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PART II

Chapter 7

Waste Management

Norway now has a simpler regulatory framework for waste management and is striving to reduce the significant increase in waste generation that it has experienced since the last OECD review. Efforts have been made to make the selective collection and treatment of household waste more cost-effective, and to improve the safety of landfill operations. The chapter also presents progress in reducing emissions of hazardous chemical substances, many of which were linked with disposal of end-of-life products, as well as addressing problems related to contaminated sites. Concerns remain however, over the volumes of hazardous waste and waste transfer across Norway's borders. How to effectively use the mix of instruments in managing waste, along with better implementation of waste management plans, is examined in this chapter, along with best ways of dealing with tax and other incentives that can improve performance.

Assessment and recommendations

In 2000, Norway established ambitious objectives for reducing waste generation and the amount of waste delivered for treatment and final disposal, and for assuring appropriate treatment of hazardous waste. These objectives were further strengthened in 2006. Growing importance was attached to the impact of hazardous chemicals, many of which were linked to disposal of end-of-life products.

Norway's regulatory framework for waste management, already well developed in the 1990s, was revised and simplified in 2004. A mix of instruments was applied to curb waste generation and stimulate waste recovery, including a tax on final waste disposal applied to landfills and incineration, and a ban on landfilling of biodegradable waste. These measures helped decouple waste generation from economic activity in some manufacturing sectors. Notwithstanding these efforts, the overall quantity of waste generated every year has been rising well above the growth of GDP since 2004 (17% *versus* 9%, in fixed prices). Thus Norway's objective of keeping growth in the quantity of waste generated below the rate of economic growth has not been met. Services and some manufacturing sectors, such as food processing, have experienced significant waste growth, in particular as regards wet organic waste (+40%).[1]

The cost-effectiveness of household waste collection and treatment services has been enhanced through increased use of intermunicipal waste management plans. Further efficiency gains have been achieved by outsourcing these services to private operators or to local-authority-owned entities operating on a commercial basis. In most municipalities, waste collection charges are at, or close to, cost-recovery levels. Even though Norway's reported household waste fraction of municipal waste is at about the OECD average, annual household waste generation appears to have grown considerably, by 40% over the review period. The volume of household waste grew faster than household consumption.

Efforts have been made to improve the safety of landfill operations and reduce their environmental impact. Between 2004 and 2009, all landfill permits were revised to give effect to a new classification system. The proportion of non-landfill methods of waste treatment increased at a pace in line with achieving the 2010 objective of recovering 75% of total waste generated. Rates of recovery of household and industrial waste are in line with OECD averages. Considerable progress has been made in effective resource recovery from household waste: the proportion of waste separated for material recovery increased from 40% in 2000 to 52% in 2008, though there is a room for improvement to match front-runner countries in this area. Energy recovery from waste has increased, including its use in district heating, while emissions of toxic chemicals from incineration have been reduced.

For a number of waste streams, extended producer responsibility (EPR) regimes have been introduced in conjunction with waste sorting at source. Most of the recovery targets established through agreements between the Ministry of the Environment and representatives of industry and business associations have been met, including those for used lubricating oil, electrical equipment with CFC refrigerants, batteries, end-of-life vehicles, tyres and waste packaging. Achieving targets within EPR regimes has been stimulated by the introduction of taxes connected with deposit-refund systems for end-of-life products. Norway is the first European country to provide free take-back for waste electrical and

electronic equipment (WEEE), going beyond the requirements of the corresponding EU directive. However, the government-industry agreement to achieve a minimum of 80% collection of WEEE entering the waste stream does not yet appear to have been met.

Reported volumes of hazardous waste increased by 50% over the review period and now account for 10% of waste generated. About 90% of hazardous waste is treated domestically, approaching the target of 100%. Cases of illegal export of hazardous waste have been discovered. However, the Climate and Pollution Agency, Customs, the Norwegian Maritime Directorate and Norway's environmental crime investigation unit, *Økokrim*, have increased collaboration to stop such exports.

There has been a notable increase in waste transfers across Norway's borders, with a fivefold increase in annual amounts exported between 2002 and 2009. An estimated 50-60% of Norway's combustible waste is exported to district heating incinerators, principally in Sweden and Denmark. To some extent, Norway is trading the energy content of its "non-hazardous" waste for hazardous residues of incineration.

Norway identified five hazardous chemical substances for "releases to be eliminated by 2005". Four were on target (reductions of 89% to 100%) and the fifth, PCBs, was reduced by 60%. Emissions of a number of additional substances have been reduced by over 50% from their 1995 levels, in line with 2010 targets. However, reductions in releases of arsenic and PAHs were below 50%, and releases of brominated flame retardants have increased; the 2010 targets are not likely to be met.

Progress has also been made in addressing problems related to contaminated sites. Out of the 100 most heavily polluted sites identified for cleanup by the end of 2005, 83 had been decontaminated before the target date, and all 100 are now remediated. The 2001 strategy for addressing contaminated sediments stimulated a series of pilot projects in 17 of 24 significantly contaminated fjord and harbour areas. In 2005, all priority coastal areas had action plans under implementation.

Recommendations

- Review and adjust, as necessary, the *current mix of instruments* so as to more effectively and efficiently prevent and reduce waste from the main waste-generating sectors; apply additional measures to reduce waste generation by government agencies, including through public procurement; monitor results, and report annually on progress.
- Investigate the *effectiveness of volume- or weight-based waste disposal fees* to provide further incentives for waste sorting and reduction by households; identify and promote the use of best practice models among municipalities.
- Encourage the development of *municipal and intermunicipal waste management plans* to achieve national targets for waste reduction more efficiently, in particular for biodegradable and hazardous waste.
- *Assess the implications of elimination of the incineration tax* on emissions of most hazardous substances from incinerators.
- Continue work towards further *reduction of hazardous chemicals in products* by drawing up proposals for additional substances that would be eliminated by 2020 and encouraging international action in this area; improve data collection on these substances through the product register.
- Redouble efforts to address problems associated with *contaminated sites and contaminated sediments* using reduction of negative impacts on human health, cost-effectiveness and public engagement as key guiding principles of the operations.

1. Policy and institutional setting

1.1. Policy targets

The 2000 white paper on Environmental Policy and the State of the Environment set out objectives and targets related to waste management for the review period.[2] The *priority commitments* included: *i)* significantly decoupling the growth in total waste generated from the rate of economic growth; *ii)* reducing the amount of waste delivered for final treatment to 25% of total waste generated; and *iii)* assuring appropriate treatment of all hazardous waste within Norway, either by recycling or sufficient and safe treatment and disposal (MoE, 2000). In 2005, the target for final waste disposal was tightened to 20% of waste generated in 2010 and beyond. In 2006, the commitment for reducing hazardous waste generation was extended to each type of hazardous waste with the time horizon of 2020 (MoE, 2006a).

Priority measures to achieve these targets, announced in subsequent white papers, included: *i)* expanding producer responsibility to assure sound waste collection and management routines and high recovery rates; *ii)* reducing landfilling of biodegradable waste and stimulating increased energy recovery from organic waste; *iii)* increasing research on safe uses of compost, sludge and other waste products in farming; *iv)* implementing requirements of compulsory waste plans for construction works; and *v)* increasing the collection and proper handling of hazardous waste (MoE, 2006).

The growing importance attached to addressing the impacts of *hazardous chemical substances*, many of which were linked with disposal of end-of-life products, led to the adoption of time-bound targets.[3] A list of 30 priority hazardous chemicals, first published in a white paper in 1997, was accompanied by national targets for their substantial reduction or elimination by 2005 and 2010 (MoE, 1996). In 2006, five additional toxic chemical substance were added to the list (MoE, 2006a). The 2008 revisions of the 2004-06 Hazardous Waste Strategy identified measures to achieve these targets. The key approaches included: *i)* providing extensive information and guidance to the public and industry to facilitate the purchase of more environmentally sound products; *ii)* increasing the collection of prioritised hazardous waste and ensuring environmentally sound treatment; *iii)* improving knowledge of hazardous waste quantities and identifying new types of such waste; and *iv)* developing new regulations and instruments to lead to reduced use of chemicals in new products.

Building on previous efforts to substantially remediate *contaminated sites* and mitigate the effects of *sediments in fjords contaminated by substances that are hazardous to health or the environment* remained important policy targets in the review period (MoE, 2006a).

Government waste management targets are tracked against *indicators* presented regularly in white papers. Key indicators include: total annual quantity of waste generated relative to economic growth (expressed by GDP); proportion of the total amount of non-hazardous waste that is recovered; quantity of hazardous waste exported for final disposal; and quantity of hazardous waste for which disposal is unknown (KLIF, 2010a).

1.2. Legislative and administrative framework

Waste management in Norway is governed by the 1981 Pollution Control Act, a unified law covering solid, liquid and gaseous discharges (Chapter 3). In 2004, several pieces of waste management legislation were unified under the *Waste Regulations (Avfallsforskriften)*, which entered into force in 2004. This measure did not change the intent of the original legislation but aimed to simplify its use by the regulated community. The regulations covered landfilling, incineration, hazardous waste management and transboundary

shipment of waste. The Waste Regulations also strengthened the regulatory systems for managing particular waste streams, including waste electrical and electronic equipment (WEEE), batteries, end-of-life vehicles, tyres, beverage packaging, biodegradable municipal waste, construction and demolition waste, and waste containing hazardous chemicals.

