6 WASTE AND WASTE WATER MANAGEMENT IN TOURIST ACCOMMODATION

Tourism and waste generation

Tourism is responsible for a small share of waste generation within Europe, contributing towards the 6.7 % of total waste generation that arises from the wider services sector in the EU-27 (EEA, 2010). Nonetheless, the quantities of solid waste generated by tourism enterprises are large in absolute terms – 35 million tonnes of solid waste per year globally (Conservation International, 2003) – and the types of waste generated are associated with greater environmental impacts than bulky and often inert wastes from the construction and mining sectors that dominate waste generation statistics.

Tourists may generate up to twice as much solid waste per capita as local residents (IFC, 2007). Waste from accommodation has similar characteristics to mixed household waste, being composed of a diverse mix of materials, including organic and hazardous materials, that can give rise to significant environmental impacts upon disposal (especially through GHG emissions and leaching of toxic materials). Accommodation and restaurants are major contributors to packaging waste (Eurostat, 2010), including plastics and metals with high embodied energy that are responsible for significant resource depletion upon disposal. Furthermore, tourism waste often varies seasonally, and is generated in areas sensitive to littering, potentially putting pressure on waste management facilities during peak season and damaging high nature value resources. Plastic waste in the oceans poses a threat to whales, dolphins, sea turtles and birds.

Accommodation waste sorting

Waste generation and sorting varies considerably across hotels (Figure 6.1), and other types of accommodation. Waste sorting partly depends on the waste collection services available in different locations, and this may partly explain the large differences in unsorted waste generation across hotels within the same hotel chain but in different countries (Figure 6.1).

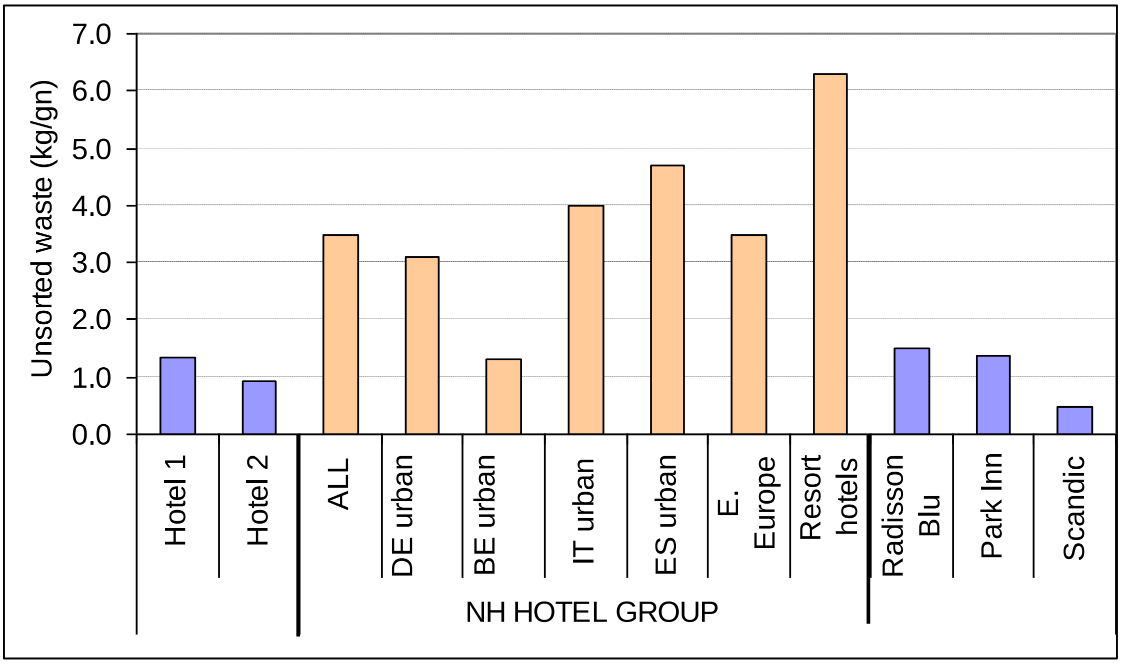
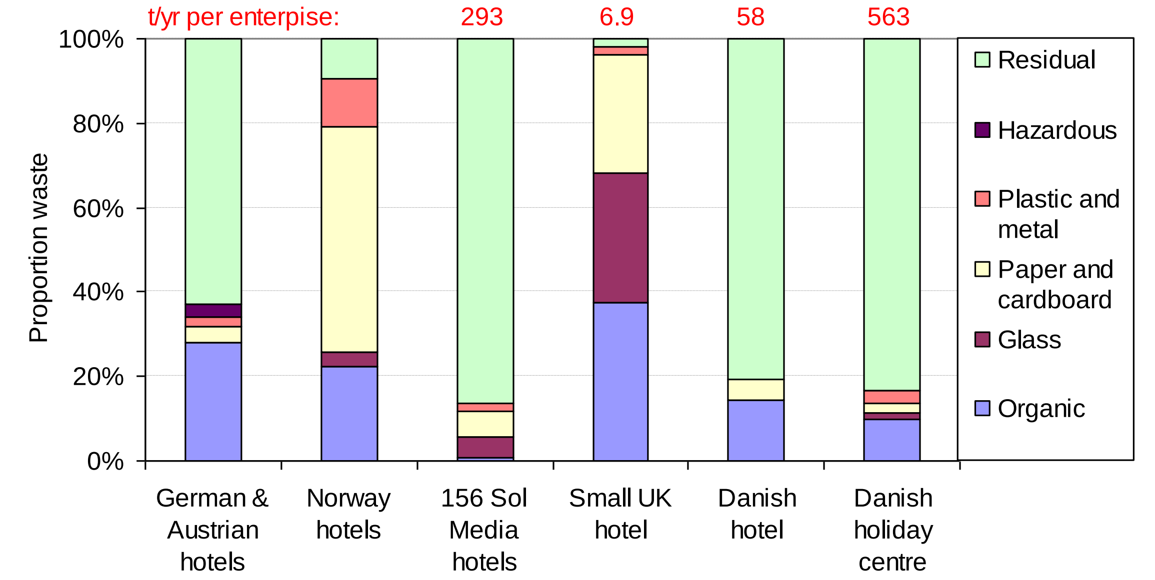


Figure 6.1: Unsorted waste generated per guest-night across different groups and types of hotel, from sustainability reports

The composition of waste from accommodation establishments is similar to household waste, but varies somewhat depending on the services offered. Hotels with restaurants have a higher share of organic waste. Classification of waste varies according to sorting, but organic, glass, paper and cardboard and plastic and metal are the main fractions (Figure 6.2). For many hotels with poor sorting, residual waste is the dominant fraction.



Sources: Ecotrans (2006); SFT (1998); Sol Media (2011); Envirowise (2008); Miljøstyrelsen (2000).

Figure 6.2: Composition of waste for accommodation enterprises reported by different sources

Waste management hierarchy

Figure 6.3 displays priority actions for resource efficiency and waste management, with actions relevant for accommodation managers highlighted. Priority actions relevant to accommodation managers are summarised below.

1. **Reduce:** Create as little waste as possible by not producing it to begin with – implement green procurement, do not over-order, select products with little packaging or returnable packaging.
2. **Reuse:** Consider where certain items can be reused, sold or donated to others that can use them.
3. **Sort:** Have a system in place for sorting everyday waste items such as bottles, cans, cardboard and paper for recycling. Consider what else might be recycled, taking into account local disposal possibilities.
4. **Recycle:** Send sorted waste for recycling.

Source: Derived from EC (2011).

Figure 6.3: The waste management hierarchy, with priority actions at the top

Driving forces for waste management

Various regulations are relevant for waste management in the tourism sector. Accommodation enterprises generate, store, and in some cases trade waste. European legislation relevant to accommodation providers with respect to waste management is listed below.

- Directive 2008/98/EC on waste and repealing certain directives.
- Decision 2000/532/EC establishing a list of hazardous wastes.
- Directive 2002/96/EC on waste electrical and electronic equipment.
- Regulation 1774/2002 laying down health rules concerning animal by-products not intended for human consumption.
- Directive 75/439/EEC regarding disposal of waste oils.
- Directive 94/62/EC on packaging and packaging waste and the amendment of Directive 2004/12/EC.
- Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators.

Other regulations are relevant for local authorities and waste management companies. These include Directive 99/31/EC on landfill of waste and Directive 2000/76/EC on waste incineration.

There are also strong economic incentives for minimising waste. For many types of waste, such as packaging, accommodation pays twice for it: at purchasing and at disposal.

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6.1 Waste prevention

Description

The first step in waste prevention and management in accommodation is to generate an inventory of the types and sources of on-site waste generation. Waste generated by accommodation is diverse, with a similar composition to domestic (municipal) waste, and comprises paper and cardboard items, glass and aluminium products, plastic items, organic waste, building materials and furniture, and used oils and fats (see Figure 6.2 in section 6). The Danish EPA conducted a waste survey of all service sector operations in Denmark in 2000, including accommodation facilities, and conference and course centres (Table 6.1). Hotels were generally found to sort into four main waste types: ordinary (residual) waste, bottles and other glass jars, organic waste and cardboard packaging.

Table 6.1: Typical waste constituents from different types of hotel, according to Danish waste classification

Hotels with restaurants	Holiday centres
– mixed waste for incineration – batteries – waste with household characteristics – bottles and glass – garden and park waste – iron and metal – organic waste – fluorescent tubes – cardboard waste – paper – plastic packaging – machines – equipment and furnishings – refrigerators – electric and electronic products	– mixed waste for incineration – batteries – waste with household characteristics – bottles and glass – garden and park waste – iron and metal – organic waste – fluorescent tubes – cardboard waste – paper – plastic packaging – machines – equipment and furnishings
Source: Miljøstyrelsen (2000).	

Table 6.2 presents the results from a more recent analysis of waste management in 36 hotels in the 2- to 4- star categories in Germany and Austria. Total waste generation averaged 1.98 kg (6 litres), per guest-night. Plastic and metal comprised a relatively small proportion of overall waste in this survey, but this may reflect low separation rates for these materials. The classification of waste in accommodation depends on the degree of sorting, and 'residual' classification is typically applied to a large proportion of waste where sorting rates are low. Waste types and quantities from accommodation depend on the services offered, especially in relation to food and beverage services.

Table 6.2: Waste percentages from Survey among German and Austrian hotels

	Residual	Paper	Glass	Plastic and metal	Organic
kg	49 %	12 %	6 %	2 %	31 %
Litre	55 %	23 %	5 %	8 %	9 %
Source: Ecotrans (2006).					

Hazardous wastes may include batteries, solvents, paints, antifouling agents, some packaging wastes, leftover insecticides and pesticides, leftover chlorine and hydrochloric acid from swimming pool operations, and de-icing chemicals. Generally the amount of hazardous waste resulting from hotel operations is small. Commission Decision 2000/532/EC lists how hazardous waste, including electronic equipment, shall be separated, collected and disposed of. Directives 2002/96/EC and 2002/95/EC of the European Parliament and the Council specify hazardous waste types affected.

