. In addition, sustainable cycles can only be achieved if a greater proportion of waste can be reused and recycled. This saves both materials and energy, while also reducing the use of hazardous chemicals and environmental problems in waste management. One aspect of this work is focusing on issues relating to chemicals in articles within SAICM.

Reduced landfilling of waste together with increased sustainable recycling of waste

Waste can be both a resource and an environmental problem. Sweden considers that waste management that works poorly involves considerable wastage of valuable material and can lead to environmental and health problems. In cases where waste management does not work, this can lead to problems related to sanitation and health, as well as soil and water pollution.

The aim as far as possible is to make use of the resources contained in waste. At the same time, it is important to reduce adverse effects in the form of emissions of methane gas from landfills and carbon dioxide from

combustion, as well as emissions of heavy metals and organic environmental pollutants. There is a hierarchy for how waste is to be managed in EU legislation. This primarily means that we have to try to produce as little and as non-hazardous waste as possible. Material recycling is prioritised over energy recycling for waste that nevertheless arises, where this is environmentally justified. The waste ultimately has to be disposed of by landfilling. There are no obvious answers as to what method is preferable for all types of waste in choosing material recovery and incineration. Several analyses generally support material recovery that lets materials and nutrients enter a cycle. Sweden considers the waste hierarchy to represent a good starting point for achieving sustainable waste management.

An all-embracing perspective on the area of waste is required to attain sustainable waste management. Various measures that reduce the volumes of waste and control waste streams according to the hierarchy for different methods of treatment are required. The key is to increase the material recovery of waste. Recycled raw material saves energy compared with the use of new raw material, in addition to which material recycling often leads to lower emissions than other methods of treatment. When producers start to recover material a valuable link also arises to environmentally oriented product development in order to improve the efficiency of manufacturing. Several measures have been taken to promote biological treatment, in part to reduce greenhouse gas emissions from landfills and be able to make use of the plant nutrients contained in food waste. The ban on landfilling organic waste and the targets for increased biological treatment of food waste and for waste from the food industry have been most effective.

Transboundary movements of waste under the Basel Convention
The Basel Convention on Control of Transboundary Movements of Hazardous Wastes and their Disposal is a global convention that was adopted in 1989 and came into force in 1992. The fundamental purpose of the Convention is to protect human health and the environment against harm that can be caused by movements and disposal of hazardous waste and other waste. The Convention regulates transboundary movements of waste, and the parties to the Convention have undertaken to manage hazardous waste and other waste in an environmentally correct manner. Sweden considers it important to comply with the rules in the Basel Convention and the amendment banning exports of hazardous waste from OECD countries to non-OECD countries (ban amendment) in order to reduce the negative aspects of transboundary movements of waste. As a consequence of the question of when an end-of-life product is to be classified as waste, problems in relation to transboundary movements have arisen in particular with regard to electronics, cars, refrigerators and also

end-of-life ships. The problems associated with these movements are that large quantities of hazardous waste accumulate in countries that do not have the capacity or knowledge to deal with waste in an environmentally correct way. This can lead to risks to the environment and human health in these countries. Sweden views this problem as serious and welcomes the initiatives taken under the Basel Convention to discuss solutions.

Safe management of hazardous waste

Sweden considers an important element of the work of guiding waste management in the direction of sustainability to be reducing the amount of hazardous waste. Substances that pose a health hazard or are harmful in some other way must be removed from the cycle. Incorrect management of hazardous waste can pose a great risk of harm to humans and the environment. It is therefore important not to mix it with other waste but to present it separately to professional waste receivers. Some of the characteristics that distinguish hazardous waste are that it may be toxic, carcinogenic, corrosive, harmful to the foetus, ecotoxic, infectious or combustible. The hazardous substances in hazardous waste must not be dispersed in nature or be allowed to be re-introduced into the cycle of society. Examples of such hazardous substances are heavy metals such as mercury, lead and cadmium and stable organic compounds such as PCBs and dioxins. Sweden therefore considers it self-evident from the environmental point of views that hazardous waste has to be kept separate from other types of waste as far as possible and that separation at source of generation is necessary in this context. Only then can the hazardous substances be separated out and dealt with in the best possible way from the points of view of the environment and health. Waste that is not separated at source of generation must as far as possible be separated at the next link in the chain, in order to avoid diffuse dispersal of hazardous substances contained in waste.