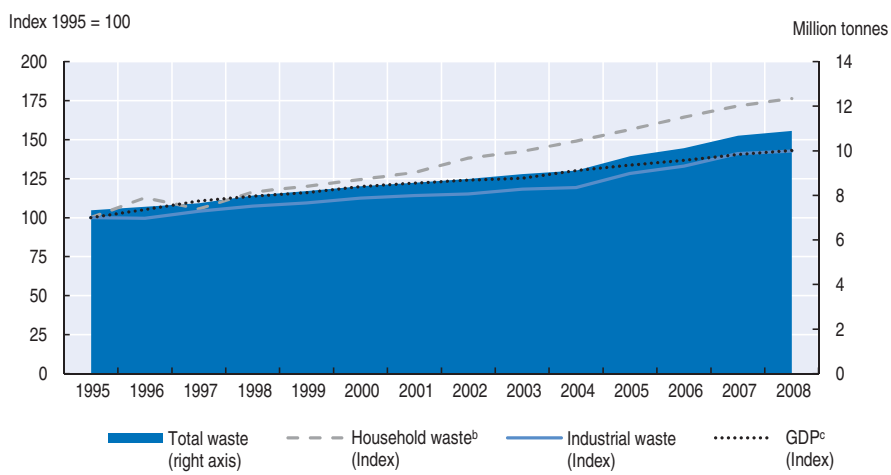
The *institutional framework* for waste management has not changed since the last review. At the national level, the Climate and Pollution Agency (KLIF) issues permits to firms that manage hazardous waste, including those operating incinerators and landfills. It also develops management guidelines for regional and municipal governments. County governors issue permits for non-hazardous waste management and for the reception and temporary storage of hazardous waste by specialised firms. The permits specify criteria that must be met to ensure that waste is properly handled. In co-operation with KLIF, county authorities provide technical support for municipalities, which arrange contracts for collection and management of household waste, enforce regulations such as the bans on littering and open fires, and handle other waste issues under local waste regulations adopted by municipal councils.

The Pollution Control Act used to require all municipalities to draw up *waste management plans*, but this provision was dropped. Norway maintains that it meets its obligations to prepare waste plans under EU waste directives through national documents rather than local plans. However, municipal autonomy is strong and several municipalities still develop local waste management plans. A growing number of municipalities collaborate on regional waste management plans to facilitate joint waste collection and treatment services and increase efficiency.

2. Trends in waste generation

The total volume of waste generated every year in Norway grew by nearly 30% over the review period, from around 8.4 million tonnes in 2000 to nearly 11 million tonnes in 2008 (Figure 7.1). Part of the increase was due to changes in waste classification introduced in 2004. However, the increasing trends continued afterwards and in spite of regulatory and

Figure 7.1. **Waste generation, trends 1995-2008**[a]



a) Preliminary data.
b) Includes scrapped cars and other waste not collected through the municipal collection scheme.
c) Constant prices.
Source: Statistics Norway.

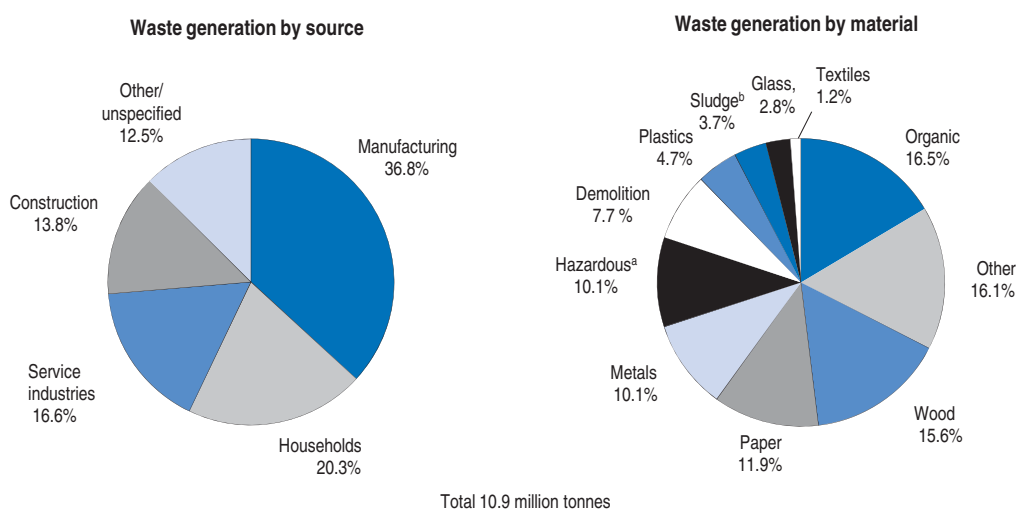
StatLink http://dx.doi.org/10.1787/888932374901

infrastructure development efforts, waste generation has grown by 19% since 2004 while GDP has increased by 10% (in fixed prices), a trend directly countering the 2000 objective of decoupling the waste generation and economic growth rates (Figure 7.1).[4]

The amount of *industrial waste* has increased in recent years, particularly in the second part of the decade. About a third of non-hazardous industrial waste is generated in *manufacturing* (37% in 2008) (Figure 7.2). There appears to have been some decoupling from economic activity in the manufacturing sector, in line with the 2000 objective, as manufacturing waste grew by 6% over 1993-2005 while production grew by 25%. When disaggregated by subsector, however, this apparent decoupling held for only some industries. Most notable was the wood and wood-product industry, where decoupling was much greater than the manufacturing average: it reduced its waste generation by 50% over 1996-2005, while income from production increased by 16% in fixed prices. In contrast, food processing waste increased by 32% over the period but production rose by only 1% (Statistics Norway, 2008). The *services sector* generated 1.8 million tonnes of waste in 2008, or 16% of the national total, and showed a strong upward trend, with growth since 1995 as high as 82%. However, part of the increase can be attributed to a new estimation method introduced in 2004. Just above half of the services waste was delivered as mixed waste. The quantity of *construction waste* rose by 28% between 2004 and 2008, and this category made up 14% of total waste in 2008.

Generation of *municipal waste* in Norway remains high by OECD standards, above the OECD and EU15 averages and on a par with the USA, Ireland and Denmark. This figure must be treated with caution, as not all countries report household waste and municipal waste separately and the composition of "municipal waste" varies.[5] Comparing the reported *household waste* fraction of municipal waste, Norway's results are at about the OECD average, and significantly less per capita than those of Denmark, the Netherlands, Spain and Germany. Nevertheless, annual household waste generation has grown considerably – by 40% over the review period, from 1.45 million tonnes in 2000, to more than 2 million in 2009 (from 330 kg per capita to 440 kg).

Figure 7.2. **Waste generation, state 2008**



a) Includes impregnated wood.
b) Includes water.
Source: Statistics Norway.

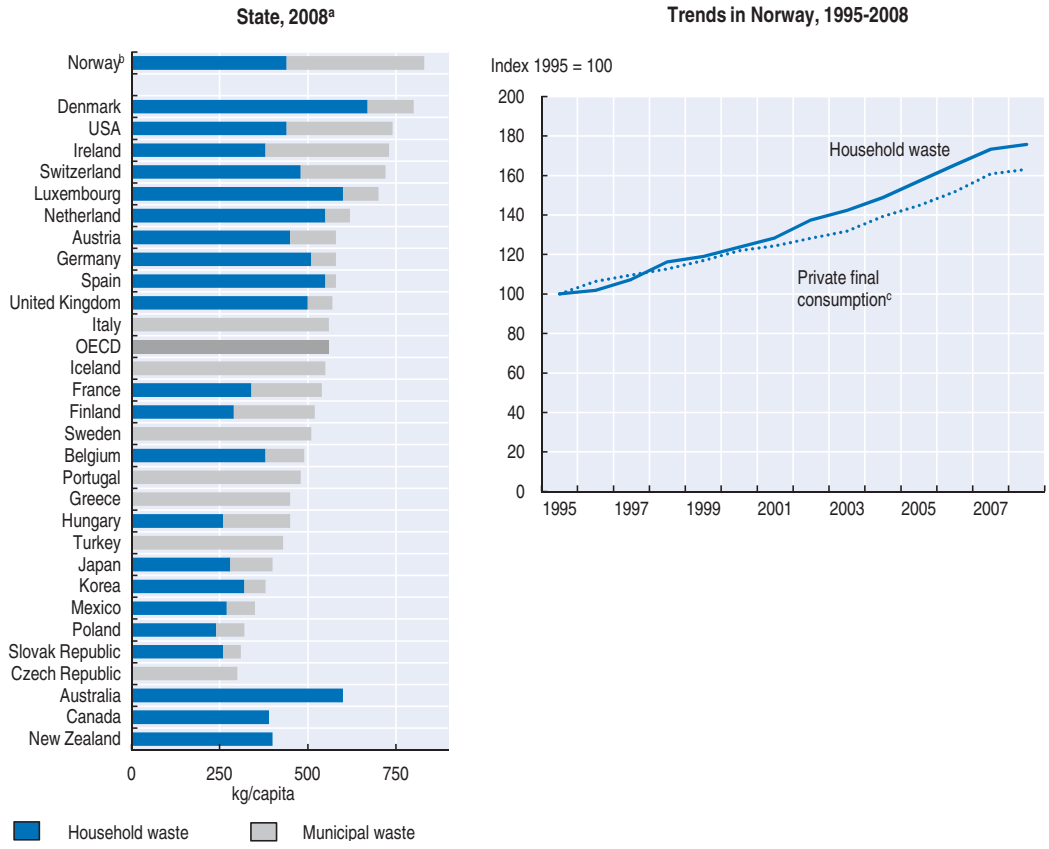
StatLink http://dx.doi.org/10.1787/888932374920

The volume of household waste grew faster than household consumption (Figure 7.3). Statistics Norway has estimated that 46% of the increase can be explained by population growth and 54% by growth in consumption (Statistics Norway, 2008).