A large portion of accommodation waste can be readily eliminated from the waste stream through prevention measures and recycling (section 6.2), informed by a site-specific waste inventory. An effective waste management programme can usually reduce the volume of waste sent to landfill or incineration by more than 50 % (Travel Foundation, 2011). Waste management programmes also save money by improving the use of materials and resources, and by lowering waste disposal costs. Senior management and procurement staff, housekeeping staff, catering staff and reception staff must be fully involved with waste management programmes to ensure effective implementation of prevention measures (Table 6.3).

Following the creation of a waste inventory, waste prevention and minimisation are the first priority steps in waste management and resource efficiency (see Figure 6.3 in section 6). There is considerable scope to prevent waste in the accommodation sector by taking a number of actions across different departments (Table 6.3).

Table 6.3: Best practice measures to prevent and avoid waste

Department	Measure	Description
All (management led)	Develop waste inventory	Survey all areas and processes to identify types and sources of on-site waste generation
Procurement	Efficient ordering and storage	Order perishable products frequently in quantities required. Store perishable products in appropriate conditions (e.g. correctly adjusted refrigeration units: section 8.4). Order non-perishable products in bulk
	Local sourcing and packaging return	Source food locally where appropriate, and return packaging for reuse (see also section 8.1)
	Select low packaging products	Select products with less packaging where possible and consistent with other green procurement criteria (section 2.2) – e.g. purchase chemicals in concentrate form
Housekeeping	Efficient bathroom toiletries	Replace individually wrapped soaps and shampoos with soap and shampoo dispensers. Provide additional toiletry items only on request
	Efficient housekeeping	Avoid use of bags in bins, or where used, replace only when soiled
Catering	Provision of low impact drinking water	Avoid bought-in bottled water where possible. Provide guests with tap water in rooms and dining area (may be filtered and bottled), and provide reusable glasses for drinking
	Efficient breakfast provision	Avoid single-portion servings as far as possible within hygiene constraints, and cook to order (see also section 8.1). Avoid single-use plates, cutlery, etc.
Reception	Efficient document management	Print documents only when absolutely necessary, double-sided in small font. Use electronic billing.

Packaging alone can account for up to 40 % of a hotel's waste stream (Travel Foundation, 2011), and avoiding single-use and individually wrapped items can prevent a considerable quantity of waste. The quantity of packaging is a relevant criteria for green procurement decisions, and it may be possible to return packaging to local suppliers for reuse – such practices may be negotiated with suppliers where they are not already offered. Procurement of concentrated products (e.g. chemicals) can also reduce packaging requirements, as can buying in bulk where appropriate, and avoiding over-ordering of perishable products. Accor (2007) estimated that just 30 % of individual hygiene products provided to guests are used, leading to considerable product waste in addition to packaging waste. Installation of soap and shampoo dispensers is one effective and economic measure to reduce waste. Similarly, there is often scope to reduce individually wrapped portions provided for breakfast, and to install tap-water dispensers (with filtration and bottling systems where necessary) to reduce the purchase of bottled water. Provision of information electronically, including electronic invoices and newspapers, instead of hard copies, can significantly reduce paper waste.

Achieved environmental benefit

Environmental benefit by waste type

Preventing waste is associated with multiple environmental benefits arising from avoided production and transport of products, and reduced handling and land-filling or incineration of waste. Preventing waste reduces the following environmental pressures:

- resource depletion
- land occupation
- soil contamination
- water pollution
- air pollution
- GHG emissions.

Table 6.4 indicates the magnitude of GHG emissions prevented by avoiding different types of waste.

Table 6.4: GHG emissions avoided per kg of different types of waste avoided

Material	Glass	Board	Wrapping paper	Dense plastic	Plastic film
kg CO_2	0.92	1.60	1.51	3.32	2.63
Source: WRAP (2011).					

Accommodation premises savings

Figure 6.4 demonstrates the magnitude of waste avoidance achieved by a single average-performing 189-room hotel. A 30 % reduction in total (sorted plus unsorted) waste generated per guest-night over a period of five years translated into a reduction of 35.7 tonnes per year of waste sent for disposal.

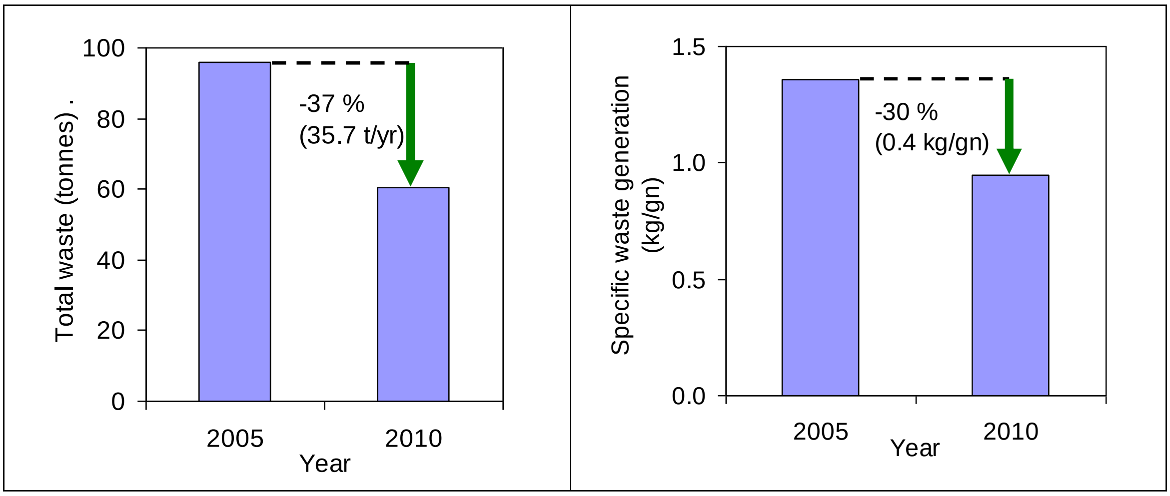


Figure 6.4: Trend in total (left) and specific (right) unsorted waste generation for a 189-room hotel between 2005 and 2010

Meanwhile, a reduction of waste generation per guest-night from the median of the 135 hotels displayed in Figure 6.5 (1.05 kg/guest-night) to the best-performing tenth percentile (0.59 kg/guest-night) would represent a 44 % reduction in the environmental pressures listed above associated with production and disposal of waste products. Thus, implementation of waste prevention measures could easily lead to a reduction in waste-incurred environmental impact of 30 % to 50 % for average hotels and other accommodation.

The Scandic Hotel group found that only 15 % of individual soaps and shampoos provided to guests were used. Following the installation of soap and shampoo dispensers and associated bulk buying (see Figure 6.7), Scandic Hotels reduced waste volume by 40 %, including a reduction of 11 tonnes per year in packaging waste.

In relation to bottled water alone, an estimated 2.7 million tonnes of plastic are used to bottle water globally each year, and 25 % of bottled water is exported across national boundaries (EEA, 2010). In addition to environmental pressures arising from production and disposal of the plastic (e.g. non-renewable resource depletion), transport of bottled water incurs environmental pressures including energy consumption, GHG emissions, air emissions and congestion, compared with minor pressures arising from the piped transport of drinking water from treatment works to consumers' taps (EPI, 2007). By replacing bottled water with filtered tap water provided in reused glass bottles, one 65-room five-star hotel in London avoids the purchase and disposal of 500 000 plastic bottles of 200 ml capacity and 200 000 plastic bottles of 1 L capacity, and 205 tonnes of glass bottle, every year (Rafayel Hotel, 2011).

Appropriate environmental indicator

Indicators

The total quantity of waste generated per guest-night is the most appropriate indicator of the intensity of waste generation, and the effectiveness of accommodation management measures to reduce it. To specifically reflect waste **avoidance**, sorted fractions sent for recycling should also be included in total waste generation. The density of waste varies considerably depending on the type and the degree of compaction. Therefore, the **weight** of waste generated is a more reliable indicator of performance in waste avoidance than the **volume** of waste generated, and one aspect of best practice is to monitor and record all waste generation by weighing waste fractions. In the absence of weighing, waste quantities may be expressed by volume, easily estimated from the number of waste receptacles (e.g. bins, skips) filled every day, week or month. The weight of waste may be estimated from (non-compacted) volumes according to estimated densities (Table 6.5).

Table 6.5: Average density of non-compacted waste fractions from different establishments

Type	Card	Paper & card	Mixed glass	Mixed recycling	Food	Metal	Mixed plastic	Mixed waste	B&B	Hotel	Hotel & restaurant	Pub
Density (kg/L)	0.03	0.08	0.27	0.06	0.52	0.05	0.05	0.1	0.079	0.05	0.064	0.1

Source: ITP (2008); WRAP (2011).

Benchmark of excellence

Figure 6.5 displays the range of total waste generation (sorted plus unsorted) performance across hotels in a mid-range European hotel chain, based on aggregated monthly data for 2010. The median rate of waste generation across hotels in this chain is 1.05 kg per guest-night. Based on the top tenth percentile of hotels in this chain, the following benchmark of excellence is proposed:

BM: total waste generation (sorted plus unsorted) of ≤0.6 kg per guest-night.

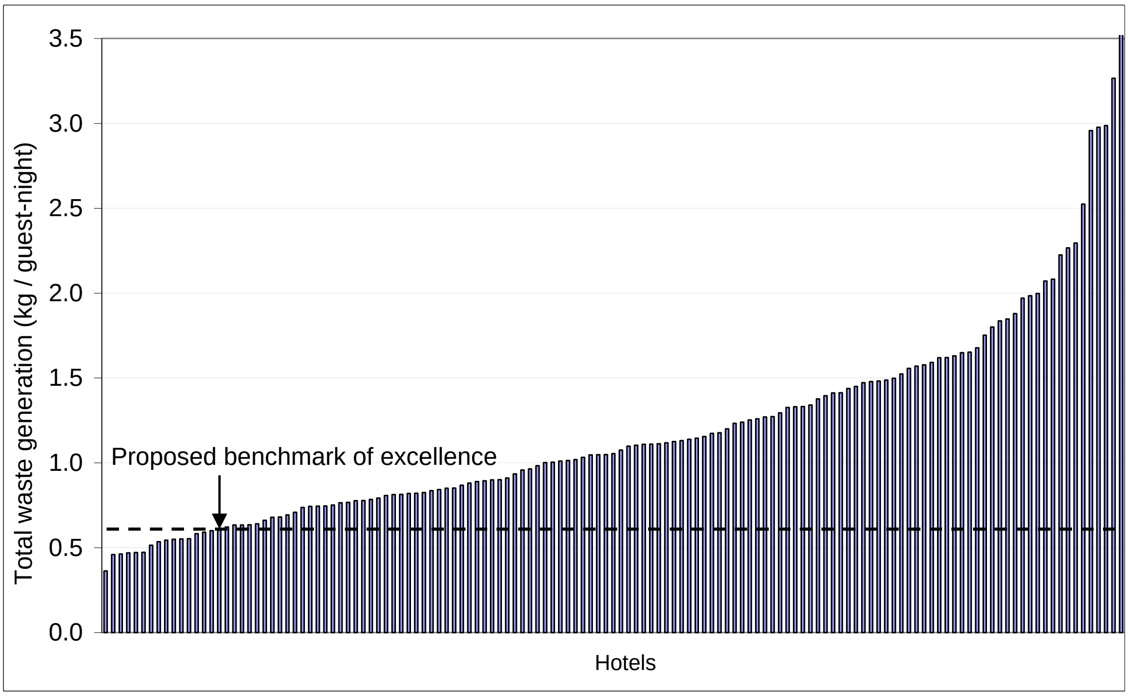


Figure 6.5: A distribution curve for total waste generation (sorted and unsorted fractions) from 135 hotels within a mid-range European hotel chain

Cross-media effects

Preventing waste is often associated with significant and multiple upstream, as well as downstream (i.e. waste disposal) environmental benefits.