2. Waste management

Prevention and minimisation and environmentally sound management of hazardous wastes

Policy measures for the prevention and minimisation of hazardous wastes

The Swedish view has been that the volume and hazardousness of waste can only be influenced to a limited degree by measures taken at the waste stage. Measures to reduce the hazardousness and volume of waste should be primarily taken as part of work on products and chemicals. An important condition to be met to enable the risks to be reduced at the waste stage is that the actors concerned are aware which substances can be

hazardous to the environment and health and which of these hazardous substances are contained in the articles they manufacture, handle or buy. The sharply increased turnover of consumer goods with broader ranges of similar products and products with a shorter life, are important factors for example in the problems associated with electronic waste that contains hazardous chemical substances. Clothing is another example of articles with a short life, large quantities going to general waste management. The most effective way of reducing chemical risks is to take action at the start of a chain of production and handling, as all later stages, including the waste stage, are affected. The flow of information in production and handling chains is, however, often inadequate, and there are several factors underlying this. The chains of production and trade for articles are often long and can pass through several different countries. There are trading companies here that are not manufacturers of either chemicals or articles and only market and trade in articles. It can therefore be difficult for a purchaser in Sweden to trace back and obtain answers to questions about production methods in many supplier links. Work to improve access to information about the substances in articles, for example by introducing information requirements, therefore needs to be pursued at international level.

Sweden's efforts to reduce the hazardousness of waste by limiting the use of substances of very high concern leads to products that affect human health or the environment in a less harmful way throughout their lifecycle. Another instrument is the product choice rule in the Environmental Code (Chapter 2 Section 4), which states that anyone who undertakes or intends to undertake an activity has to avoid using chemical products or biotechnical organisms that may be feared to pose risks to human health or the environment, if they can be replaced by such products or organisms as may be assumed to be less hazardous. The same requirement applies to goods that contain or are treated with a chemical product or biotechnical organism.

A large and growing waste stream consists of waste from electrical and electronic products. The turnover of new products is rapid. Some of the products, for example computers and television sets, become hazardous waste when they are discarded, and control of the route this waste takes is often deficient or difficult to implement. An important measure would be to make sure at the time of manufacturing that as little hazardous material as possible is used and additionally to make the products easy to dismantle. The RoHS Directive regulating the use of certain substances in electrical and electronic products is a particularly important instrument in this respect.

In addition, Sweden has taken active steps to reduce the hazardousness of waste through its efforts to reduce the use of hazardous chemicals internationally. This is discussed in more detail in the section on chemicals.

Transfer of environmentally sound technologies and know-how on clean technologies and low-waste production

Waste management and recycling is the largest field in the environmental technology sector. This is also where the largest increases in turnover and exports are to be found. In 2007 turnover was nearly SEK 50bn, an increase of 24% on 2006. Exports in the same year totalled nearly SEK 11bn, an increase of 29% compared with 2006. Information is lacking on technology transfer regarding hazardous waste and methods to limit the creation, hazardousness or treatment of hazardous waste.

Initiatives to treat, recycle, reuse and dispose of wastes at the source of generation and regulatory mechanisms (Polluter-pays principle)

Swedish environmental law contains overarching rules on consideration and the principles to apply to all activity that has an impact on the environment or human health. Among these is the requirement that a person who pursues an activity or takes a measure has to be economical with raw materials and energy and utilise the opportunities for reuse and recycling. Renewable energy sources are primarily to be used.

Producer responsibility for products that become hazardous waste at the waste stage applies to electrical and electronic products, cars and batteries. The purpose of collecting electrical waste is to prevent hazardous substances ending up in the wrong place. Producer responsibility is formulated so that those who manufacture electronics or import electronics into Sweden bear responsibility for collection and disposal. Importers and manufacturers have to ensure that there is collection in all municipalities for those electrical products that are usually used in households. They have to bear the cost of recycling and treatment, while the municipality is responsible for the manning of recycling centres. The producers have to manufacture products that contain less environmentally hazardous components and that are easier to recycle and treat. In 2006 the quantity of electrical waste collected per head of population was 16 kg, which is a very good result in comparison with other EU Member States. The target in the EU Directive on producer responsibility for electrical and electronic products is 4 kg per head of population. The purpose of producer responsibility for cars is to:

• reduce emissions of environmentally hazardous liquids, products and refrigerants from end-of-life vehicles

• increase the recycling of metals, plastics, rubber, textiles etc. from end-of-use vehicles,
• increase the recycling of components from end-of-life vehicles and
• reduce the volume of waste from end-of-life vehicles sent to landfill

A producer has to take an end-of-life vehicle without payment, has to make it easy for people wishing to hand over end-of-life vehicles to the producer to do so and is obliged to ensure that the car is disposed of by an authorised vehicle scrapper. The car producer is responsible for the satisfactory working of the system to reuse and recycle cars. This responsibility includes reporting, guidance and fulfilling the reuse and recycling targets. A producer has to ensure that at least 85% of the weight of the car be reused or recycled. The target for 2015 is that at least 95% of the car's weight is reused or recycled. In 2006 the proportion of the weight of scrapped cars reused or recycled was 86%, which means that the target set has been achieved.

On 1 January 2009 producer responsibility for batteries was introduced in Sweden as a consequence of an EU Directive. The producer's responsibility is to ensure that batteries are collected, disposed of and recycled in an environmentally acceptable way. The producer is whoever first places a battery on the Swedish market by commercially supplying a battery. Spent batteries have been separately collected in Sweden since the 1980s. A new development in this context is that all batteries have to be collected and recycled, including non-environmentally hazardous ones that were previously sent to landfill. As producer responsibility for batteries has been introduced so recently, there are no figures on results achieved.