Regarding particular *types of waste*, over the review period the volume of *wet organic waste* grew by 40% and now accounts for 17% of total waste (Figure 7.2). Some 1.8 million tonnes of wet organic waste was generated in 2008. Of this, around 40% came from manufacturing (mainly slaughterhouse waste, sludge from dairies and other production residue from the food industry) while households generated 30% (mainly cooking waste, food past its shelf life and other food waste, along with garden waste) and services, such as retail, hotels, restaurants and hospitals, generated 20%. Other types of waste that grew significantly included *wood waste* (up by 30%, to 17% of total waste generated); *other materials* such as concrete, slag, asphalt, sludge, glass, textiles, rubber and ceramics (by 30%, to 16% of the total); and *paper and cardboard* (by 20%, to account for 12% of total waste). *Glass waste* increased by 50% but at 300 tonnes, accounts for only a small fraction of the total.

About 1.1 million tonnes of *hazardous waste* was collected for approved treatment in 2008. The amount of hazardous waste increased by 64% during the review period and now accounts for 10% of all waste generated (Figure 7.2).

Figure 7.3. **Municipal and household waste generation**



a) Or latest available year.
b) 2007 data. Municipal waste includes production waste collected and handled by municipalities.
c) Based on values expressed in national currency at constant prices.
Source: OECD, Environment Directorate.

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The main cause of the increase is believed to be improved collection and reporting. The regulatory changes in 2004-06 also broadened the category of hazardous waste to include new types, such as plastic with brominated flame retardants, impregnated wood and asbestos fibre cement. In 2008, some 40 000 tonnes of the new types of hazardous waste were registered for approved treatment. Waste containing heavy metals (mainly slag) accounts for 50% of all hazardous waste, followed by oil-contaminated waste (22%) and corrosive waste (acids and bases, 21%) (Statistics Norway, 2009a). Manufacturing generates about 60% of hazardous waste whose sector of origin is known, including almost all corrosive waste, about 70% of all waste containing heavy metals and about one-sixth of other hazardous waste. Oil-contaminated waste comes mainly from oil and gas extraction, which accounts for about half of the total, while service industries (especially petrol stations, workshops and transport) account for about one-quarter of the total (Statistics Norway, 2009a).

Despite regulatory and technological efforts, and despite the longstanding objective of decoupling growth in waste generation and economic growth, the amount of waste generated continues to increase disproportionately to the growth of the population, consumption and economic activities. Areas of particular growth include waste generated by services and some types of manufacturing. Not only has household waste not been reduced, its volume has increased faster than consumption. With effects of the economic slowdown likely to be felt for a few more years, *the growth in amounts of waste generated may ease in some sectors*, such as construction, but the gap will not close quickly without more vigorous policy responses promoting efforts to reduce waste generation. The Norwegian Government has yet to study the drivers of waste generation and lessons that could be learned from household and industry experiences in waste generation and reduction. Such case studies could prove beneficial, both domestically and for other OECD countries.

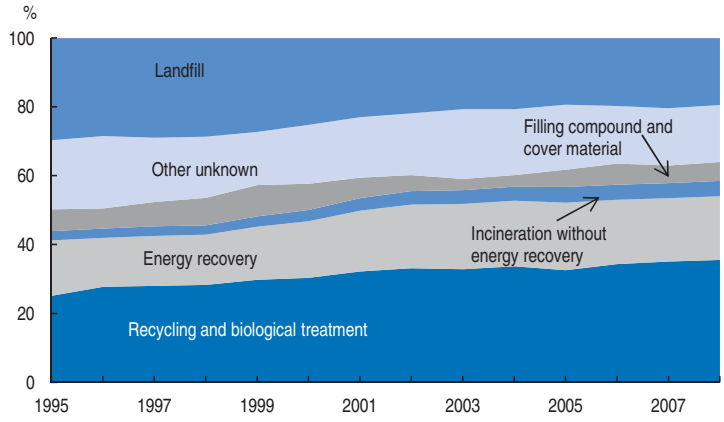
In order to engage market forces in reduction of waste, there is a need to create wider *markets for products and services that contribute to waste reduction*. Some companies that supply products to Norway voluntarily participate in the Nordic Swan and EU Flower ecolabeling systems and public awareness of these labels is high in Norway. Since 2001, the Public Procurement Act required public procurement operations to "have regard to the resource implications and environmental consequences of the procurement". The executive Regulations on Public Procurement specified further options for using life-cycle impacts and ecolabelling criteria (Chapter 3). However, government procurement does not yet overtly or consistently support waste and hazardous substances reduction policies and there is no data on waste generation or waste reduction by government agencies. Setting targets for waste reduction by all government agencies could help to stimulate procurement policies to drive waste reduction efforts. The implementation of the Action Plan for Environmental and Social Responsibility in Public Procurement adopted in 2007 provides such an opportunity.

3. Performance in managing non-hazardous waste

3.1. Trends in treatment and disposal

Norway has made significant progress in diverting waste from landfills. The proportion of *non-landfill methods of waste treatment* increased from around 73% of all waste generated at the beginning of the review period, to 77% in 2008 (Figure 7.4). This trend suggests that Norway is likely to achieve the long-term target of recovery of 80% of waste generated. Excluding portions of the waste stream that cannot be reused to any great extent, such as concrete, slag and contaminated soil/sediment, the recovery rate was 78% in 2008, already close to the target.

Figure 7.4. **Trends in waste treatment,[a] 1995-2008[b]**



a) Exported waste is classified according to the known type of treatment or disposal it undergoes in the destination country. Export waste for which the treatment or disposal method is unknown is classified under unknown or specific handling. Imported waste is excluded.
b) Preliminary data.
Source: Statistics Norway.

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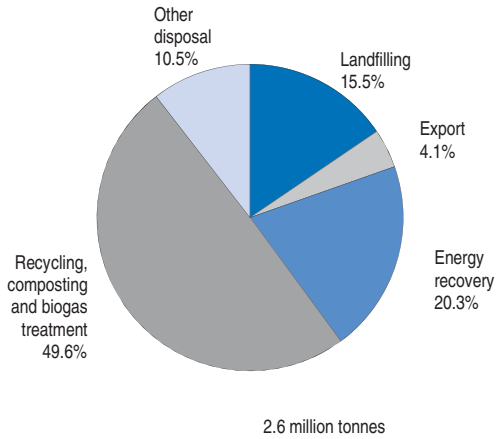
Some 70% of *manufacturing waste* does not go to landfill but is rather subjected to recycling, composting or energy recovery (Figure 7.5). Considerable progress has been made in effective *resource recovery from household waste*: the proportion of waste separated for material recovery increased from 40% in 2000 to 52% in 2008 (Figure 7.6).[6] This share compares well with the achievements of many other OECD countries, though Norway would need further improvement to match countries leading in household waste recovery, such as Switzerland and the Netherlands. In terms of recovery methods, this progress includes increases in tonnes sent to composting (by 88%), material recovery (46%) and energy recovery (45%).

Figure 7.5. **Waste in manufacturing industries, by type of treatment,[a] 2005**



a) Excludes hazardous waste, waste sent for sorting (25 000 tonnes) or handled in unknown ways (370 000 tonnes).
Source: Statistics Norway.

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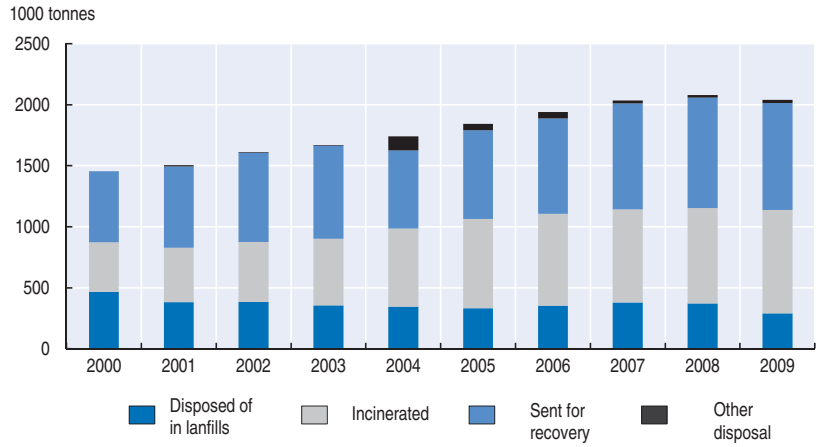
Figure 7.6. **Household waste, by type of treatment,[a] 2000-09**



a) Break in time series in 2004.
Source: Statistics Norway.