One aspect where some care may be required is packaging minimisation. When considering the quantity of packaging in product selection, it is important to ensure that the risk of product spoiling is not increased, as this could more than offset any reduction in packaging waste. Also, product packaging is one criterion that should be considered alongside other, often more important, lifecycle environmental criteria (e.g. production method, use efficiency) when selecting environmentally responsible products.

Operational data

Useful guidance on waste prevention has been compiled on a European Commission website dedicated to the subject: http://ec.europa.eu/environment/waste/prevention/index.htm.

Firstly, it is useful for accommodation managers to generate an inventory of all the waste arising in different parts of the premises, and possible measures to prevent or reduce this waste. The main areas of waste generation are:

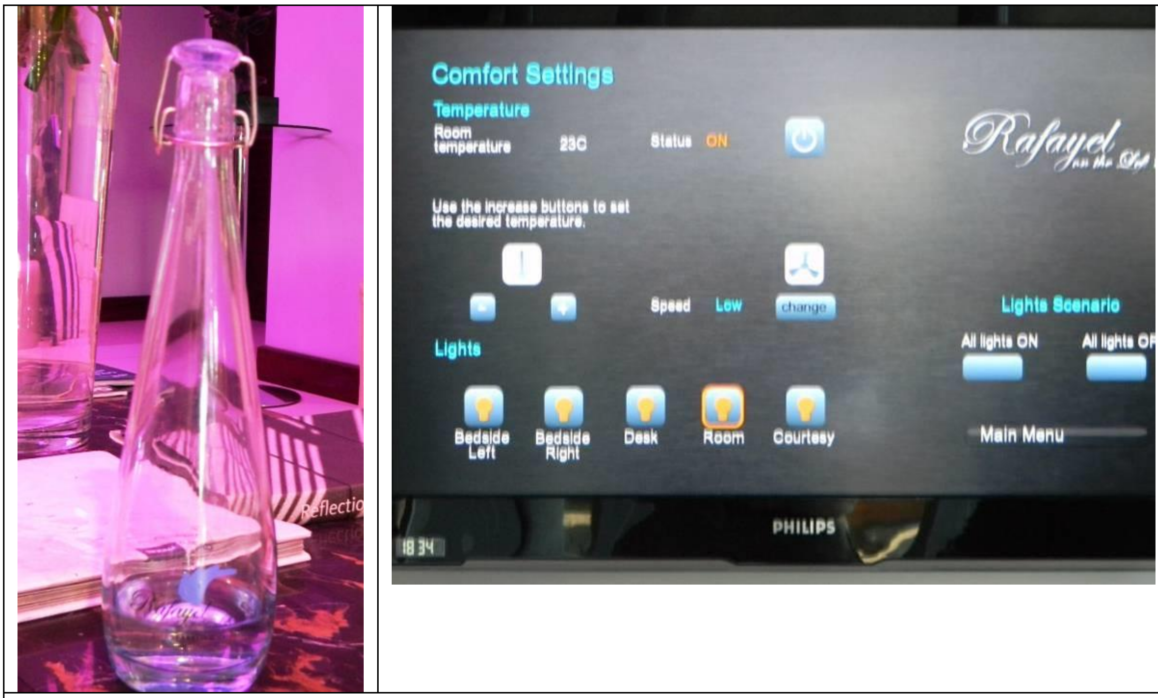
– guest rooms
– kitchen (see section 8.2 for organic waste management)
– bar area
– housekeeping stores.

A once-off survey may be performed to generate such an inventory, also identifying sources (e.g. packaging of specific products).

It is also important to regularly monitor and record the total quantity of waste sent for recycling or disposal, ideally following separation into fractions as defined in the subsequent section (section 6.2): organic, glass, paper and cardboard, plastics, metals, electrical items, hazardous wastes. The cost associated with disposal and recycling of these factions, based on local rates, can be calculated in order to indicate the achievable cost savings. Costs associated with excess purchasing should also be considered.

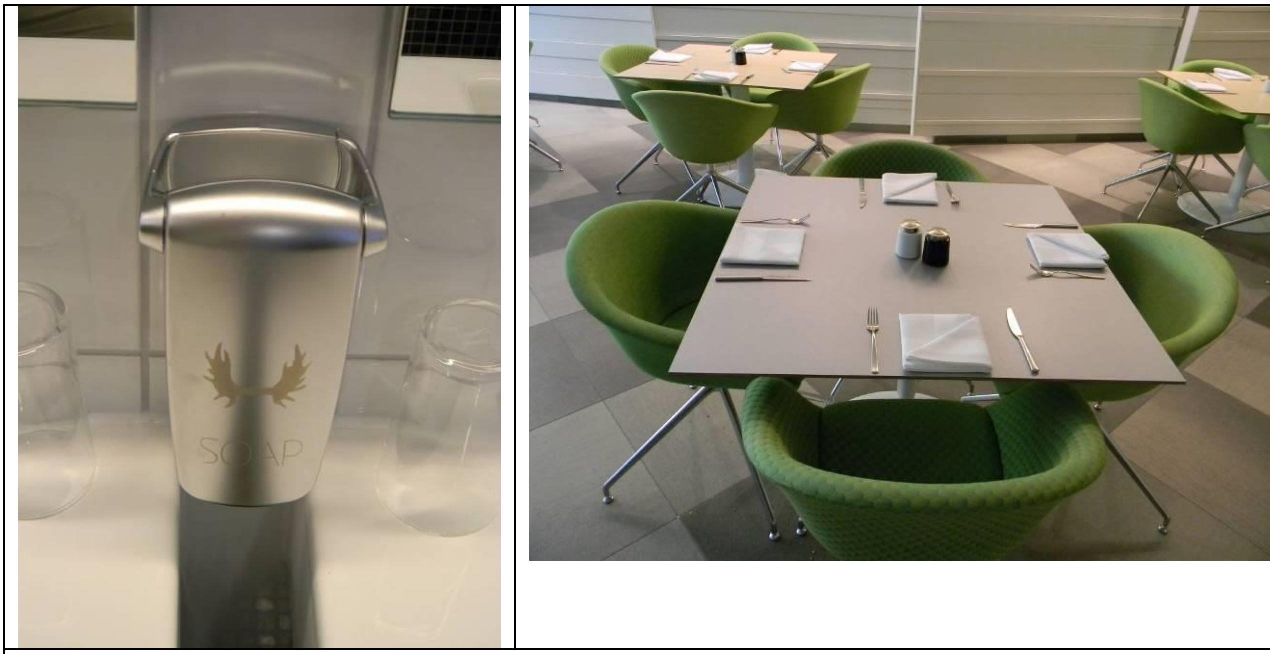
As an example, the Rafayel Hotel in London provides electronic newspapers for guest viewing on large TV screens in rooms, and has a 'no plastics' policy. Guests are provided with water filtered in-house and served in reusable glass bottles (Figure 6.6), using Vivreau bottling technology.

Many hotel chains use refillable soap dispensers (Figure 6.7), and a considerable amount of waste can be avoided by using reusable, or better still no, table cloths and place mats, and by using refillable condiment and other food containers.



Source: Rafayel Hotel (2011).

Figure 6.6: Reusable glass bottles for filtered tap water, and entertainment screen in rooms on which newspapers can be read, in a luxury hotel



Source: Scandic Berlin (2011).

Figure 6.7: Refillable soap dispenser, and tables set without tablecloths, and with reusable napkins and refillable condiment containers

Table 6.6: Summary of items to avoid, items to select and actions to prevent waste in accommodation

Avoid	Select	Do
– bought-in bottled water – single-use hygiene products – single-portion food products – disposable plates, cups and cutlery – excessive use of paper napkins – items with unnecessary or excessive packaging – offering newspapers and magazines	– refillable amenity dispensers in guest bathrooms – food sold in bulk packaging where appropriate – cloths instead of disposable paper towels – durable coasters instead of paper ones – electrical resistance or refillable burners instead of disposable heating fuel cartridges for buffet lines – cloth bags or baskets instead of plastic bags to collect and return towels, linens and guest laundry – refillable printer and copier cartridges – rechargeable batteries	– provide guests with filtered tap water – provide guests with reusable glasses and cups in rooms – put condiments and food servings in refillable containers – purchase chemicals in bulk and dispense them from refillable pump bottles or containers – give preference to vendors that supply their products in returnable and reusable containers – minimise the use of hazardous chemicals (e.g., drain cleaning chemicals, solvents and bleach) – provide electronic information and newspapers – print double sided – collect outdoor waste in canvas bags, wheelbarrows or carts rather than in disposable plastic – identify reuse possibilities
Source: ITP (2008); Travel Foundation (2011).		

Accommodation managers may be able to influence suppliers to reduce packaging, or to use returnable and reusable packaging (e.g. Gavarni Hotel Paris, Strattons Hotel UK). However, packaging is just one of many sustainability criteria relevant to green procurement. Green procurement selection should be informed by identification of product-specific environmental hotspots, and products that perform well across these hotspots (section 2.2; section 8.1). One effective method to reduce packaging from existing suppliers, or new suppliers selected according to non-packaging-related green procurement criteria, is to return all packaging to them (Green Hotelier, 2011).

Applicability

Some hotel groups prefer to provide guests of higher classification hotels in certain countries with individually-wrapped single-use hygiene products, citing customer expectations in those countries (e.g. NH Hoteles, 2011). Nonetheless, effective waste prevention and avoidance can be implemented by all types of accommodation, including high end luxury hotels – as demonstrated by the example of the five-star Rafayel Hotel in London.

Economics

Replacing single-use products with durable alternatives can often generate substantial cost savings. For example, replacing disposable heating fuel cartridges with electric resistance elements in a buffet line of 10 chafers (water vessels for heating food) avoids the purchase of EUR 11 400 per year of disposable cartridges (Travel Foundation, 2011).