Procedures for environmental impact assessment, taking into account the cradle-to-grave approach

Material-flow analyses provide a basis for being able to follow the impact of different substances from cradle to grave. Material-flow analyses provide knowledge on hazardous substances introduced into society through products. It is then possible to judge whether these hazardous substances reach the waste stage on the basis of knowledge of the life of different articles.

Statistics Sweden is developing statistics on material flows. Among other things it will be studying the flow of lead in more detail. Basic studies of the flows of a number of heavy metals in society have been carried out previously, for instance in the Swedish Environmental Protection Agency's research programme "Metals in Town and Country".

The 'Articles Guide' (Varuguiden) being developed by the Swedish Chemicals Agency is another example of a system for gathering information on hazardous substances in articles.

Recovery, reuse and recycling of hazardous wastes and their transformation into useful material

In 2006 around 33% of the total volume of hazardous waste arising was treated by material recovery. The predominant types of waste include contaminated soils used as construction material after treatment, batteries sent for recovery of metals, discarded equipment sent for remelting, for example in copper smeltworks and waste from incineration used as construction material. Another good example of the transformation of hazardous waste into a useful product is the regeneration of waste oil to obtain new base oil. Under the EU waste directive, waste oil is primarily to be regenerated if it is possible to do so according to the waste hierarchy in consideration of technical, economic and organisational constraints. Sweden does not have its own facility for the regeneration of waste oil, but exports waste oil to another EU Member State. This processing of Swedish waste oil has increased steadily in recent years from around 1,400 tonnes in 2001 to around 25,000 tonnes in 2007.

Phase-out of toxic, persistent and bio-accumulative waste

Sweden has been successful to date in its efforts to phase out the use of mercury, and is well advanced in an international comparison. In the early 1990s instruments and electrical components containing mercury were banned, and an export ban was introduced for mercury and chemical compounds and preparations containing mercury. Sweden was early in introducing restrictions on the level of mercury of batteries.

On 15 January 2009 the Government decided on a general ban on mercury, as well as articles containing mercury, to come into effect on 1 June 2009. The ban means that mercury, mercury compounds and preparations may not be placed on the Swedish market, used in Sweden or commercially exported from Sweden. Articles containing mercury may not be placed on the Swedish market or professionally exported from Sweden. The ban on use does not apply to articles containing mercury if the articles have already been used for the first time. On the other hand, the article may not be transferred elsewhere, i.e. placed on the market or exported form Sweden. Nor may it be topped up with new mercury.

Mercury fallout over Sweden is principally due to long-range transportation by air from the rest of Europe, but also from other parts of the world. Despite mercury fallout having decreased in Sweden in recent decades, this is not sufficient to prevent an increase in mercury levels in

the environment. Levels are, for example, increasing by around 0.5 per cent annually in the top layer of forest soil. The Swedish Environmental Protection Agency estimates that mercury fallout needs to decrease by 80 per cent if levels in fish that do not exceed the WHO/FAO limit of 0.5 mg mercury/kg fish are to be achieved in the longer term.

The largest source of mercury emissions to air globally is the burning of coal. Other emission sources include, for example, smeltworks, crematoria (amalgam fillings) and waste incineration (mercury in products).

Mercury is also dispersed directly to soil and water for example through emissions from industrial sites, leaching from rubbish tips and through the spreading of sewage sludge. Sweden was early with programmes for the phase-out of PCBs. A start was made in the early 1970s on this phase-out, which comprises requirements for inventories, decontamination, restrictions on or prohibitions of PCBs in transformers, capacitors, PCB products in building such as sealant, flooring compounds, sealed glazing units and other products that may contain PCBs, such as cables. PCB levels in the environment have previously decreased but are no longer doing so. Following EU decisions on bans or restrictions for certain chemical substances, Sweden has implemented these bans in its own legislation. The bans or restrictions relate for instance to cadmium substances, chlorinated solvents, heavy metals in packaging materials, ammunition containing lead and textile detergents containing phosphates. In addition, as indicated above there has been a ban since 1 July 2006 on manufacturing electrical products containing mercury, cadmium, lead, hexavalent chromium and the flame retardants PBB and PBDE.

Environmentally sound waste disposal and treatment

Waste can be both a resource and an environmental problem. Waste management that works poorly signifies great wastage of valuable material and can also lead to environmental and health problems. The aim as far as possible is to make use of the resources contained in waste. At the same time, it is important to reduce adverse effects in the form of emissions of methane gas from landfills and carbon dioxide from combustion, as well emissions of heavy metals and organic environmental toxins. There is a hierarchy for the management of waste. This primarily means that we have to try to produce as little and as non-hazardous waste as possible. Material recycling is prioritised over energy recycling for waste that nevertheless arises, where this is environmentally justified. The waste ultimately has to be disposed of by landfilling. There are no obvious answers as to what method is preferable for all types of waste in the choice between material recycling and incineration. Several analyses generally support material recovery that causes materials and nutrients to enter a cycle.