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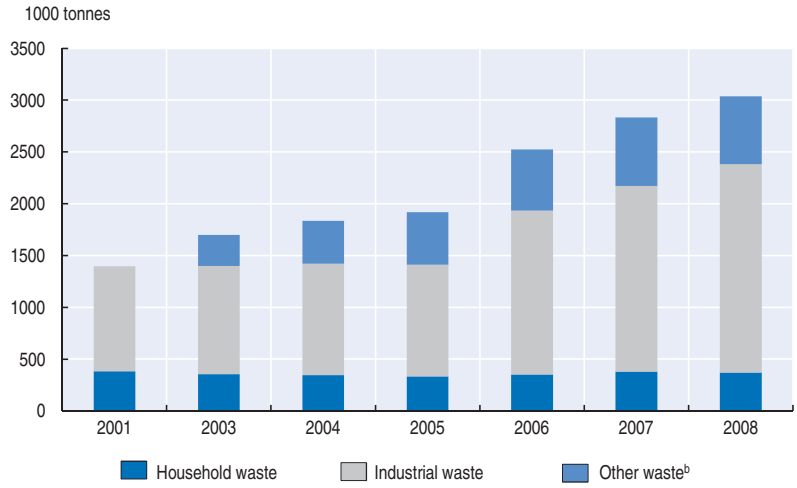
From 2001 to 2005, the amount of *waste deposited in landfills* was stable at about 1.4 million tonnes per year. Between 2005 and 2008, the tonnage of waste landfilled rose by nearly 70%, largely reflecting more deposition of contaminated soil from construction sites due partly to growth in the construction sector but also to increased attention by agencies and the industry (Figure 7.7) (Statistics Norway, 2010a). The annual amount of *household waste landfilled* also remained at the 2001 level (around 380 000 tonnes) even though total household waste generated increased by 43% between 2000 and 2008 (Figure 7.6).

The increase in landfilling in the latter half of the decade was accompanied by efforts to *improve safety of landfill operations and reduce their environmental impact*. Between 2004 and 2009, all landfill permits were revised to give effect to new classifications of hazardous waste, non-hazardous waste and inert waste. In addition, landfills now require gas collection systems for flaring or gas use, liners to prevent contamination of groundwater, and leachate management plans.[7]

There has been a notable increase in *transboundary waste transfers*. In 2009, Norway exported around 770 000 tonnes of waste after substantial growth from the beginning of the review period: the annual amounts exported increased fivefold between 2002 and 2009 (Table 7.1) (KLIF, 2010a).[8] Over 70% of Norway's combustible waste is exported for use in district heating incinerators, principally to Sweden, but also to Denmark. Norway imports around 300 000 tonnes of waste per year, with some fluctuation (Table 7.1).[9] The imports are dominated by hazardous aluminium-containing slag and by incinerator fly ash. To some extent, Norway is trading the energy content of its "non-hazardous" waste for hazardous incineration residue.

KLIF is the authority responsible for *authorising waste imports and exports* in Norway. In principle, it refuses exports of waste for disposal if there is an environmentally sound alternative in Norway (KLIF, 2010b). In collaboration with the Customs and Excise Directorate, KLIF carries out spot checks along the border and at larger ports to ensure that all waste exports and imports comply with regulations. Following a serious accident in May 2007 involving treatment of hazardous waste at the Vest Tank facility in Gulen, a

Figure 7.7. **Waste landfilling,[a] 2001-08**



a) Excluding landfilling by manufacturing industries at their own landfills.
b) Other waste used as cover material in between different layers of household and industrial waste, or as final cover.
Source: Statistics Norway.

StatLink http://dx.doi.org/10.1787/888932375015

Table 7.1. **Exports and imports of waste, 2002-09**

Tonnes

	2002	2003	2004	2005	2006	2007	2008	2009
Exports	134 052	220 798	229 865	323 874	376 159	306 735	491 600	770 235
Energy recovery	87 972	165 046	177 706	276 159	332 695	242 588	359 034	561 692
Material recovery	36 602	52 802	47 403	43 899	31 690	46 875	95 912	128 416
Final disposal	9 478	2 950	4 756	3 816	11 774	17 272	36 654	80 127
Imports	243 628	323 419	230 504	237 049	202 666	128 917	269 075	303 206
Energy recovery	3 330	8 693	2 242	3 325	8 639	15 289	20 867	13 128
Material recovery	61 421	14 597	9 351	29 660	60 924	23 889	97 392	104 976
Final disposal	178 877	300 129	218 911	204 064	133 103	89 739	150 816	185 102

Source: KLIF.

StatLink http://dx.doi.org/10.1787/888932375319

municipality in Sogn og Fjordane county, KLIF initiated a working group, with participation from the Directorate for Civil Protection and Emergency Planning, the Norwegian Coastal Administration, the Norwegian Maritime Directorate and the Customs and Excise Directorate, to improve controls over hazardous waste exports and imports by tankers and bulk carriers (KLIF, 2010c).

About half the *sludge* from wastewater treatment is treated in biogas plants, 25% undergoes other biological treatment, and the remaining 25% is landfilled. Some 80% of compost made from sludge is used in agriculture, public parks and green spaces, and topsoil products, and 10% is used as landfill cover (Statistics Norway, 2010a).

It is estimated that in 2007, 14% of all non-hazardous waste underwent *unknown treatment and disposal*. This includes disused material left *in situ*, such as old pipelines and underground cables, and Norwegian vessels in foreign trade that are scrapped abroad. The figures in this category are somewhat uncertain (Statistics Norway, 2009b).

3.2. Measures for improving non-hazardous waste management

Norway has taken several *important steps* to achieve objectives and targets set in national policy documents. The measures have included: *i)* strengthening municipal collection and treatment of household waste; *ii)* introducing a mix of instruments to reduce final waste disposal and promote recovery; and *iii)* strengthening management and reducing impacts of landfilling and incineration.

Strengthening non-hazardous waste collection and recovery

Municipal systems for *household waste collection* were well established before 2000. The services are primarily outsourced to commercial or municipal-owned waste operators, which collect and treat waste on multi-year contracts. The number of companies owned by local authorities rose from 1 560 in 1999 to 2 203 in 2004. Some neighbouring municipalities joined efforts to take advantage of economies of scale, developing joint management plans and delegating collection and treatment to inter-municipal companies. The number of such companies increased from seven in 1996 to 206 in 2004. Publicly owned companies continue to play an important role in waste collection and treatment; only 10-15% of the waste management service is provided by private companies. However, many municipal-owned services have been commercialised: the number of firms that are legally independent from the municipalities reached 1 728 in 2004, up from 773 in 1996 (Sørensen, 2008). In 2008, nearly 8 000 people were employed in waste activities and material recovery; of those, nearly 5 000 worked in waste collection (Statistics Norway, 2010b).

The 1981 Pollution Control Act requires *waste collection charges* that are applied to households to be set high enough to recover both capital and operating costs of local waste collection and source segregation systems.[10] In most municipalities the cost recovery ratio is at, or near 100% (Statistics Norway, 2009b). This suggests that households and others are taking part in the municipal waste collection systems to a larger extent than before and are shouldering the real environmental costs of waste management.[11] In 2009, the average annual fee per municipal subscriber was NOK 2 166, a substantial increase from NOK 1 476 in 2000 (Statistics Norway, 2010c). The fees vary by community, being higher in less densely populated areas such as Finnmark county (with an average of NOK 2 879) while municipalities in Østfold county have the lowest average annual fees (NOK 1 941) (Statistics Norway, 2010c).

While municipal waste management fees are likely to be based on the user pays principle, they do not necessarily provide "polluter pays" incentives at point of generation.[12] Only limited progress has been made in *differentiating charges by amount generated*: in 2009, some 56% of municipalities had annual waste fees that could be varied by waste bin size, 11% had fees variable by collection frequency and 9% charged different fees for households with home composting (Statistics Norway, 2010c). Expansion of differentiated charges according to weight or waste fractions could provide incentives for households to increase recycling and could stimulate waste reduction. Some analyses indicate that municipalities with relatively low waste charges have the highest percentage of recycling (Martinsen, Vassnes, 2004). This may indicate that a high rate of recycling, and a reduction in waste delivered to landfills and incineration, can result over time in lower waste charges.

The efforts of the national and local authorities in the review period focused on expanding arrangements for *waste sorting at the source*. In 2009, around 99% of Norway's population was covered by collection systems allowing sorting of at least one waste category (paper, glass, plastic, or wet organic waste). Some municipalities' systems allow

sorting of up to 10 categories. The best coverage for the country as a whole is for paper (95% of the population), followed by plastic (71%), and wet organic waste (68%) (Statistics Norway, 2010d).[13] In some counties, relatively high shares of the population can separate hazardous waste and waste electrical and electronic equipment (WEEE) for household collection; Rogaland, for example, has a rate of 47% for both, while Aust-Agder provides hazardous waste collection to 64% and electronic waste collection to 38% (Statistics Norway, 2010d). Such rates can be attributed to municipal leadership, as the obligation under producer-responsibility regulations is limited to provision of reception facilities for producer-collected material such as WEEE and chlorofluorocarbons (CFCs). High return rates have characterised paper recycling since the 1980s without any regulatory requirements. Such leadership should be further encouraged through recognition of municipal efforts in waste sorting. Award systems, in conjunction with wider organised sharing of effective approaches, could motivate local authorities to strengthen their efforts.