The Ascos Beach Hotel in Paphos, Cyprus, invested EUR 867 to purchase 3 000 reusable plastic cups to replace disposable plastic cups, and stopped using plastic bin liners in guest rooms. In the first year of operation, the disposal of 100 000 plastic cups was avoided, saving almost EUR 2 000, and 50 % fewer bin liners were disposed of, saving a further EUR 300. Guest satisfaction was not affected (Travel Foundation, 2011).

Driving force for implementation

Legislation is an important driver for preventing and managing waste. Some relevant legislation is listed in section 6, and on the European Commission's waste prevention website: http://ec.europa.eu/environment/waste/prevention/index.htm. In particular, the Waste Framework Directive (2008/98/EC) is an important driving force.

Waste prevention is closely related to resource efficiency and cost reductions. Avoiding excess products and packaging can reduce purchasing costs and disposal costs. The cost of waste disposal has increased sharply in most European countries over the past decade, and is likely to continue increasing owing to escalating landfill and incineration taxes.

In summary, the driving forces to prevent waste are:

- environmental responsibility
- legislation
- waste disposal costs
- waste handling costs
- excess product costs (partially used products and unnecessary packaging).

Reference companies

Gavarni Hotel Paris (FR), Strattons Hotel (UK), Rafayel Hotel (UK), Scandic Hotel group.

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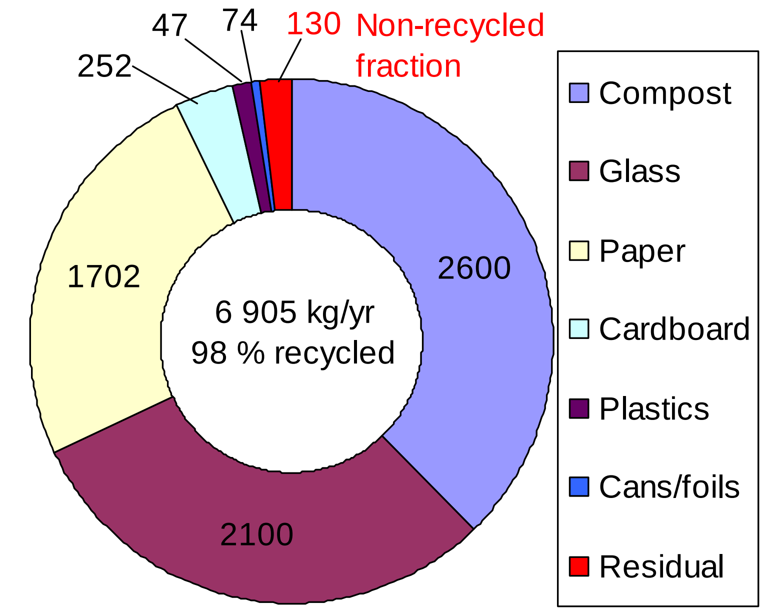
6.2 Waste sorting and sending for recycling

Description

On average, hotels generate approximately one kg of unsorted waste per guest per night (ITP, 2008), equating to 66 tonnes per hotel per year in the UK (WRAP, 2011). Waste disposal costs are likely to increase steadily in the future due to diminishing landfill space and increasing collection and disposal costs. Poor waste management has implications for hygiene and health, environmental quality, resource and economic sustainability. As outlined in section 6, a multitude of regulations pertain to waste management and handling, including local, national and European waste regulations, health and safety regulations in relation to waste handling, noise regulations in relation to compaction and collection operations (Waste Management World, 2011). The largest waste fractions generated by hotels are glass, organic, cardboard and paper, metals and plastics. Organic waste originates mainly from kitchen activities, for example preparing breakfast and meals for in-house restaurants. Best practice for organic waste management is described in section 8.2, in the chapter addressing kitchens. Meanwhile, economic factors are driving widespread glass recycling, with a similar situation evolving for cardboard and paper fractions. This section therefore focuses on best practice for the management of non-organic waste, and especially plastic waste, arising in accommodation.

Hotels face a range of barriers to sorting and recycling their waste. They are to some extent limited by the waste management infrastructure in their locality, often owned and operated by the local authority, especially if they are not able to find other takers for waste fractions that the local system does not accept. In city hotels, available ground floor space may constrain the storage of multiple bins for separated waste fractions – front-of-house areas such as reception, lobby, restaurant and banqueting facilities are prioritised for ground floor space. However, experience shows that there are many innovative means of sorting and recycling waste in accommodation, in the process reducing disposal costs. Figure 6.8 presents an example of the high sorting and recycling rates achievable by best performers, summarising data for a small UK hotel where 98 % of waste is recycled. Interesting aspects of the hotel's waste minimisation strategy include the reuse of clear bottles in the kitchen and return of food and drink packaging for reuse by local suppliers.



Source: Envirowise (2008).

Figure 6.8: Sorted waste fractions recorded and recycled in a small 14-room boutique UK hotel and restaurant

As described in section 6.1, a relevant starting point for waste prevention, sorting and recycling is to record on-site waste generation by category and source. In addition, it may be necessary to perform or organise a study exploring local reuse and recycling options (Table 6.7). As outlined in Figure 6.3 (section 6), where possible, opportunities for product reuse should be sought before waste is sent for recycling. These may be on site or off site, and include options such as returning packaging to suppliers. Implementation of a successful waste sorting and recycling programme requires engaged management to coordinate technical and human resource requirements across all departments, including relevant staff training and time allocation (Table 6.7). In particular, staff should receive clear instructions on what types of waste are to be sorted and how, with specific responsibilities assigned. On-going monitoring and reporting of waste quantities should be monitored and reported so that recycling rates and unsorted waste disposal can be benchmarked to track progress. Consequently, hotels should seek to integrate waste management into an overall EMS (see section 2.1).

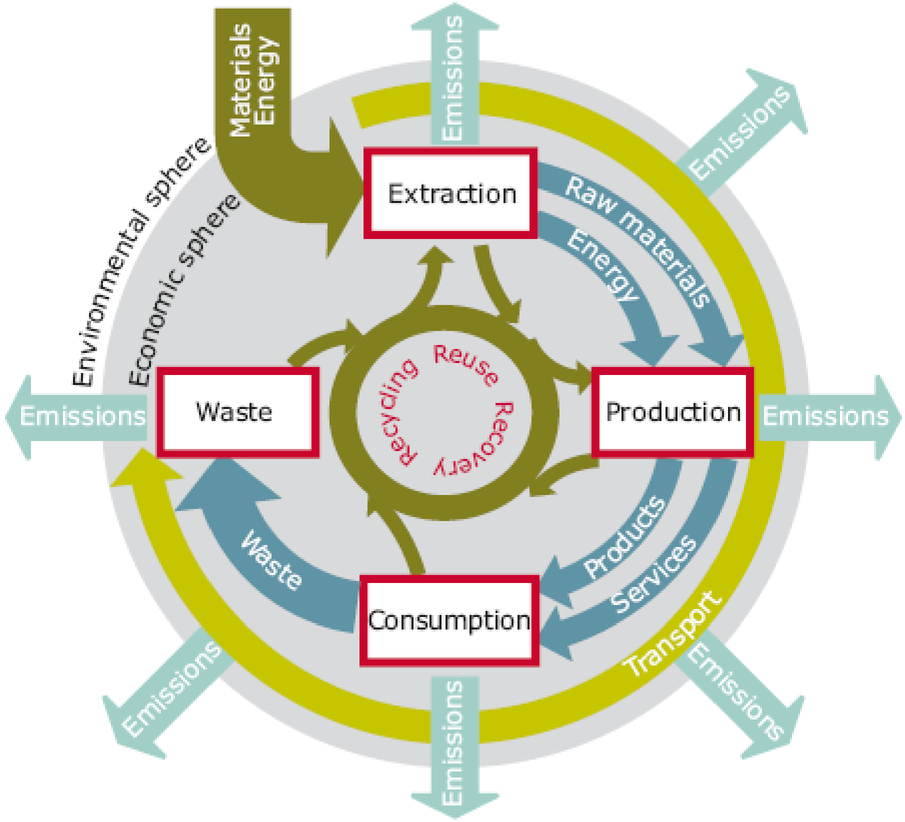
Table 6.7: Best practice measures to separate and recycle waste

Department	Measure	Description
All (management led)	Develop waste inventory and identify options	Survey of all areas and processes to identify types and sources of on-site waste generation. Identify waste recycling and packaging return options available locally
	Monitoring and reporting	Continuously monitor and periodically report waste generation and collection by fraction
Procurement	Procurement selection	Select products and packaging made from recycled and recyclable material
Housekeeping	Waste bins	Install separated waste collection bins in rooms
	Waste collection in rooms	Separate waste during room cleaning into fractions collected separately from accommodation premises
	Back-of-house waste management	Separate waste arising from public areas, maintenance of outdoor and indoor facilities, and other back-of-house areas into appropriate fractions for recycling and correct disposal
Catering	Green procurement	Consider packaging volume, production impact and recyclability when assessing products for green procurement (see section 8.1)
	Separation	Install and train staff to use conveniently located bins for separate collection of glass, plastics, and paper and cardboard in kitchen and dining areas. See section 8.2 for separate organic collection
Reception and public areas	Collection points	Install collection points for paper and magazines, batteries and other hazardous waste

Achieved environmental benefits

Lifecycle environmental benefits

Figure 6.9 displays the lifecycle chain for extraction, production, consumption and waste generation. Reuse, recovery and recycling within the economic sphere are associated with environmental pressures, most notably energy consumption and emissions. However, these actions avoid much greater pressures associated with extraction and waste disposal, particularly resource depletion, energy consumption and emissions.



Source: EEA (2010).

Figure 6.9:The lifecycle chain for extraction, production, consumption, waste management

Table 6.8 indicates the GHG emissions avoided by recycling one kg of different types of waste. Despite significant energy requirements to recycle some types of waste (e.g. glass transport and recycling), GHG emission savings are significant compared with disposal and production of new products with virgin materials.

Table 6.8: GHG emissions avoided per kg of different types of waste recycled

Material	Glass	Board	Wrapping paper	Dense plastic	Plastic film
kg CO_2	0.39	1.08	0.99	1.20	1.08
Source: WRAP (2011).					

However, recycling results in a range of environmental benefits, in addition to GHG reduction, compared with disposal. Table 6.9 summarises the range of reuse and recycling options for different types of material, and the main environmental benefits of reuse/recycling.