An important element in efforts to deal with waste is a clear consumer perspective. It must be simple for households to separate and hand over their waste so that the proportion of waste that is recycled is increased. Information on the purpose and benefit of household participation is also important. An overarching change that is required if we are to approach ecological management of waste is a reduction in the volume of waste and its hazardousness. This cannot be attained just through measures at the waste stage and is largely dependent on a change in the production and consumption of articles. Volumes of waste today are increasing in line with economic growth. A fundamental requirement to enable the goal of sustainable cycles to be achieved is more resource-efficient production and consumption that breaks this relationship. Companies that design and manufacture products have great responsibility for reviewing the environmental impact of their products throughout their lifecycles, using more recovered material and thinking about the future recycling of their products. Consumers also have an important role to play in the choice of products and how to use them.

Inventories of hazardous waste production, their treatment/disposal, and contaminated sites

Nearly 2.8 million tonnes of hazardous waste accrued in 2006, according to Report 5868 Waste in Sweden 2006 produced by Svenska MiljöEmissionsData (SMED) on behalf of the Swedish Environmental Protection Agency. The largest categories of waste were hazardous mineral waste, 480,000 tonnes (including PAH asphalt), end-of-life vehicles, 470,000 tonnes, contaminated soil and dredging material, 435,00 tonnes, chemical residues and deposits, 300,000 tonnes, and hazardous waste from incineration, 300,000 tonnes. The sectors that generated most hazardous waste were building and households. The volume in the building sector is 890,000 tonnes, of which contaminated soil and dredging material accounts for 400,000 tonnes and hazardous mineral waste (mostly PAH asphalt) 460,000 tonnes. Households accounted for 489,000 tonnes of hazardous waste. The greater part of this was 305,000 tonnes of end-of-life vehicles and 139,000 tonnes of discarded equipment (mainly electrical scrap) classified as hazardous waste. Other sectors that generated large quantities of hazardous waste were:

- production of metal and metal products, 340,000 tonnes
- supply of gas, steam, hot water and heating, 190,000 tonnes
- manufacturing of chemicals, rubber and plastic, 111 000 tonnes.

According to study, approximately 1 million tonnes of hazardous waste was treated. The remaining volume of hazardous waste was treated in such a way that it is not included in the actual report or consists of a type of waste that is not included in the reporting with regard to treatment, for example

end-of-life vehicles. Of the treated waste, 33% or 339,000 tonnes went for recycling. A large proportion of the recycling consists of the treatment of uncontaminated soil, waste from incineration and mineral waste which after any pre-treatment is used as construction material or as material to cap landfills.

Around 312,000 tonnes of hazardous waste was incinerated: 209,000 tonnes as energy recovery (R1) and 103,000 tonnes as disposal (D10), although energy is also extracted in that case. Around 378,000 tonnes of hazardous waste was landfilled. This was largely made up of waste from incineration (including filter dust from metal smelting), contaminated soil and sewage sludge from industrial sites (including metal hydroxide sludge).

The total quantities of hazardous waste have apparently increased in recent years. The increase has probably not been as great it may appear as different methods and limitations have been applied in the collection of statistics in the most recent surveys and the results are thus not comparable.

More than 80,000 sites have been identified as potentially contaminated. Work to determine and estimate the number of contaminated sites in the country takes place in several stages and is mainly done by the county administrative boards. The identification of contaminated sites is considered to be more or less complete, as the number of identified potentially contaminated sites has been relatively constant in recent years. New locations may be discovered while work on contaminated sites is in progress. An identified potentially contaminated site need not be polluted in practice or need remedial action. The number of actually contaminated sites is thus probably lower than the number of identified sites. Of the identified sites, it is estimated that 1,500 could pose very great risks to human health and the environment (risk class 1) and around 15,000 great risks (risk class 2). It is primarily these sites that must be investigated for remediation.

It is stated in the Swedish Environmental Protection Agency's report "Lägesbeskrivning av efterbehandlingsarbetet i landet 2008" ("Status report on remediation work in Sweden in 2008") (M2009/760/Kk) that by 31 August 2008 a total of 1,010 sites had been remediated and closed, of which around 30 with grants and around 980 sites at the operator's expense through supervisory activity. Another approximately 220 sites had been remediated, but follow-up was still in progress. Twenty-eight of the sites were grant-funded locations and 193 were locations subject to supervision. Locations subject to supervision mean contaminated sites with a known wholly or partially responsible operator, and grant-funded locations mean sites with a

responsible operator who is unknown or who no longer exists. In addition, partial measures are in progress or have been carried out on a large number of sites in the framework of enforcement activity. Many contaminated sites, particularly in the metropolitan regions, are remediated in conjunction with development, for example when an industrial site is converted into a residential area.