The expansion of waste sorting has been accompanied by a broadening of *extended producer responsibility* regimes, which require business and industry to collect and treat waste from products they put on the market. For some waste streams, the recovery targets were established through agreements between the Ministry of the Environment (MoE) and representatives of industry and business associations (Table 7.2).[14] Many targets have been met, including those for used lubricating oil, electrical equipment with CFC refrigerants, batteries, end-of-life vehicles, tyres and waste packaging (corrugated cardboard, cartons, glass, metal, beverage cartons, plastic packaging and one-way beverage containers such as cans and PET bottles). Despite a rapid increase in the amount of WEEE collected, the government-industry agreement to achieve a collection rate of at least 80% does not yet appear to have been met (Box 7.1).

In the last decade, *new extended producer responsibility regimes* have been introduced. Since 2001, Norway has run the world's only programme for the collection and recycling of sulphur hexafluoride (SF_6), a potent greenhouse gas widely used in power plants. The government's target of reducing emissions by 30% by 2010 was exceeded: the rate reached 55% in 2008. There are also new programmes for collection of particular materials containing hazardous substances, such as insulating window units made with sealants containing polychlorinated biphenyls (PCBs) (Table 7.2). However, it is too early to assess their success.

The achievement of producer responsibility targets was helped by the introduction of *taxes connected with deposit-refund systems* for end-of-life products. Some had been in place since the 1990s, such as deposit-refund systems for end-of-life vehicles; taxes and deposit refund systems for beverage containers (including non-refillable ones); and taxes and refund systems for used lubricating oil (Table 7.2). Taxes introduced in the review period included one on the use of the chlorinated solvents trichloroethylene (TRI) and tetrachloroethylene (PER), introduced in 2000.[15] Since 2003, a tax has been levied on the import and production of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) to reduce their emissions by stimulating use of alternative gases and development of new technology and products that do not use HFCs and PFCs (Table 7.2). Taxes have been an important source of revenue. Beverage container taxes generated NOK 649 million in 2008 (NOK 474 million for the basic tax on non-refillables and NOK 175 million for the variable tax), lubricating oil generated NOK 86 million and TRI and PER generated NOK 11 million (Næss and Smith, 2009).

Table 7.2. **Collection and recovery programmes for specific waste streams in Norway**

Year of introduction and modification	Waste stream or product	Type of programme	Instruments (2009 rates)	Impact on waste stream
			Introduced before review period	
1974 1994 2000	Beverage packaging (*refillable and non-refillable beverage containers*)	Extended producer responsibility (EPR) programme: tax on containers, deposit-refund system	Base tax on non-reusable containers (NOK 1.00 for PET bottles and cans up to 0.5 litres and NOK 2.50 over 0.5 litres) plus tax by material type (NOK 4.97 per unit for glass or metal, NOK 3.00 per unit for plastic, NOK 1.24 per unit for carton/cardboard). Tax reduced according to recycling rate, full rebate for recycling rates over 95%. Registered participation in take-back system entitles manufacturers and importers to benefit from reduced beverage taxes. Milk and juice packaging covered from 2006. Government-industry agreement on targets renegotiated in 2003. There are 13 approved take-back systems. Two take-back companies, Norsk Resirk (non-refillable plastic bottles and cans) and the Norwegian brewers and soft drink producers association (refillable glass and plastic bottles) use deposit-refund systems. For one-way cartons and non-refillable glass, no deposit-refund system exists. In both cases collection and reuse/recycling is financed through industry fees on the products.	Packaging with refund is collected at collection points, *e.g.* supermarkets. The system is run and financed by producers and importers of beverages. Coverage is national. Most municipalities provide collection services for some types of beverage packaging not covered by the refund system. Collection and recycling is partly financed by producers.
1995 2003	Other packaging (brown paper, cardboard, plastics, metal)	EPR: industry agreement	Voluntary agreements between the MoE and industry organisations set specific targets for recycling and total recovery. Industry established dedicated companies to assure meeting the targets. Collection through municipal waste collection and private waste management companies. Financing through industry fees on packaging.	Recovery rates (recycling + energy recovery) exceed industry-government targets at over 80% for glass, brown paper, plastic.
1978 2007	End-of-life vehicles (ELVs)	EPR: deposit-refund/ take-back system	Refund system for ELVs weighing less than 3.5 tonnes established in 1978 to motivate car owners to return hulks to a certified treatment plant. System also covers snow scooters and minibuses. A deposit of NOK 1 300 is applied on new cars, and a NOK 1 500 refund is given on delivery of cars for disposal. Industry-run system established in 2007 under EU ELV Directive (2000/53), but state refund system was retained. A transitional subsidy to vehicle dismantlers for vehicles not covered by the industry system (NOK 5 000 for some of the most polluting car types) was provided in 2008.	Return rate 93% and recovery of materials 86% in 2009.
1988 2006	Waste electrical and electronic equipment	EPR: take-back system, regulation and industry agreement	Under formal agreement with the MoE, producers aim to ensure that at least 80% of WEEE is collected and reduce the problems associated with WEEE. Producers had to establish take-back companies to manage WEEE in accordance with regulations. From 2007, membership in government-approved take-back company required for WEEE importers and producers.	Tonnage collected increasing; per capita, seven times higher than EU average. Industry target of 80% not met.
1988 (tax) 1994 (refund)	Waste lubricating oil	State administered programme: tax-refund system	Refund given for oil delivered to approved facilities. More types of oil added in 2000. Tax rate (2009) is NOK 1.77 per litre and refund rate is NOK 2.00 per litre.	Return rate estimated at 80-85%.
1990	Batteries	EPR: take-back system	Lead and nickel-cadmium batteries are covered.	Collection rates 99% for leaded batteries (2009), 196% for Ni-Cd batteries (2007).
Prior to 1994	Vehicle tyres	EPR: take-back system	System set recycling targets of 85% recovery by January 2006 and 95% by January 2015. System underpinned by ban on landfill disposal of tyres.	Collection rates exceeded 100% of estimated waste generated every year from 2001 to 2009 as some importers did not take part in the take-back system.

Table 7.2. **Collection and recovery programmes for specific waste streams in Norway** *(cont.)*

Year of introduction and modification	Waste stream or product	Type of programme	Instruments (2009 rates)	Impact on waste stream
			Introduced during review period	
2000	Chlorinated solvents	State administered: tax-refund system	System promotes return and phase-out of trichloroethylene (TRI) and tetrachloroethylene (PER). Tax NOK 60.96/kg;refund rate NOK 25/kg for waste containing TRI delivered to certified waste collector.	Emission reductions: TRI 92%, PER 91% between 1995 and 2005.
2003 (tax) 2004 (refund)	Hydrofluorocarbons, perfluorocarbons	State administered: tax-refund system	Tax on import and production of HFCs and PFCs. Tax NOK 204.99/tonne CO_2 eq, fully refunded on delivery to waste treatment facility.	In 2003, projected reduction in use was 40% by 2010. Recent data not available.
2004	PCB windows	State administered: take-back system, hazard plans	Requires producers and importers of double-glazed windows to participate in approved take-back programmes for insulating window units made with sealant containing PCBs. Also included in hazard mapping required under construction and demolition rules.	Over 2002-09, 416 065 units collected. Estimated total installed over 1965-75: 2.05 million.
2008	Construction and demolition waste	State administered: waste plans and sorting rules	Before demolition or renovation can proceed, municipality must approve waste management plan including survey of types and amounts of hazardous waste. At least 60% of waste must be sorted.	National monitoring and information campaign, 2009. Some evidence of success. Waste collection industry representatives consider construction and demolition rules to have been successful. Industry forced to sort waste for recovery, resulting in less waste generation, cleaner construction sites, development of systems to deliver goods without excessive waste. A 2009 review of private hazard mapping contractors provided anecdotal evidence that system has greatly reduced prevalence of small operators that did not manage hazardous demolition materials safely.

Source: Speck *et al.*, 2006, Lindhjem *et al.*, 2009.

Box 7.1. **Recovery of waste electrical and electronic equipment**

In 1998, Norway became the *first country in Europe* to pass legislation providing for free take-back of discarded electrical and electronic equipment. The following year, the MoE and producers and importers of electronic and electrical goods concluded an industry-wide agreement, setting a target of an 80% collection rate by 1 July 2004. Three co-operative return companies were later formed, covering 94% of WEEE collection-related activity: *Renas, Elektronikkretur and Hvitevareretur* (the last two merged in 2005, becoming one company under the name *Elretur*). Other take-back companies established independently of the agreement included *Eurovironment* and *Ragn Sells Elektronikkgjenvinning*. At first the various companies were assigned to collect different types of WEEE but as of 2007 all companies take all categories of WEEE.