Table 6.9: Recycling options and associated environmental benefits for different materials

Material	Recycling option	Environmental benefit
Meat and fish	– Send for anaerobic digestion or composting, to local pig farm for feed (legislation permitting) or compost onsite using 'in vessel' composter	– Reduced GHG emissions, water pollution, landfill
Other organic waste	– Send for anaerobic digestion or composting, to local pig farm for feed (legislation permitting) or compost on site	
Garden greenery	– Compost on site, chip and use as mulch on site, or send for composting	
Used cooking oil	– Send for conversion to biodiesel	– Reduced resource depletion, water pollution and landfill
Cork	– Send to make insulation, tiles, pin-boards, soil mulch, etc.	– Reduced resource depletion and landfill
Aluminium cans and foil	– Send for recycling and use in aluminium industry	– Reduced resource depletion and landfill, and 75 – 90% reduction in energy and air pollution compared with virgin aluminium production
Glass	– Send bottles for reuse where possible, and send remaining glass fractions for crushing and recycling into new glass products	– Reduced landfill and 20 – 30% reduction in energy compared with virgin glass. Recycling one tonne saves 100 kg oil
Paper and card	– Separate into fractions (low- and high-grade) as specified by collectors and send for recycling	– Reduced resource consumption, landfill and energy
Plastics	– Return to supplier (packaging) or send for recycling into new plastic products through melting and remoulding or shredding Depends on types of plastic: see Table 6.11	
Other packaging	– Select new, or work with existing, suppliers to reduce non-recyclable packaging waste	
White goods	– Return to supplier for recycling and disposal	– Reduced soil, water and air pollution from leakages
Chemicals and pharmaceuticals	– Return to supplier or send to specialist contractor	
Batteries and lighting	– Return to supplier or send to specialist contractor	
Engine oils	– Send to specialist contractor	

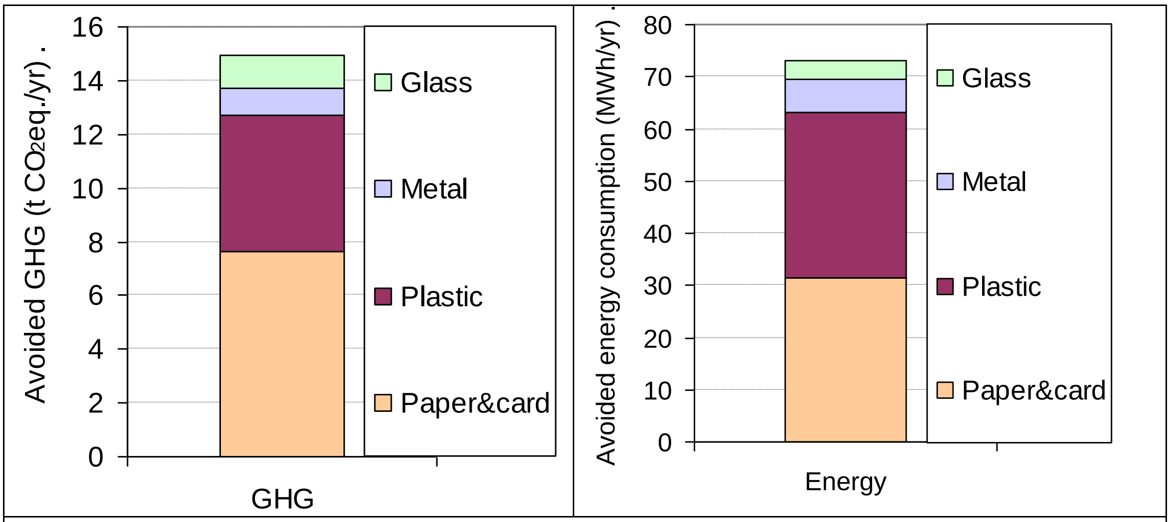
<u>Accommodation premises savings</u>

Table 6.10 summarises the energy and GHG emission savings associated with recycling different materials, and indicates the magnitude of environmental savings achievable for a small 14-room hotel (Figure 6.8).

Table 6.10: GHG and energy savings from recycling compared with land-filling, and an example of savings achievable for a small 14-room hotel (Figure 6.8)

Recycled fraction	GHG saving from recycling	Energy saving from recycling	Small hotel waste generation	GHG emissions avoided by small hotel with 84 % recycling rate	Eenergy saved by small hotel with 84 % recycling rate
	kg CO_2 eq./kg	kWh/kg	kg	Kg CO_2 eq./yr	kWh/yr
Paper & card	1.0	4.1	1 954	**1 700**	**6 730**
Plastic	1.10	6.9	74	**70.8**	**429**
Metal	3.30	20.5	47	**58.9**	**1 274**
Glass	0.39	1.17	2 100	**712.5**	**2 058**
Source: Envirowise (2008); Browne et al. (2009); WRAP (2011).					

Compliance across the entire hotel chain represented in presented Figure 6.12 with the proposed benchmark of 0.16 kg waste per guest-night would lead to a reduction in unsorted waste sent to landfill or incineration of 0.3 kg per guest-night. Compliance with the proposed benchmark across average hotels generating one kg residual waste per guest-night (ITP, 2008) would reduce the quantity of unsorted waste sent to landfill or incineration by 0.84 kg per guest-night. These reductions would translate into annual reductions in unsorted waste collection from a high occupancy 100 room hotel of 11 tonnes and 31 tonnes, respectively. In turn, these waste reductions would lead to annual GHG avoidance of over 13 t CO_2 eq., and annual energy avoidance of over 70 MWh, per hotel (Figure 6.10).



NB: Assumes average 80 % room occupancy, and 25 % double occupancy within occupied rooms, residual waste reduction from 1.0 to 0.16 kg per guest-night, residual waste fractions as per WRAP (2011).

Figure 6.10: Potential annual GHG and energy savings for a 100-room hotel arising from achieving residual waste of 0.16 kg per guest-night (excludes organic fraction)

Appropriate environmental indicator

Indicators

There are two primary indicators of performance in terms of sorting and recycling waste generated on accommodation premises:

- the proportion of waste that is sorted and sent for recycling (percentage mass of total waste)
- the quantity of unsorted waste sent for disposal (kg per guest-night).

Benchmarks of excellence
Figure 6.11 displays the range of recycling rates across hotels in a mid-range European hotel chain, based on aggregated monthly data for 2010. The median recycling rate across hotels in the chain is 56 %, and the top tenth percentile best performers achieve recycling rates above 84 %.

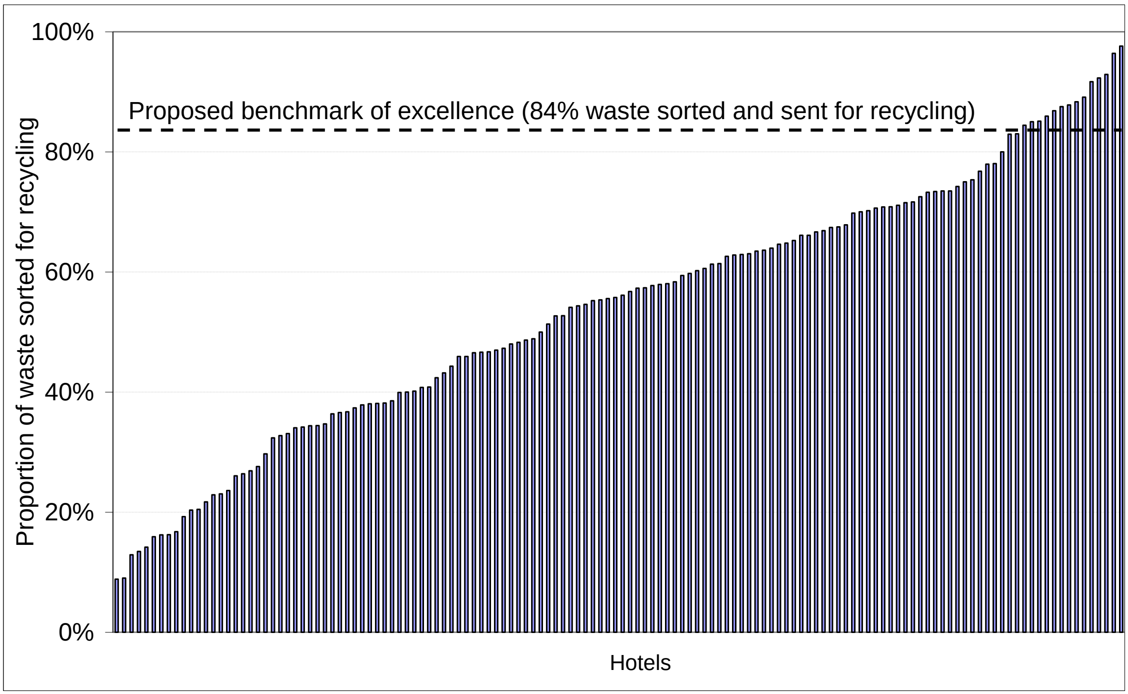


Figure 6.11: Distribution of recycling rates across hotels in a mid-range European hotel chain

Figure 6.12 displays the range of unsorted waste generated per guest-night (final waste sent for disposal) across hotels in a mid-range European hotel chain, based on aggregated monthly data for 2010.

The median quantity of unsorted waste per guest-night is 0.46 kg, and the top tenth percentile best performers generate less than 0.16 kg of unsorted waste per guest-night.

Thus, the following benchmarks of excellence are proposed:

BM: at least 84 % of waste, expressed on a weight basis, is recycled

BM: unsorted waste sent for disposal is less than 0.16 kg per guest-night.