Establishment of combined treatment/disposal facilities for hazardous wastes in small- and medium-sized industries

It happens that small and medium-sized industries treat their own hazardous waste for example through physico-chemical processes or the distillation of polluted solvents or by similar methods. It may also happen that small and medium-sized industries treat hazardous waste from others if the waste that has arisen externally is of a type similar to their own. There are no general regulations or similar rules for this. Each facility must apply for its own permit for the activity, including waste treatment, under the Environmental Code.

Dissemination of scientific and technical information dealing with various health and environmental aspects of hazardous wastes

Several extensive campaigns on separate collection of discarded batteries have been conducted in Sweden. The first one was carried out in the 1980s and related only to hazardous batteries. The campaigns were aimed at various target groups and were regarded as successful. The requirement for separate collection of batteries now covers all types of batteries.

Most local authorities have information targeted at households on the collection of household hazardous waste. The information covers different types of hazardous waste, why it is hazardous and how it should be handled. The local authorities, which have the sole right to collect hazardous waste from households, use various systems for the collection of this waste.

It is estimated that 26,000 tonnes of hazardous waste was collected from households in 2004, averaging 2.9 kg per person. At the same time there are calculations showing that between 4,000 and 6,000 tonnes of hazardous waste is placed in domestic refuse every year.

Preventing illegal international traffic in hazardous wastes

Sweden is a party to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. It reports annually to the Convention's secretariat on volumes and types of waste transported across borders to and from Sweden. Cases of illegal traffic in waste are also reported.

Sweden has implemented the Basel Convention and its prohibition of hazardous waste movements to countries outside the EU and the OECD through Regulation 1013/2006/EC. The Swedish Environmental Protection Agency is what is known as the competent authority, while county administrative boards and municipalities are inspection and enforcement authorities. Sweden takes part in the European network IMPEL (European Union Network for the Implementation and Enforcement of Environmental Law) and its cluster on transfrontier shipments of waste (IMPEL-TFS). Joint inspections of transfrontier shipments of waste are organised in this forum, principally in ports but also on the road. Projects concerning shipments of electronic scrap are of special relevance at present. There is discussion in particular of how illegal transfrontier shipments of electronic waste to countries in Asia and Africa could be prevented. Sweden takes part in and supports the partnership programme PACE (Partnership for Action on Computing Equipment) under the Basel Convention.

The issue of illegal transfrontier shipments is also relevant with regard to ships sent for dismantling and recycling, particularly in Asia. The handling of hazardous waste at these places is highly unsuitable from the point of view of the working environment, nor is it appropriate from the point of view of either the environment or health. Sweden views the problem seriously and welcomes the recently adopted international IMO convention on ship recycling. Before the convention comes into effect it is important to comply with the currently applicable rules in the Basel Convention with regard to ships when they become waste. Sweden considers it important for the ship if possible to be cleared of hazardous waste (provided this does not affect maritime safety) before it is sent for recycling, in order to comply with the ban in the Basel Convention on shipping hazardous waste to non-OECD countries.

Environmentally sound management of solid (non-hazardous) wastes and sewage, in the context of integrated planning and management of land resources

Policies aimed at waste prevention and minimisation, reuse and recycling

Waste management in Sweden has changed substantially since the mid-1990s. Landfilling of household waste has fallen by 85 per cent since 1994. In 1994 the proportion of household waste sent to landfill was 40 per cent. Today only four per cent of household waste goes to landfill. The rest of the waste is sent for material or energy recovery. On the other hand, the

trend has not been so favourable with regard to preventing waste. The volume of household waste has increased by 35 per cent since 1994.

The increased level of recycling is the result of a consistent strategy for landfilling to diminish and recycling to increase. Important objectives and instruments for this trend have been the environmental objectives for waste, producer responsibility for different product groups, the requirement for municipal waste planning, the ban on landfilling combustible and organic waste and the landfill tax. These instruments and a few others are described below. Some of these instruments are also intended to reduce volumes of waste. The description below concludes with a section on the application of sewage sludge to arable land.

Environmental objectives

The overall objective of environmental work is to be able to hand over to the next generation a society in which the major environmental problems have been solved. On this basis, the Swedish Parliament has adopted sixteen national environmental quality objectives and 72 interim targets. The interim targets for waste are as follows:

The total quantity of waste generated will not increase and maximum use will be made of its resource potential while minimising health and environmental effects and associated risks. In particular:

- The quantity of waste sent to landfill, excluding mining waste, will be reduced by at least 50% by 2005 compared with 1994.
- By 2010 at least at least 50% of all household waste will be recycled through materials recovery, including biological treatment.
- By 2010 at least 35% of food waste from households, restaurants, caterers and retail premises will be recovered by means of biological treatment. This target refers to food waste separated at source for both home composting and centralised treatment,
- By 2010 food waste and comparable wastes from food processing plants etc. will be recovered by means of biological treatment. This target relates to waste that is not mixed with other wastes and that is of such a quality as to be suitable, following treatment, for recycling into crop production.
- By 2015 at least 60% of phosphorus compounds present in wastewater will be recovered for use on productive land. At least half of this amount should be returned to arable land.