The Norwegian WEEE system goes *beyond the requirements of the EU WEEE Directive* (2002/96/EC), as it covers all types of electronic and electrical machinery, including large and small household appliances, information and telecommunication equipment, photocopiers, medical equipment, fluorescent lamps, and cables and flexes.

WEEE collection systems include municipal waste treatment facilities and vendors of electronic and electrical products, which accept waste equipment at no charge. Public and corporate customers, such as hospitals and offices, can dispose of their equipment at any municipal WEEE collection point or conclude agreements with take-back companies to arrange pickup of WEEE. Distributors and vendors are required to take back WEEE and clearly inform consumers about this option. The cost of WEEE collection and treatment is covered by importers and manufacturers, which pay fees depending on the product and the overall cost of running the programme. The average fee is around 0.3% of net product value. After collection, WEEE is dismantled manually at specialised facilities. Components containing dangerous substances are treated as hazardous waste.

The *amount of WEEE* collected increased significantly over the review period, from around 40 000 tonnes in 2000 to more than 150 000 In 2009. The amount collected per capita increased from around 8 kg to 32 kg, eight times the level required by the EU directive. It is unclear, however, how much of the high recovery is attributable to the greater product range coverage of the Norwegian system, better diversion systems and participation, and/or higher waste generation rates.

The WEEE collection tonnage for several classes of equipment has been higher than the estimated total supply of goods in a given year (*e.g.* in 2008, the collection rate for small household appliances was 122% and that for computer monitors was over 300%). Yet the *overall collection rate for all types of WEEE* was 55% of estimated WEEE supply in 2008. Thus, the industry agreement to achieve at least an 80% collection rate does not appear to have been met. Of the recovered material, about 90% is reused, recycled or processed for energy recovery. The remaining 10% is landfilled or incinerated without energy recovery.

The *WEEE take-back system* has been modified to increase its effectiveness and to reflect provisions of the 2002 EU directive. The 2004 Waste Regulations require KLIF to approve each take-back company in a specially designed certification system. They also require producers and importers of electrical and electronic equipment to affiliate with an approved take-back company. To aid in tracking of producers and importers, a WEEE register was established in 2006. It provides information on the legislation and requirements with which producers and importers must comply, and makes it possible to identify companies that may not be meeting their obligations under the regulations. The register collects and collates data from the take-back companies on the amount of WEEE collected and processed.

Further improvements to the system should include better enforcement for retail outlets, as some major supermarket chains that sell electrical and electronic products do not accept WEEE. Given discovery of illegal exports of WEEE, better control at collection points may also be required. As a leader in the WEEE area Norway may wish to consider including in the recuperation system the computerised components of cars that enter the end-of-life vehicle system as current provisions are not made for safe disposal of their electrical and electronic components.

Waste final disposal taxes were introduced in 1999 on waste sent to landfills and incinerators. They were intended to reflect cost of environmental damage connected with final treatment of waste and to encourage increased source separation and recycling to reduce the amount of residual waste. The taxes were reduced for energy recovery at incinerators and later for good environmental practices at landfills. In 2003, the incineration tax differentiation was pegged to emissions of hazardous substances, such as dioxins, rather than the amount of energy recovered (Box 7.2).

Box 7.2. **Differentiated taxes on waste final disposal**

The 1996 Green Tax Commission, in Norway's first discussion on taxing waste, recommended a partial shift in the tax system from taxing labour to taxing the use of natural resources and harmful emissions. The commission noted that the worst environmental problems related to waste treatment concerned leachate from landfills and air pollution from incineration. It also pointed out that municipal waste charges did not fully reflect the costs of these problems.

In response, the *final disposal taxes* introduced in 1999 set a rate of NOK 300 per tonne for either landfilling or incineration, although the incineration tax was designed as a basic tax of NOK 82 and an additional tax of up to NOK 245 that could be deducted depending on the degree of energy recovery. Hazardous waste was exempted from the disposal tax to avoid creating a disincentive for proper treatment. Waste delivered for recycling and recovery was also exempted.

Reviews in 2003 concluded that the differentiated incineration tax did not effectively cover the environmental costs of incineration or provide an effective incentive for energy recovery. Thereafter, the incineration tax was *differentiated on the basis of air pollutant emissions* (*e.g.* dioxin emissions, NOK 2.7 million per gram; lead, NOK 74; mercury, NOK 24; and NO_x/SO_2, NOK 0.02). The tax is applied on actual emissions, monitored either continuously based on 24-hour average concentrations, or through manual monitoring or analysis every sixth month by an independent third party. There are detailed requirements about how to carry out the various monitoring or analysis activities. The average incineration tax amounted to about NOK 100 per tonne of treated waste.

The landfilling tax was also differentiated in 2003, linked to *landfill environmental standards*. Each tonne of waste delivered to landfills fulfilling EU requirements on sealing of the base and sides of the landfill faced a tax rate of NOK 327, while other landfills charged a tax rate of NOK 427 per tonne. The extra NOK 100 per tonne corresponded to the estimated environmental cost of leachate. The rates have been adjusted over time: in 2009 the tax was NOK 447 per tonne of waste delivered to landfills of high environmental standards and NOK 583 per tonne for the rest, and in 2010 the lower rate was reduced to NOK 275 per tonne to reflect the lower environmental costs expected from reduced methane emissions after a ban on landfilling of biodegradable waste was strengthened in 2009.

The landfilling and incineration taxes are paid by owners of landfills and incineration plants to the Customs and Excise authorities. Estimated *revenue from waste disposal taxes* was NOK 684 million in 2007, an increase from NOK 483 million in 2000 (current prices). The funds go into the general state budget and are not earmarked. The tax rates have mostly been adjusted for inflation since 2006. One exception was the rate for chrome emissions, which was substantially reduced between 2006 and 2007 because most chrome emissions from incineration plants are in the form of chrome (III), and not the far more damaging chrome (IV) as previously assumed.

Waste for incineration also attracts a carbon tax: in 2009 it amounted to NOK 62 per tonne of waste delivered, based on a carbon price of NOK 200 per tonne of CO_2 eq. The rate has been adjusted for inflation, except in 2007 when it was increased to put it on a par with the CO_2 tax on oil. Plants that can prove that they do not burn fossil fuels (*e.g.* those fired by biomass) are exempt from the carbon tax. The landfill tax is corrected for the additional tax exceeding a permit price in the CO_2 emission market of NOK 200 per tonne of CO_2.

Due to simultaneous effects of various factors, it can be difficult to *evaluate the effects of these taxes* on waste generation, recycling and emissions. However, the trends show that the amount of household waste entering municipal waste collection systems has gradually increased since the introduction of the taxes and the percentage of waste recovered (recycling plus energy recovery) has increased considerably (Figure 7.6). The relative increase in recovery is assumed to be at least partially an effect of the waste taxes. In the same period, there was a decrease in the amount of waste landfilled and an increase in the amount incinerated. This may be because the average tax per tonne has been higher for waste delivered to landfills than for waste delivered to incineration plants (Martinsen, Vassnes, 2004).

Even though the differentiated incineration tax linked to type of air pollutant seems to have led to significant reduction of emissions from incineration plants, especially of dioxins, Norway is considering *removing the incineration tax in 2010*. The proposal follows an increasing trend in exports of Norwegian waste to Sweden for incineration. The Swedish tax on waste incineration is lower, and many Norwegian waste service suppliers have signed agreements with Swedish incinerator operators, leading to a shortage of waste supplied to Norwegian incinerators. However, Sweden is also considering removing its incineration tax. Thus, halting the Norwegian tax might not create a significant economic incentive for keeping combustible waste in Norway. Instead, the change would remove tax differentiation that depends on the degree of hazard. It has been argued that conditions in emission permits provide adequate incentive against hazardous emissions (WtERT, 2010).

Strengthening non-hazardous waste treatment and disposal

A *ban on landfilling of wet organic waste*, which took full effect in 2002, was instrumental in reducing the amount of this type of waste delivered for final disposal. The ban reduced methane emissions, cut pollution from leachate and boosted efforts to use waste for district heating generation.[16] It was accompanied by extended efforts to encourage source separation and treatment of organic waste (Box 7.3). The ban was strengthened in 2009 by a prohibition of landfilling of all biodegradable waste. However, the regulations allow county governors to issue exemptions to the ban if processing capacity is deemed insufficient. Such exemptions have totalled around 400 000 tonnes in recent years; for comparison, the total annual amount of biodegradable waste going to landfill before the ban was one million tonnes. Most of the exemptions have been for municipalities that were in the process of building, or gaining access to, new incineration capacity. In light of the strong export trade in combustible waste with Sweden, KLIF has recommended to the governors that they stop issuing exemptions.

Recovery of energy from waste has been a priority of the Norwegian government. In 2008, half of the energy for district heating (delivery of hot water to buildings and industry) was produced from waste incineration, and the amount of energy from this source increased 46% between 2000 and 2008 (Statistics Norway, 2009c). *Enova*, a state enterprise established in 2002 under the Ministry of Petroleum and Energy, has indirectly supported energy recovery from waste incineration through investment support for district heating systems totalling NOK 1.7 billion over 2002-09. The support was expected to trigger further private and municipal investment of NOK 10.8 billion. Since 2009, *Enova* has also provided direct support for energy recovery from waste by financing the development of biogas plants; the amount available for grants in 2009 was NOK 24 million.