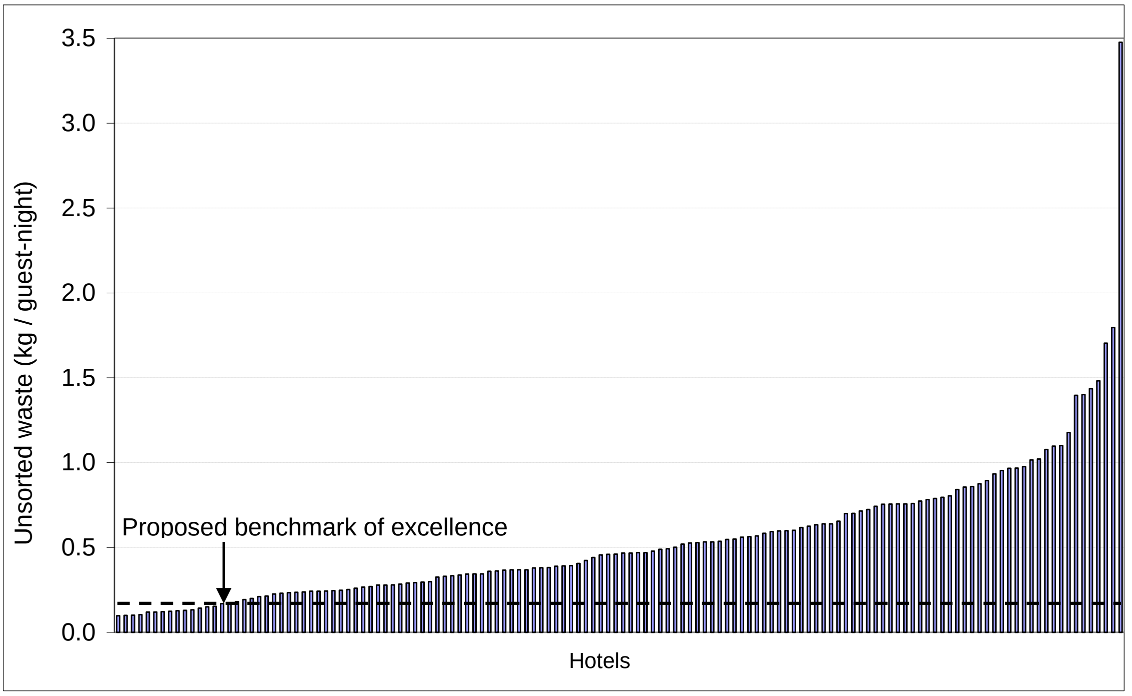
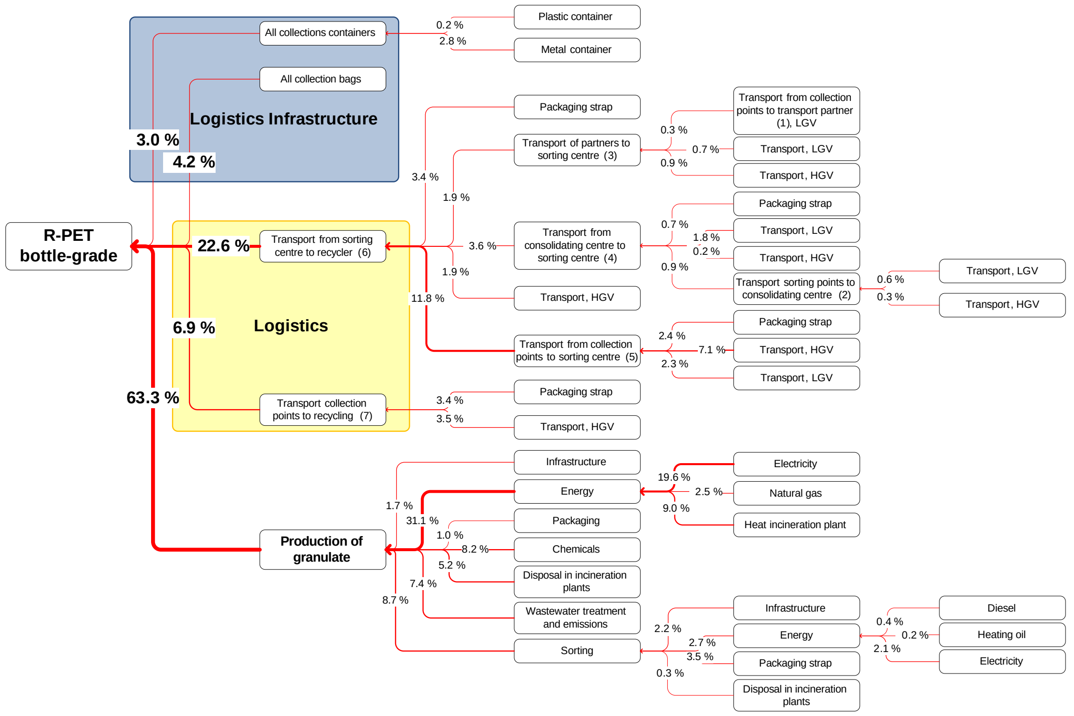


Figure 6.12: Distribution of unsorted waste sent for disposal across hotels in a mid-range European hotel chain

Cross-media effects

As represented in Figure 6.9, recycling is associated with energy consumption and other environmental impacts that arise during collection, transport and recovery operations. These impacts are usually considerably smaller than impacts arising from production from raw materials (Table 6.10). A detailed lifecycle assessment for PET recycling demonstrated that the environmental impact of recycling is comprised of logistics activities (37 % of overall burden) and production of PET (63 % of overall burden) (Figure 6.13). However, PET recycling is significantly more environmentally friendly than the incineration of the PET bottles in municipal waste incineration plants with waste heat recovery (Dinkel, 2008).

Packaging volume and recyclability is one of a number of important environmental criteria that should be considered in the context of lifecycle impacts when making procurement decisions (section 2.2). For many products, the production and/or use phases dominate lifecycle environmental impacts, so that procurement decisions based on packaging alone may not identify the best performing products from an overall environmental perspective.



NB: The impact was calculated according to the Swiss Ecological Scarcity Method (Frischknecht et al., 2008), Legend: HGV = Heavy goods vehicles, LGV = Light goods vehicles.

Source: Dinkel, 2008.

Figure 6.13: Environmental impact of the production of bottle-grade PET-flakes from recycled PET bottles

Operational data

Hazardous waste

A basic practice is to ensure that all hazardous waste, including chemicals, electronic equipment and fluorescent bulbs, is disposed of correctly, as required under relevant legislation and as recommended by producers (e.g. on packaging) or suppliers. Battery collection points may be provided at the reception for guests.

Waste inventory and reuse-recycling feasibility study

As for waste prevention described in section 6.1, developing an inventory of on-site waste types and sources is a relevant starting point for waste recycling and minimisation of residual waste. This requires management coordination and involves all departments, for example:

- housekeeping
- catering
- leisure facilities
- maintenance
- office.

Catering and housekeeping typically account for the majority of waste in accommodation. The initial waste inventory should be sufficiently detailed so that the major sources of all waste can be identified. Many sources can be identified from a simple tour of the premises, but in some cases there may be specific products to which large volumes of waste can be attributed, and that requires the involvement of specific relevant staff to identify. The information generated may then inform procurement decisions within a lifecycle context (see section 2.2 on supply chain management), and indicate existing recycling potential.

With respect to economic implications, charges for collection of different waste fractions vary considerably across, and sometimes within, European countries. Therefore, it is important to identify locally applicable costs associated with various reuse, waste recycling and disposal options. It may be possible to form partnerships with other local enterprises producing similar types of waste in order to efficiently implement recycling collection or delivery (e.g. by guaranteeing the existence of a sufficiently large recyclable waste fraction for providers to collect separately, or by making organised delivery of waste fractions to central waste management stations economic). Alternatively, it may be possible to reach agreements with suppliers who may take back used products. For example, magazines provided to guests in the Rafayel Hotel in London are returned to the publishers for recycling.

Housekeeping

Recycling bin in Scandic Berlin

Housekeeping staff may separate waste from guest rooms, but some hotel groups have a policy for staff, based on health and safety concerns, not to retrieve waste already placed in bins (Accor, 2007). One solution to this problem is the provision of recycling bins in guest rooms, such as those provide in Scandic Hotels (left, inset). These bins comprise three separate compartments to facilitate sorting of organic, paper and other materials (inset, left).

The Hilton Slussen in Stockholm separates waste into 26 different fractions (ITP, 2008). However, for a typical hotel, it is usually unnecessary to separate waste into so many fractions – depending on the collection and recycling service. The Savoy hotel in London sends over 95 % of waste for reuse or recycling. Waste from throughout the hotel, including rooms, is separated into eight fractions: glass, cardboard and paper, wood, plastic and metal, cork, organic oil, batteries, and electrical. Housekeeping staff recover recyclable waste from room bins. One company deals with the majority of the waste, and undertakes further separation after collection (The Savoy, 2011).

Catering

Management of organic kitchen waste is described in section 8.2. The Savoy in London incorporates a large kitchen for its restaurants, three smaller banqueting kitchens, and a staff canteen kitchen, and provides a particularly good example of catering waste management. Kitchen waste is carefully separated at source into the eight recycling streams listed above. Of particular note is the installation of a new automated system to monitor and change cooking oil, and store used oil centrally for collection to be converted into biodiesel. In addition, a use has been found for the thousands of bottle corks produced every week from the hotel and associated restaurants. Two 140-litre bins of corks are collected by catering staff every week and returned to Laithwaite's wine suppliers, who shred them to produce a mulch that is applied to their vineyards to help maintain soil moisture and suppress weeds (The Savoy, 2011).

Plastic waste recycling

Plastics represent a significant fraction of waste from accommodation which create environmental problems when sent to landfill owing to their slow decomposition. Many types of plastic are available across a wide range of products, some of which are easier and more likely to be recycled than others (Table 6.11). These may be identified by commonly used symbols similar to those displayed in Table 6.11 and referred to in the ISO 11469 standard relating to the generic identification and marking of plastics products. Depending on the area and service provider, mixed plastics may be collected for subsequent separation of recyclable fractions, or accommodation staff may have to separate specific recyclable fractions. In either case, an important aspect to consider in green procurement decisions is the use of difficult-to-recycle plastics such as polyvinyl chloride, low density polyethylene and polystyrene (Table 6.11) in consumable products and packaging. Packaging minimisation and reuse (without affecting product quality and longevity) is the most straightforward measure to reduce waste from a lifecycle perspective. Accommodation managers may request suppliers of preferred products to improve the environmental performance, including recyclability, of their packaging.

Lifecycle impacts of packaging are heavily dependent on factors such as whether or not recycled material is used in production, different packaging weights associated with alternative materials, manufacturing location and methods, transport distance, energy sources, fate of used products, etc. (Öko-Institut, 2008). In a study of alternative drinking cup options for the Euro 2008 football games in Germany, Austria and Switzerland, Öko-Institut (2008) used LCA methods to assess the environmental performance of different cup types. Based on the Eco-Indicator-99 method, cups were ranked in the following order of environmental preference (best first):

- reusable PP cups (1^{st})
- disposable cardboard cups (2^{nd})
- disposable PET cups (3^{rd})
- disposable biodegradable polyacetide cups (4^{th})
- disposable PS cups (5^{th}).

The results from this study highlight the environmental superiority of light-weight reusable cups, and cardboard over polystyrene cups.

Table 6.11: Main types of plastic, their identifiers, typical applications, and recyclability

Polymer	Identifier symbol(*)	Typical relevant applications	Example	Recyclability
Polyethylene Terephthalate	01 PET	Drinks bottles; food containers; condiment containers.		Very good. Recycled into new bottles and clothes.
High Density PolyEthylene	02 PE-HD	Chemical containers (e.g. detergents, cosmetics); water pipes; garden furniture; other outdoor equipment such as water butts, potting trays, flower pots.		Good. Recycled to produce new bottles or pipes.
Polyvinyl Chloride	03 PVC	Bubble-wrap packaging; cling film for non-food use; electrical cable insulation; rigid piping; window and door frames.		Poor owing to additives.
Low Density Polyethylene	04 PE-LD	Shrink wraps; frozen food bags; squeezable bottles; cling films; flexible container lids.		Poor owing to economics and frequent contamination of films with e.g. food.
Polypropylene	05 PP	Reusable microwaveable ware; kitchenware; yogurt containers; margarine tubs; microwaveable disposable take-away containers; disposable cups; plates; bottle tops; nappies.		Poor. Wide range of types and grade make recycling difficult.
Polystyrene	06 PS	Egg cartons; packaging protection; disposable cups, plates, trays and cutlery; disposable take-away containers.		Poor owing to economics.
Other (e.g. polycarbonate)	07 O	Beverage bottles; baby milk bottles; compact discs; 'unbreakable' glazing; electronic apparatus housings.		Poor because often present in components of mixed plastic.

(*)American Society of the Plastics Industry. Symbols may vary across Europe (e.g. German DIN pre-fixes numbers with '0').

Source: Demesne (2011); Marius Pedersen (2011); Recyclemore (2011); British Plastics Federation (2011); Wikipedia (2011).