The interim target for waste has achieved a great breakthrough among Swedish municipalities, which is evident for instance in the municipal waste plans. The expansion of separate collection of food waste for biological treatment has come about largely as a result of there being a national target for this.

Producer responsibility
Producer responsibility exists for several products (packaging, waste paper, cars, tyres, batteries and electrical and electronic products). The purpose of producer responsibility is to reduce the quantity of waste, increase recycling and achieve more environmentally sound product development. In addition to this there are what are known as voluntary commitments on producer responsibility in three product groups (office paper, agricultural plastic and building and demolition waste).

Producer responsibility has been successful insofar as materials recovery has increased. The targets for recycling of packaging are met in all cases except for metal packaging. The significance producer responsibility has had in reducing the hazardousness of waste is described in the section on hazardous waste. The results of producer responsibility for electrical and electronic products and cars are also described there. Producer responsibility for packaging has not meant a decrease in the total quantities of packaging. On the other hand, the quantity of packaging per kg of article has decreased, partly as a result of lighter packaging materials.

An important reason why Swedish households separate at source of generation is that they wish to contribute to a better environment and an ecocycle-based society. It is therefore essential that they receive clear feedback on the results of separation at source of generation and recycling. Well formulated information is the single most important factor in attaining good results for household waste.

Swedish experience also indicates that the level of service in the collection of packaging waste and waste paper should not be closely regulated centrally but should be formulated locally. To attain good results and provide households with good service it is crucial that the parties have constructive cooperation with common goals. This has previously been lacking, but since January 2009 there has been an agreement between producers and local authorities to join forces in further improving recycling results and raising the level of service in collection systems. Information and cooperation are thus very important for producer responsibility for packaging to work well in Sweden.

Municipal waste planning
Since 1991 all municipalities have a waste plan that covers all types of waste and the measures needed to manage waste appropriately from the points of view of the environment and resources. The plans frequently include targets and strategies for different waste streams but often focus on household waste. Waste planning has meant that the municipalities have

taken great responsibility for improving the management of household waste. Many have, for example, built up extensive systems for separation at source of generation and recycling of various types of waste. On the other hand, these plans do not guide the management of commercial waste to any great extent, as the municipalities are not responsible for this waste. Several municipalities have recently drawn attention to the issue of waste prevention in their plans. An example of such a measure is to make it easier to dispose of second-hand articles. It is possible to hand in second-hand articles for sale at certain municipal recycling centres.

Prohibition of landfilling combustible and organic waste
The landfilling of separated combustible waste has been prohibited in Sweden since 2002 and the landfilling of organic waste since 2005. The purpose of these bans is to improve the conservation of resources and reduce environmental impact. Certain types of waste should be landfilled for various reasons, for example because the substances contained in the waste should not be dispersed or because recycling is not possible in practice. Waste with a very low content of organic matter does not have significant environmental impact in landfilling. These types of waste are therefore exempt from the bans.

If there is a lack of capacity for recycling the waste, the county administrative boards can permit dispensations from the ban. Landfilling by dispensation has gradually decreased as capacity for other treatment of waste has increased. The Swedish Environmental Protection Agency estimates that by around 2012 there will be sufficient treatment capacity for landfilling by dispensation to cease.

Landfill tax
A tax on the landfilling of waste was introduced in 2000. The purpose of the tax is to reduce landfilling. The tax is levied at SEK 435 per tonne. Waste that should be landfilled for environmental reasons is exempted.

The tax has been used as an instrument for reducing landfilling and increasing recycling. It has unfortunately also contributed to such recycling as is not the environmentally best way of treating waste. This applies to waste containing hazardous substances used for various civil engineering purposes, for example in roadbuilding. This increases the risk of hazardous substances being dispersed to the environment.

State investment aid
Over the period 1998 – 2002 central government grants were distributed to local investment programmes (LIPs) in more than half the municipalities in Sweden. Some of the grants were made to waste-related measures such

as the expansion of digestion and composting. Landfilling as a consequence of measures in LIPs has meant a decrease of around 462,000 tonnes in the landfilling of waste. LIPs were succeeded by climate investment programmes (Klimp). The aim was to reduce greenhouse gas emissions. Grants to Klimp programmes were awarded over the period 2003 – 2008, A third of Klimp grants have gone to measures to increase production and the use of biogas from waste.

Sewage sludge

Sludge has been spread on arable land for many years, but the practice has been questioned. 'Moratoria on sludge' have been introduced twice following recommendations by the Federation of Swedish Farmers to its members not to spread the sludge owing to fears that it contains toxic substances. Before the second sludge moratorium in the 1990s, up to 30-35 per cent of sewage sludge was spread on arable land. The proportion that is spread has now started to rise again, and stands at around 15%. As indicated by the interim target for waste, there is an objective for phosphorus in sewage sludge to be returned to productive land. In recent years efforts to return phosphorus to arable land have largely been concerned with a dialogue between various parties affected in order to reduce non-degradable components in sewage.