Box 7.3. **Household organic waste**

Regulations concerning organic waste

The main environmental threats from landfill disposal of organic waste are production of methane (a greenhouse gas 20 times more potent than carbon dioxide) and of leachate (contaminated liquid that can drain from landfills), and prevention of materials derived from the natural environment from re-entering important nutrient cycles.

Source separation of food waste started in Norwegian municipalities in the 1990s, spurred by a 1992 ban on landfilling of easily degradable organic waste. The ban was phased in as permits for each landfill were revised; it took full effect in 2002. It allowed landfilling of mixed municipal waste (whether or not it contained biodegradable waste) if a municipality had a system for source separation of wet organic waste. The landfilling ban was extended in 2009 by prohibiting landfilling of degradable waste with total organic carbon contents amounting to more than 10%.

The coverage of source separation systems for organic waste grew to 56% of the population in 2008. The amount of bio-waste (waste of vegetable or animal origin) collected increased from 151 000 tonnes in 2000 to 200 000 tonnes in 2008. Around 1% of the population composts organic waste (including garden waste) in home composters. In return for not having to collect the waste, the municipality grants the household a reduction in the waste collection fee and/or a reduced price for compost bins (such as those with the Nordic Swan ecolabel).

Trends in organic waste treatment

Norway has 62 centralised plants treating 455 000 tonnes per year of organic waste, including sewage sludge treated off-site and garden waste. This amount represents a rise of 60% since 2001. Composting is the dominant technology, accounting for 392 000 tonnes. Around 40% of the compost produced is used in private gardens, though the use of compost in landscaping and construction is rising, with this category now accounting for 33%. Only 17% was used in agriculture, with organic farming taking 4%. The low rate of use in agriculture is due to a combination of low demand for soil improvers and high-compost product development aimed at landscaping and construction.

Some 62 000 tonnes of organic waste is treated in anaerobic digestion plants for biogas production. Most aerobic treatment plants are small and operated in open facilities using turned windrows or static piles. A few plants use closed, in-vessel technology. The largest plant, situated outside Stavanger, has a design treatment capacity of 28 000 tonnes per year. Some municipalities are leading the conversion of bio-waste to energy. For example, Oslo has begun collection of household organics for biogas plant feedstock in a system that is to be expanded to the rest of the city and neighbouring municipalities. The city's two sewage plants produce biogas that is used to power 80 municipal buses. By producing biogas from household and restaurant food waste, the city expects to expand the programme to 400 city buses.

The transposition of EU Directive 2000/76/EF into the Pollution Control Act regulations created an expectation that thermal energy generated by incineration should be recovered as far as practicable, and incineration permits from county governors usually require a recovery rate of at least 50%. If that level cannot be reached initially, exemptions may be granted for a few years while district heating systems are constructed. The average energy recovery rate (heat and electricity) from incinerated waste was 78% in 2009. Since the beginning of 2008, there has also been a subsidy for electricity from biomass: NOK 0.10 per kWh (IEA, 2010).

4. Improving management of hazardous waste and substances

Hazardous waste

Norway's goal of treating all its *hazardous waste* domestically has nearly been realised: about 90% of such waste was treated in Norway in 2008.[17] Of the hazardous waste generated and treated as approved, 74% was landfilled, 15% recovered and 11% exported (KLIF, 2010d). Over 1 800 hazardous waste treatment facilities operated in 2009, were all subject to permitting and compliance assurance by KLIF.[18] For example, spot checks carried out by KLIF and regional authorities in 2010 uncovered regulatory violations in 123 of 149 municipal and private treatment facilities for hazardous waste, with more than half of the facilities falling short of operational requirements for receiving waste, particularly new types of hazardous waste, and another 50% breaching rules for waste handling and violating for internal control regulations.

About 6% of the hazardous waste generated every year appears to be going to "*unknown handling*".[19] In 2008, this share was estimated at 65 000 tonnes (KLIF, 2010d). Most of this is believed to be impregnated wood and waste containing oil. While the product life cycle analysis method tends to provide overestimates, there is nonetheless cause for concern. The amount of hazardous waste in the original regulatory categories that was treated in unknown ways has decreased, but 40 000 tonnes of new material was added to the hazardous waste treatment framework when the definition of hazardous waste was changed in 2004 (Statistics Norway, 2009a).

The fraction of *hazardous waste* that is exported from Norway for treatment in other OECD countries, even if it is minor (11%), nearly doubled over the review period, from 75 000 tonnes in 2001 to 123 000 tonnes in 2008. Of the exported waste, 60% was recycled, 13% used for energy recovery and 27% sent to landfill. Complex waste, such WEEE, waste containing PCBs and waste batteries, tends to be treated in specialist plants abroad. *Imports of hazardous waste* were stable over the review period at around 200 000 to 250 000 tonnes a year (Statistics Norway, 2010c).[20] The imports are dominated by slag containing aluminium and by incinerator fly ash. At the end of 2009, new regulations banned the import for recycling of waste containing mercury. This decision followed a near-total ban in 2008 on the use of mercury in Norway, though some exports are allowed where the waste is to be treated in a safe way.

Cases of *illegal export of hazardous waste* have been discovered, including 11 in 2008. Most have involved end-of-life vehicles, WEEE or old ships. In 2009, 63 containers were stopped at the border, but detection has been primarily through discovery in destination countries and tracking to Norway, and/or via domestic complaints. In general, Norwegian customs authorities have focused more on imports than on exports. In the last few years, however, KLIF has increased its collaboration with Customs and the Norwegian Maritime Directorate to stop illegal exports of hazardous waste. KLIF has a co-operation agreement with Customs to increase inspection of transboundary movements. Norway's environmental crime investigation unit, *Økokrim*,[21] has been active in prosecuting breaches of hazardous waste legislation, selecting a small subset of the known cases based on their significance of environmental impact and/or their deterrent value. Successfully prosecuted and well-publicised cases over the last decade have included a Norwegian firm breaching Basel Convention rules in exporting to Africa and a case of fraud in the product refund programme for waste oil.

Hazardous substances

Several persistent and accumulative hazardous chemical substances (also called eco-toxins) that may have a toxic effect in the environment are linked to waste streams. They include PCBs, dioxins, hexachlorobenzene (HCB), brominated flame retardants and heavy metals. Targets were set in 1997 to substantially reduce or eliminate the releases of such chemicals, and several measures have since been undertaken. In 2000, the *substitution principle* was added to the Product Control Act, requiring businesses to replace dangerous substances with less hazardous alternatives whenever possible, provided it does not entail unreasonable cost.

The government set *reduction targets* for five types of eco-toxin, aiming to eliminate their release by 2005.[22] Four were on target that year, with reductions ranging from 82% to 100%, and PCBs had been reduced by half. Additional substances were listed in 2006 to be "substantially reduced" by 2010, from 1995 levels.[23] Projections in 2007 indicated that most national emissions would be reduced by over 50% and up to 100% for some (KLIF, 2010e), suggesting that the targeted reductions would be achieved by 2010 in the majority of cases.[24] Progress on arsenic and polycyclic aromatic hydrocarbons (PAHs) was below 50%, however, and the use of brominated flame retardants has increased (Box 7.4).

Factors contributing to the achievement of targets include strict emission limits in industry, regulations on the amount of hazardous substance in products and requirements regarding safe handling of waste containing hazardous substances. Measures on eco-toxins include bans on PCBs in ballasts of vapour lamp fixtures and indoor fluorescent light fixtures (2005), PCBs in ballasts of outdoor fluorescent light fixtures, mercury in new products and perfluorooctansulfonate (PFOS) in firefighting foam, impregnation agents and textiles (2007), and the brominated fire retardant deca-BDE in new products (2008). Electrical bushings containing PCBs are banned from 2010 (KLIF, 2010e).[25] Norway also prohibits incineration of waste containing more than 0.25% mercury, and is phasing out PFOS.

Box 7.4. **Prioritised hazardous substances**

Total consumption of *brominated flame retardants* has increased significantly since 1995, from slightly less than 100 tonnes to 450 tonnes in 2007. A ban on penta-, octa- and decabrominated diphenyl ether (PBDEs) reduced emissions of these substances, but use of other products increased, notably hexabromocyclododecane (HBCDD) and tetrabromobisphenol A (TBBPA), the flame retardant used in printed circuit boards, thus raising emissions via routes such as municipal drainage systems, landfills and other waste treatment. A national action plan for brominated flame retardants was adopted in 2002, and updated in 2009 with measures aiming to reduce emissions in line with goals set for 2020.

National emissions of *arsenic* decreased by 23% over 1995-2007. The main source of arsenic emissions is wood impregnated with chromated copper arsenate (CCA). The use of CCA-impregnated wood is now strictly limited, but arsenic and chromium leach out of wooden structures predating the limits. Rebuilding all such structures is seldom cost-effective. Current waste management systems and procedures are considered adequate for environmentally responsible handling of waste containing CCA-impregnated wood.

Emissions of *polycyclic aromatic hydrocarbons* (PAH) fell by 46% between 1995 and 2007 due to modernisation of aluminium production processes. Diffuse emissions from residential heating with biofuel and wood, and from traffic, are expected to be the largest type of PAH emissions in 2010.