Storage and collection

Storage areas for waste fractions may be limited in some hotels, particularly those located in city centres. Compaction and densification of waste fractions using compactors, shredders or balers reduces storage area requirements and transport costs. Waste volume may be reduced 20 to 50 fold (Waste Care Corporation, 2011). The Savoy hotel in London compresses cardboard and paper waste into bales for collection, and stores plastic, metal and wood in a large compactor for collection and subsequent separation (Table 6.12).

Table 6.12: Waste compactor and compressed cardboard for collection from a large hotel

Source: The Savoy (2011).

Donate items for reuse

Having addressed waste at source, the next step is to put appropriate systems in place to identify how the remaining waste can be redeployed, on site or by external organisations (ITP, 2008). Amongst others, Carlson Hotels Worldwide, Radisson Hotels & Resorts, Marriott International and Fairmont Hotels and Resorts donate untouched food from catering displays and trolleys, unwanted bed linens, mending kits and bathroom amenities to community projects such as homeless shelters, orphanages, homes for the elderly and drug rehabilitation centres, sometimes working through charitable organisations (Waste Management World, 2011).

Case Studies

Strattons Hotel

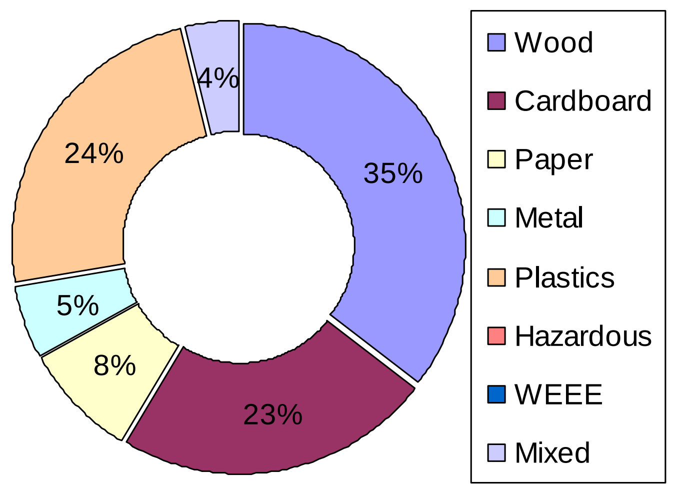
Strattons Hotel in Norfolk (UK) provides a good example of extensive reuse and recycling in a small boutique hotel (see Figure 6.8 above).

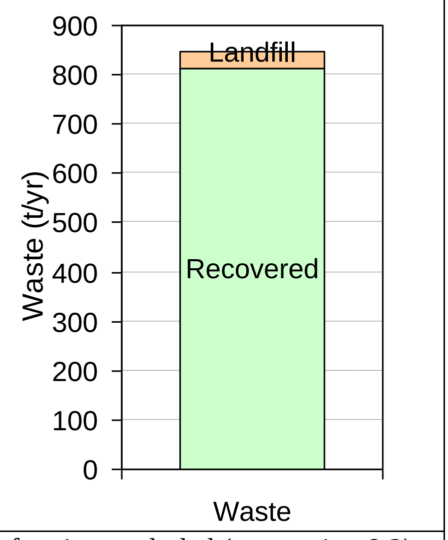
Hilton Slussen Hotel

Amongst larger high-end hotels, the Hilton Slussen in Stockholm sorts waste into 26 different bins. Introduction of a sorting and recycling scheme in 1997 reduced the 125 tonnes per month sent to landfill by 76 %, to 0.3 kg per guest-night. Cardboard was diverted to recycling, wooden pallets were diverted for heating buildings outside Stockholm, and other combustible materials were sent to generate district heating for apartments. Candle stumps were diverted to day care centres and to a church to be made into new candles for sale (ITP, 2008).

The Savoy

The Savoy hotel in London is a traditional luxury five-star establishment managed by the Fairmont Hotel Group. The establishment comprises 268 rooms, 62 suites (equivalent area of two rooms each), two restaurants, two bars and a tea room, and employs over 600 staff. Upon reopening in 2010 following a major refit, a comprehensive waste recycling programme was implemented in accordance Fairmont Hotel's Green Partnership Program (Fairmont Hotel Group, 2011). This included extensive and ongoing staff training – daily staff briefings incorporate environmental management topics, including waste separation, reuse and recycling. Consequently, over 95 % of non-food waste is now diverted from landfill (Figure 6.14), and unsorted waste generation for the hotel and restaurants is equivalent to approximately 0.3 kg per guest-night (this includes waste arising from 30 % non-resident restaurant customers). Organic waste amounting to a further 344 tonnes per year is separated and sent for energy recovery (see section 8.2)





NB: Data from first quarter 2011 annualised. Organic waste fraction excluded (see section 8.2).

Source: The Savoy (2011).

Figure 6.14: Non-organic waste fractions (left) and total volume (right) arising from The Savoy in 2011

Key actions of The Savoy's waste management programme include:

- purchasing department reduces packaging as part of green procurement (e.g. UKOS office suppliers rated top in The Sunday Times Best Green Companies 2010);
- housekeeping department sorts and recycles all items used by guests from rooms;
- installation of paper and food recycling bins in all departments;
- instigation of 'Food waste to Renewable Energy Scheme' that sends separated organic waste for heat and electricity generation by PDM Group (section 8.2);
- installation of an 'Oilsense' management and collection system for used cooking, to enable efficient reuse as biodiesel (section 8.2);
- all natural cork is collected by Laithwaites Wines, granulated and used as a mulch in their vineyards;
- an integrated pest management programme, operated by Ecolab Pest Control, minimises hazardous waste generation;
- implementation of a recycling programme for electronic waste and toner cartridges;
- redistribution of household goods and unclaimed lost property items to charity;
- donation of wooden crates to schools for arts and crafts uses;

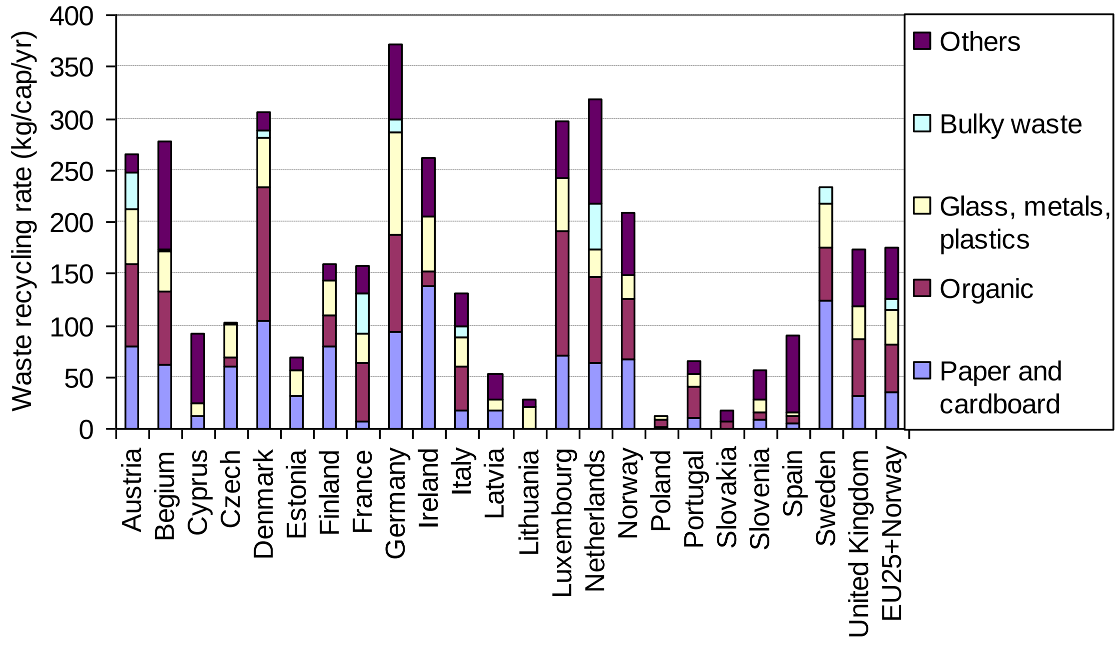
– electronic document sending, double-sided printing and the use of whiteboards to minimise paper usage.

Applicability
All types, sizes and grades of accommodation can implement waste recycling (see also example of recycling on campsites in section 9.5).

Waste recycling options available to accommodation enterprises may be restricted in some locations. The provision of waste recycling services varies considerably across countries and localities, as indicated by the range of recycling rates across Europe (Figure 6.15; Figure 6.16). In areas where the municipality or private companies do not collect separated materials for recycling, accommodation managers can request the municipality to prioritise the provision of such services and seek alternative solutions, as required in such situations by criteria for the EU Ecolabel.

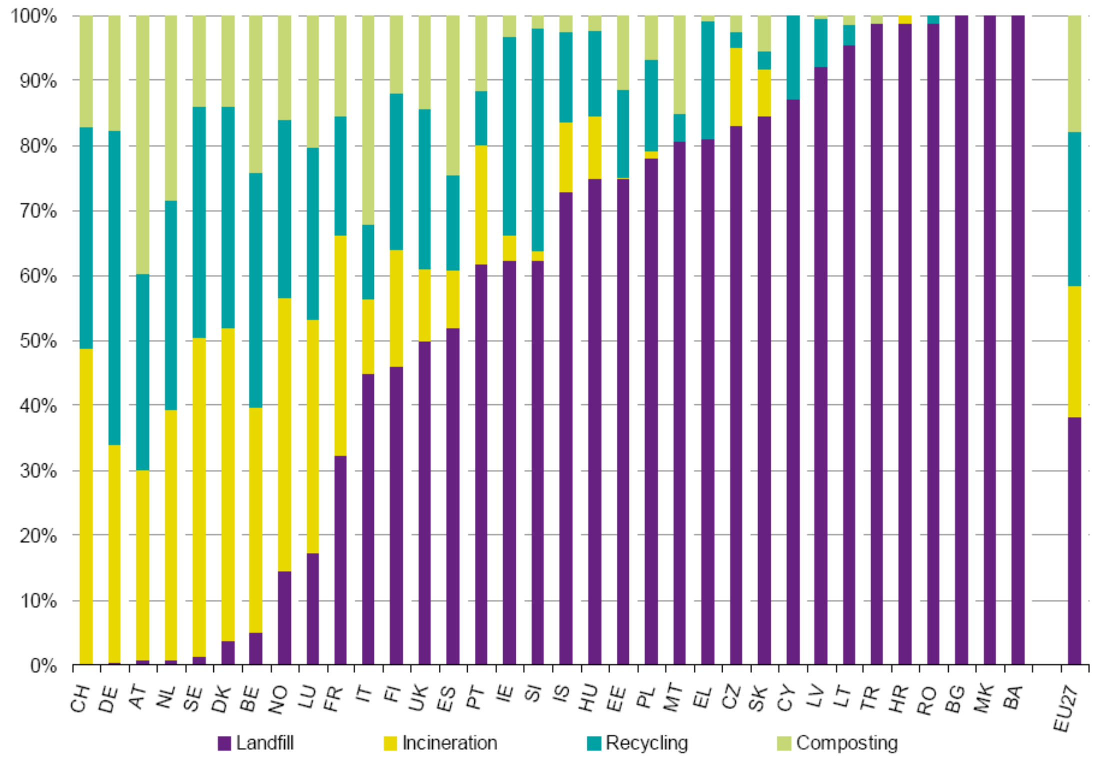
Even where collection services are not provided, proactive hotels are able to find solutions to waste recycling though cooperation with other local stakeholders, for example by arranging shared waste collection, or sending organic waste to local farmers for composting or biogas production.