Development of environmentally sound disposal facilities, including technology to convert waste into energy, such as, for example, through utilisation of landfill methane

The landfilling of waste and rules relating to this are briefly described in this section. The collection of landfill gas is also discussed. As Sweden is well advanced with regard to utilising the energy from waste through waste incineration and digestion, we describe this in more detail. The section begins with a brief paragraph describing the overarching rules in the Environmental Code applying to all environmentally hazardous activity. Finally there is a section on the expansion of sewage treatment plants in Sweden.

The Environmental Code

The central environmental legislation in Sweden is brought together in the Environmental Code. All activities (including for example facilities for waste incineration, landfilling and biological treatment) are covered by the general rules on consideration in the Environmental Code. One of the rules on consideration states that rational use must be made of raw materials and energy and that the possibility of reuse and recycling must be utilised. Other significant rules on consideration apply to requirements for knowledge, precautions and product choice. The general rules on

consideration are to be applied in permit appraisal, supervision and self-inspection.

Landfilling

In 2001 the European Directive on the landfilling of waste was incorporated into Swedish legislation (the Landfill Ordinance), which has tightened up the requirements for landfills in Sweden. The new ordinance imposes stricter requirements, for instance regarding the underlying geological barrier of landfills, bottom sealing, final capping and collection and treatment of leachate. The requirements differ depending on what type of waste the landfill receives. In addition to the Landfill Ordinance there is a regulation containing reception criteria which mean that stricter requirements can now be set on knowledge of the properties of waste for the producer of waste. This regulation is also a consequence of provisions at EU level. A large number of landfills have been closed or are in the process of being closed because waste sent to landfill is decreasing and the environmental requirements at the landfills have been tightened up.

Collection of landfill gas

The Landfill Ordinance requires landfills that receive biodegradable waste to collect landfill gas. The requirements also cover the sampling and measurement of the gas. In addition, the gas has to be treated and utilised. If the gas cannot be used for energy recovery, it has to be flared off. Methane is collected from around 60 active and about 10 closed landfills. The landfill gas is used for heating, electricity production and vehicle fuel. The landfill gas is flared to some extent. As a result of the decrease in the landfilling of organic waste, the collection of landfill gas has also decreased. The collected quantity of gas from municipal landfills fell from 508,000 MWh in 2003 to 342,000 MWh in 2007. Another way of preventing the loss of methane from landfills is to lay a methane-oxidising layer, an area that is still under development.

Waste incineration

The requirements for waste incineration are based on a European Directive. The requirements have not brought a need for any major adjustments for Swedish plants as similar requirements already existed in Sweden before the Directive came into force. Some reconstruction has, however, been needed to ensure that the requirements relating to dioxins, carbon monoxide and hydrogen chloride are safely met.

Energy utilisation through the incineration of waste is the most common method used for the treatment of household waste in Sweden. Just under half (47%) of household waste is incinerated. The volume of waste going for incineration has increased in recent years, partly due to the landfilling

of combustible and organic waste now being prohibited. Around 2.2 million tonnes of household waste was incinerated in 2007. Around 2.3 million tonnes of waste of other types was incinerated in the same plants. In addition to incineration in "normal waste incineration plants", waste other than household waste is burnt by "co-incineration". This takes place in particular industries, in particular the cement industry and the pulp and paper industry, and in some thermal power plants/combined heat and power plants. The energy generated in incineration becomes heat and to some extent electricity. Energy totalling 13.6 TWh was extracted at plants incinerating household waste in 2007, of which 12.2 TWh heat and 1.5 TWh electricity. The heat from combustion of waste meets around 20 per cent of the total district heating need in Sweden. District heating networks in Sweden are well developed, and a very large proportion of the energy can therefore be utilised in comparison with many other countries. The high level of energy utilisation is also due to many of the plants being equipped with flue-gas condensation and heat exchangers.

Emissions to air from waste incineration today are low. Attention was drawn to problems with dioxin emissions in the mid-1980s. Dioxin emissions have since decreased by 98% and emissions of hydrogen chloride, mercury, cadmium lead and dust have decreased by 90-95%. The reduced emissions are a consequence of increased waste control, a better incineration process and more effective cleaning technology.

Incineration leaves behind residues consisting of slag from the furnace, 15-20 per cent by weight of the quantity of waste supplied, and flue-gas scrubbing residues, 3-5 per cent by weight. Metal is separated from the slag at most plants. The slag is then used principally as construction material at landfills. Flue-gas scrubbing residues, on the other hand, are hazardous waste and are landfilled according to special rules.

Since Sweden is particularly in need of heat and energy during the winter, waste is stored at several facilities during part of the year (summer time) by what is known as baling, but also in open storages. Energy can then be extracted from the waste during the cold part of the year.