The country has set targets and drawn up development plans for reduction of *persistent organic pollutants* (POPs) and other persistent and bioaccumulative chemicals. The *Norwegian List of Priority Substances* contains the 12 POPs originally listed in the Stockholm Convention and some of the nine POPs added to the convention in 2009. Norway has been active in the Nordic monitoring programmes for potential new POPs, and in successful work towards the addition in 2009 of the flame retardant penta-BDE to the Stockholm Convention and the Convention on Long-range Transboundary Air Pollution. KLIF conducts yearly screening of the distribution of selected emerging pollutants in the environment, and in 2009 identified three brominated fire retardants and four polyfluorinated compounds as being of concern (KLIF, 2010f).

Norway continues to work towards further reduction of the use of hazardous substances, drawing up proposals for *additional substances to be eliminated by 2020* (MoE, 2006a). It is also focusing on improving data collection on such substances through the Product Register (Box 3.1). A multi-stakeholder committee was established and studies were commissioned, to be completed by 2011.

5. Contaminated sites

Norway has built its wealth on rapidly growing industrial development, but with this has come a legacy of *contaminated sites and contaminated sediments*.

Over 3 500 sites where the *ground is believed to be contaminated* have been identified. Clean-up operations at old landfills containing hazardous waste and industrial sites polluted with hazardous chemicals have been carried out for decades. Such efforts continued over the review period, focusing on 600 of the most contaminated sites. Out of the 100 most heavily polluted sites, scheduled to be cleaned up by the end of 2005, 83 were decontaminated before the target date and all have now been remediated. Of the 500 sites in the next most serious category, 166 had been remediated by 2009 and 334 awaited decontamination. Around 60% are industrial sites and 40% are old landfills.

A *nationwide database of contaminated sites*, including contamination and clean-up history, is available to the public. At the municipal and county levels, however, funding for monitoring, enforcement and technical expertise may be insufficient to allow proactive management and prevention of development on contaminated land.

After discovery of *contaminated soil at day-care centres, playgrounds and schools*, an action plan was announced in 2006 (SFT, GNU, 2007). Investigations of almost 2 000 day-care centres in the ten largest towns and five most polluted communities were completed in 2008. These confirmed contamination by lead, PAH (benzo(a)pyrene), arsenic and, at some sites, PCBs and mercury. The contamination was due to industrial activities, road traffic emissions and the use of contaminated soil in landscaping and CCA-impregnated wood for sandboxes. Although the concentrations were not so high as to pose an acute health hazard for children, actions were recommended to remove polluted soil or impregnated wood in nearly 70% of the centres investigated. Contaminated surface soil and CCA-impregnated sandbox frames were to be removed by summer 2010.[26]

Serious *contamination of marine sediment* has been found in more than 120 areas classed as hazardous for fish and shellfish harvest. They include areas receiving run-off from old shipyard sites, which typically contains high contaminant levels from sandblasting of PCB paint, and from fire training grounds, which may contain fluorobrominated compounds and PFOS. In response, restrictions were placed on the consumption of fish and fishery products

in 24 fjords and harbours covering 820 km^2. The cost of preventing further deterioration was estimated at USD 1.1 billion, and that of improving the situation to a level that poses no danger to the ecosystem was put at USD 3.5 billion (Breedveld *et al.*, 2009).

The MoE has identified the clean-up of contaminated coastal, fjord and harbour sediment as a top priority for the reviewing period and beyond. In 2001, a *strategy for addressing contaminated sediment* was put forward (MoE, 2001). As a follow-up, the ministry appointed a Norwegian Council on Contaminated Sediments in 2003 to identify gaps in knowledge and to make recommendations to the environmental regulators on sediment management. Pilot projects were launched for 17 fjord and harbour areas. KLIF began monitoring environmentally hazardous substances in sediment and in marine organisms. By 2005, all priority coastal areas had drawn up county action plans and begun implementing them (MoE, 2006b). Progress has varied among the sites; for example, remediation has been completed in Oslo's harbour, but in others, such as that of Stavanger, contamination is still spreading.

As *remediation projects are complex and costly*, the methods used need to be sustainable and provide assurance that the investment required will result in long-term improvement. Reducing impacts on human health, cost-effectiveness and the adaptation of measures to the local conditions are therefore key issues. The Oslo harbour remediation project drew considerable interest from non-government organisations and local interest groups, albeit mainly after the remediation had begun. Stakeholders need to be involved at an early stage in the development of remediation plans to ensure that all aspects are considered before decisions are made.

Notes

1. Some caution is needed in interpreting waste data due to the use of different national definitions and changes in some estimation methods during the review period.
2. White papers on the Government's Environmental Policy and State of the Environment, issued every two years, present the main elements and priorities in Norway's environmental policy and report on trends in eight priority areas (Chapter 3).
3. The Norwegian list of dangerous substances records some 3 500 substances that may lead to serious harm to human health and ecosystems when accumulated in the environment and in food chains. The list was drawn up according to Annex 1 to the EU Directive on Dangerous Substances (67/548/EEC).
4. In comparison, the population of Norway grew by 8% over the review period.
5. Until 2004, the Pollution Control Act referred to "consumption" and "production" waste, and attributed all consumption waste to municipalities regardless of its origin. The classification was changed in 2004 into "household" and "industrial" waste, and while household waste is still attributed to municipalities, the term "municipal" waste is no longer used.
6. The "sent for recovery" category comprises incineration (only incineration with energy recovery is included), recycling and composting. Analysis of municipal data for 2009 shows that 40% of household waste goes to incineration (32% mixed and 8% sorted; not all waste incineration is used to generate energy), 36% is recycled, 12% landfilled and 10% subjected to other treatment, while 2% is exported.
7. Inert-waste landfills are exempt from these requirements.
8. Sweden's full-scale waste incineration plants with district heating require high utilisation rates to run properly. Given this fact plus the higher electricity prices in Sweden and higher incineration costs in Norway, there is more incentive to export waste than to use it in Norwegian incineration plants.
9. A drop in imports recorded in 2007 probably reflected inadequacies in reporting.
10. The costs were expected to include collection of up to 400 kg of hazardous waste annually per household.

11. Revenue from waste fees must not exceed the cost of the service to the municipality. Municipalities are allowed to subsidise water and wastewater service by retaining a portion of the fees and providing service at below-cost prices.
12. User-pays fees, if averaged to a general charge, do not give clear information to the waste generator, in contrast with volume or weight based "pay-as-you-throw" systems.
13. Coverage rates nationwide in other categories are lower (*e.g.* glass 12%, metal 10%, hazardous waste 10%, WEEE 5%).
14. To facilitate operations of the various programmes and facilitate exchange of experience, producer responsibility organisations have formed a common platform called LOOP that aims to inform consumers, industry and commerce of the benefits of recovery and recycling. LOOP publishes newsletters and a website (*www.loop.no*) and runs information projects targeting schools, local government, industry and commerce.
15. The tax was also applied to recovered TRI and PER and products containing more than 1% TRI and/or 0.1% PER.
16. In 2006, methane emissions from landfills accounted for about 30% of Norway's total methane emissions and 2.5% of its aggregate greenhouse gas emissions.
17. The share is estimated at 84% if waste undergoing "unknown handling" is included in the hazardous waste total.
18. Out of 1 824 facilities, 274 hold permits under the EU Integrated Pollution Prevention and Control Directive.
19. The amount is determined by comparing estimated waste generation volumes with actual waste deliveries to approved treatment facilities.
20. The tonnage is recorded when the waste is received by approved facilities.
21. Økokrim, the Norwegian National Authority for Investigation and Prosecution of Economic and Environmental Crime, was established in 1989 under the Ministry of Justice (Chapter 3).
22. The substances were short-chain chlorinated paraffin, nonyl- and octylphenol and their ethoxylates, pentachorophenol, certain surfactants (DTDMAC, DSDMAC and DHTMAC) and PCBs.
23. The substances include the brominated flame retardants penta-BDE, octa-DBE, deca-BDE, HBCDD, TBBPA; additional chlorinated paraffins; arsenic, lead, cadmium and their compounds; organic tin compounds; musk ketone and musk xylene; perfluorinated compounds; the surfactants DODMAC/DSDMAC and DHTDMAC; bisphenol, diethylhexylphtalate (DEHP); and triclosan.
24. "Substantially reduced" was defined as reduction of 50-90% from 1995 release levels. Reductions of 80-100% had been achieved for DEHP, EDC, HCB, PER, TBT, TCB, TRI and medium-chain chlorinated parafins. Reductions of 50-80% had been achieved for dioxins, Cd, CABs, and Hg.
25. Despite these and earlier bans, PCBs remain widespread in older building fixtures (sealant, filler, cement, paint, windows, lighting ballasts, electricity lead-ins, motorised appliances). A 2009 study estimated that 72 000 insulating window units containing PCBs were still in use. PCB waste identification and removal rules for building demolition and renovation were developed in consultation with business and labour organisations, and hazard management plans have been mandatory since 2008.
26. CCA-impregnated wood elsewhere is required to be varnished with oil every other year until it can be removed.

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