Digestion

There are no EU rules for digestion and other biological treatment of waste. Larger facilities for biological treatment have to undergo permit appraisal according to the Environmental Code. There is guidance from the Swedish Environmental Protection Agency on what should be done in the appraisal and supervision of biological treatment. In addition to requirements from the authorities, the waste industry (Swedish Waste Management) has undertaken to regularly check for leakage of methane

from biogas plants and plants that further upgrade biogas. For those emissions that cannot be dealt with directly, plants have to draw up a plan for further action. The digestion of waste is increasing due to several factors, but perhaps principally as a consequence of the environmental objective for biological treatment of food waste and state investment aid. More or less all digestion plants have received investment aid. Of incoming substrates to digestion plants, around 15% are food waste, while the remainder consists of wastes from the food industry and of manure. Smaller quantities of food waste are also received by sewage treatment plants for digestion. Both biogas and a digestion residue are obtained in the digestion of waste. The biogas is used for the production of heating and electricity and as a vehicle fuel after the gas has been upgraded. The digestion residue is returned to agriculture as a biofertiliser. Plants that produce biofertiliser can quality-assure their product through certification which has been established by the Swedish Testing and Research Institute. Certification makes demands on the whole waste management chain, from incoming waste to use.

Sweden is notable for its substantial use of one of the most environmentally friendly fuels, biogas, as a vehicle fuel. This trend has been supported by investment aid also having gone to biogas vehicles at filling stations. Despite an increase in biogas production from waste, most production of biogas takes place through the digestion of sludge at sewage treatment plants (50%). The collection of landfill gas also accounts for a large share (28%), but production is decreasing here as almost no new organic waste is being placed in landfills. The digestion plants for waste account for 15%. There are also smaller on-farm facilities for digestion, principally of manure.

Sewage treatment

Around 85 per cent of the Swedish population live in areas connected to municipal sewage treatment. The remainder of the population live in properties with private sewers. Between 1971 and 1979 the Swedish state invested around SEK 1.5 billion (equivalent to around SEK 11 billion in today's money) in the expansion of municipal sewage treatment plants. Around 1.3 billion cubic metres of water is received annually by the municipal sewage treatment plants. It brings with it 7,000 tonnes of phosphorus, 40,000 tonnes of nitrogen and 200,000 tonnes of organic matter.

Since the late 1990s, a special nitrogen treatment stage has been added to the major sewage treatment plants along the coast in southern Sweden, from the Norwegian border to Norrtälje. Just over half of all sewage underwent this extra nitrogen treatment in 2005. Chemical precipitation of

phosphorus is effective: on average just over 95 per cent of the incoming phosphorus is removed. Conventional biological-chemical treatment removes around 40 per cent of the nitrogen. The proportion removed rises to around 70 per cent with the extra nitrogen treatment stage. The average rate of nitrogen removal nationally is just under 60 per cent.

It is relatively poorly understood how treatment functions in wastewater that is not connected to municipal sewage treatment plants. Only around 60 per cent of wastewater is of an acceptable standard according to the requirements of the Environmental Code.

The most common treatment techniques are infiltration or trickling beds. In some areas the local authority requires a closed tank. A gully, sludge separation alone or a caisson do not provide sufficient treatment if the system receives toilet waste.

Radioactive wastes and their environmentally sound management (safe storage, transportation and disposal of radioactive waste)

A product liability system has been in place since the early 1980s for *the residual products of the nuclear fuel cycle.* It covers both technical safety and personal radiation safety and financial security for final disposal. For those parts of the system that have not yet been implemented there are statutory requirements for the nuclear power industry to carry out a research and development programme. The programme, together with calculations of the costs of implementation, is examined and evaluated every three years. Funding for future costs is provided under central government control.

Spent nuclear fuel is temporarily stored in a national interim storage facility (Clab) awaiting the establishment of a final storage facility. The plant has been in operation since 1985. The nuclear power industry plans to submit an application for permission to erect a final storage facility for spent fuel in 2010.

Very low-level waste is finally deposited where appropriate in special landfills alongside the nuclear facilities where it has been produced.

A particular type of *low and medium-level waste* is deposited in a national final repository (SFR), which has been in operation sine 1988. A project to expand SFR so that it can also receive waste from the demolition of nuclear facilities has recently been initiated. It is planned that the facility will be ready to receive low and medium-level demolition waste around 2020.

Another type of *low and medium-level operational and demolition waste* is placed in interim storage while the establishment of a special final repository is awaited. It is planned that the facility will be ready to receive waste around 2045.

A special *transport system* (transport ships and special transport vehicles) has been established by the nuclear industry to carry out transportation so that applicable rules on safety and radiation protection are met.

Radioactive residue from non-nuclear activity (hospitals, research institutions and industrial sites) is handled in consideration of its relative hazardousness. Residues from non-nuclear activity are placed – or are planned to be placed – in final storage facilities for residue from nuclear activities.