In rural areas where collection services are less likely to be provided, it is usually possible to implement composting of the important organic waste fraction (section 8.2).



Source: ETC/SCP (2010).

Figure 6.15: Recycling rates for different fractions of municipal waste across EU Member States and Norway



Source: Eurostat (2010).

Figure 6.16: Percentage of municipal waste treated in 2009 by country and treatment category sorted by percentage of landfilling

Economics

Waste management cost per guest-night

Ecotrans (2006) calculated the average cost of waste per guest-night in a German hotel. The waste collection and disposal costs for one day involving 43 overnight stays and the provision of 58 warm meals amounted to EUR 10.10, translating to around EUR 0.23 per guest-night, and EUR 115 per tonne. Waste costs were apportioned equally between the provision of accommodation and hot meals (Ecotrans, 2006). The survey found that waste charges were dominated by residual and organic waste fractions.

Waste management cost by fraction

The economy involved in sorting and recycling of waste relate to collection rates associated with the different waste fractions. These vary considerably across and within countries. Collection of residual, organic and hazardous waste usually incurs a cost, whilst collection of separated paper, plastic and metal for recycling is often free of charge (though this varies across municipalities). However, installation of appropriate waste-handling equipment and staff time for sorting different waste fractions incur costs that will somewhat offset benefits of lower collection and disposal charges. One hotel in Freiburg, Germany, is charged for removal of all waste except cardboard, for which a significant payment is received (Table 6.13).

Table 6.13: A breakdown of waste management costs for one German hotel

Fraction	Volume	Transport	Disposal	Total cost	
	Tonnes	EUR/tonne			EUR
Waste for recycling	148.18	30.27	95.63	125.90	18 656.14
Building rubble sorted	7.88	11.68	6.50	18.18	143.22
Wood packaging	10.22	77.10	9.12	86.23	881.24
Mixed construction waste	10.16	18.11	91.96	110.07	1 118.30
Cardboard packaging	59.16	20.14	-61.60	-41.46	-2 452.85
Glass	50	28.76	4.63	33.39	1 669.54
Food waste	116.64	NA	103.69	103.69	12 094.00
Light weight recyclables	18.4	49.32	93.01	142.33	2 618.96
Fat from grease traps	28.9	84.78(*)	41.18	41.18	3 640.00
Container rental					4 640.00
Total					43 008.55
(*)Service costs to empty and clean grease traps (25 hours per year).					

<u>Hotel waste management savings</u>

The Savoy in London pays approximately EUR 110 per tonne for mixed waste collection, compared with free collection for separated recyclable materials, and receives payment of EUR 0.30 per litre for the 600 litres of waste cooking oil collected every month by a private company to produce biodiesel.

A reduction in unsorted waste of between 11 and 31 tonnes per year for a 100-room hotel (see 'Environmental benefit', above) would lead to annual cost savings of between EUR 1 210 and EUR 4 030, assuming collection costs of EUR 110 to EUR 130 per tonne of mixed waste and free collection of recyclable materials.

By reusing or recycling 98 % of waste, Strattons 14-room hotel and restaurant in the UK saves over EUR 1 000 per year in waste disposal costs (Envirowise, 2008).

Table 6.14: Some examples of economic savings arising from recycling actions

Hotel	Action	Annual waste reduction	Annual saving	Source
			EUR	
96-room conference hotel	Waste separation	72 t reduction in landfill	4 120	Sustainable South Land (2011)
Hotel and restaurant	Onsite composting	150 t organic waste reduction	30 000	Irish EPA (2008)
148-room conference hotel and restaurant	Food and general waste recycling	70 % reduction in landfill	21 480 (44 %)	Irish EPA (2008)
74-room hotel and restaurant	Introduction of organic and mixed recyclable bin	127 t food waste, 17.5 t glass, 6.5 t paper and cardboard, 0.65 t plastic	2 300	Foodwaste.ie (2010)

Driving Force for Implementation
Driving forces for implementing waste sorting and recycling include:

- corporate social responsibility
- waste legislation
- differentiated charges for collection of recycling waste and disposal of waste
- voluntary EMS or ecolabel criteria
- environmental marketing – waste management is a visible demonstration of environmental commitment.

Reference organisations
The Hilton Slussen hotel Stockholm; The Savoy hotel, London; Scandic hotels; Strattons hotel Norfolk (UK).

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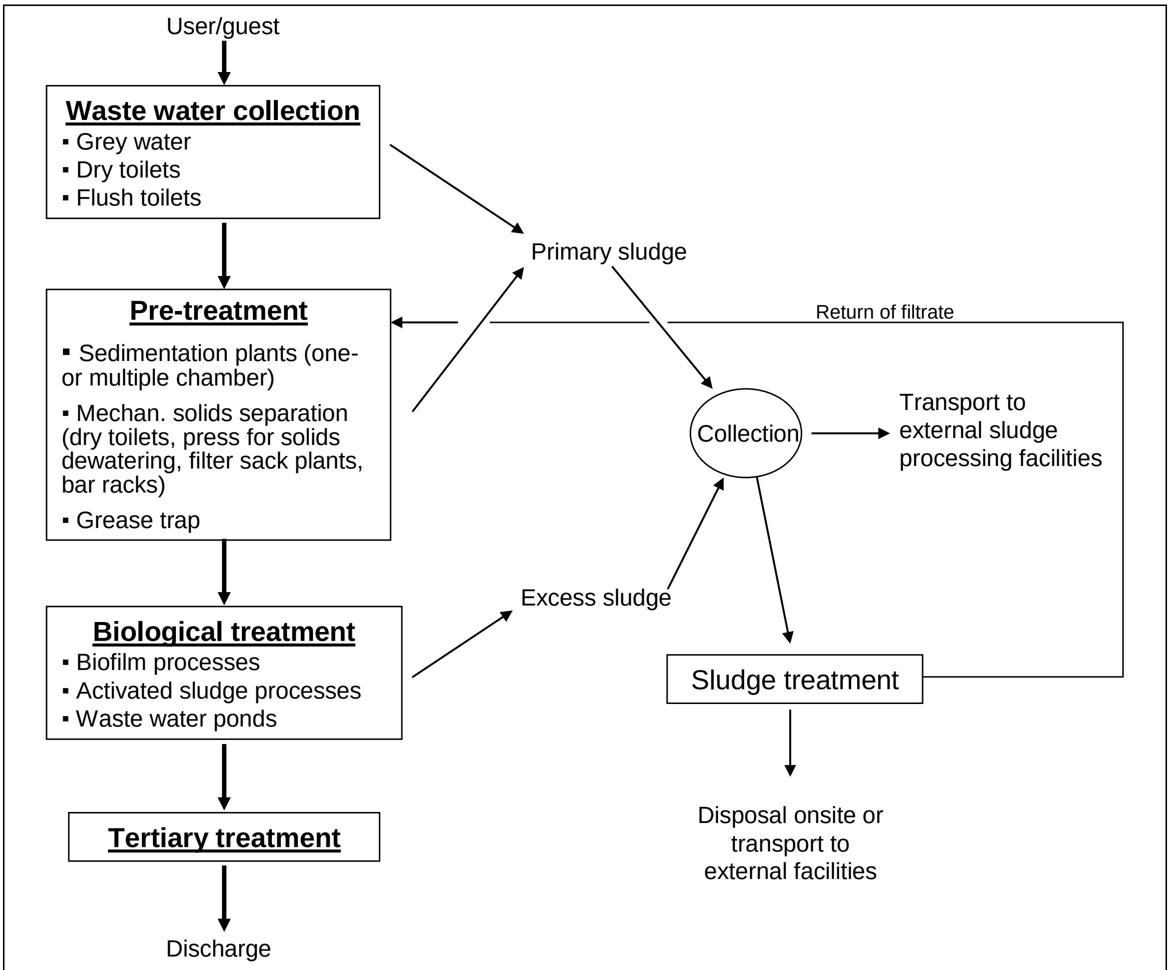
6.3 Waste water treatment

Description

In case waste water cannot be discharged to a sewer to be treated in a municipal effluent treatment plant (see section 3.3), individual local solutions have to be applied. Here, three different applications are described: for an individual hotel, a campsite and huts in the alpine region. Best practice is to apply well-designed pre-treatment (sieve/bar rack, equalisation, sedimentation), biological treatment with high BOD_5 removal and high nitrification and sludge treatment/disposal for all of these applications.

Due to the high variation of waste water flow and load across different tourism seasons, the applied technique must be flexible and able to adapt to these special conditions. For hotels and campsites, in many cases, sequencing batch reactors have been proven to be a satisfactory option to fulfil these requirements. However, other types of biological treatment may also be appropriate as long as they achieve high removal efficiencies (see operational data).

In the alpine region, mountain huts may be connected to a municipal treatment plant in an adjacent valley via individual pipes (see Figure 6.22, below). This represents best practice, but may not always be technically or economically viable, in which case individual waste water treatment solutions, as described here, are required. Similarly, many rural tourist accommodations across Europe are outside the catchment areas of municipal treatment plants. The applicable techniques are illustrated in Figure 6.17.



Source: IEVEBS (2010a and b).

Figure 6.17: Sequence for waste water treatment and sludge disposal for individual huts in the alpine region where discharge to a municipal effluent treatment plant is either technically or economically unviable

Biofilm plants have been demonstrated to be the most appropriate technology. If they are not applicable, due to local circumstances, activated sludge systems are recommended. Concerning biofilm reactors, priority is for reed bed filters. In case, they are not applicable, e.g. because of the altitude, priority may be given to trickling filters. Concerning waste water treatment for individual huts in the alpine region, a compilation is provided under operational data. Due to the climate conditions, the treatment plants should be located within a building. In the alpine region, tertiary treatment should be applied. For this purpose, in principle, simple systems such as mechanical biofilters and reed bed filters have been proven to be appropriate (IEVEBS, 2010a and b).

Achieved environmental benefit

As suspended solids and organic compounds are removed to a high extent (BOD_5 removal of more than 95 %) and ammonia is nitrified to a high extent (at least 90 %), the pollution of waste water is significantly reduced and the impact to receiving natural waters is minimised. Sludge disposal from plants for hotels and campsites should include anaerobic digestion and/or incineration according to standards meeting those defined in the Best Available Reference Techniques Reference Document on Incineration Plants (BREF WI, 2006).

Appropriate environmental indicator

Indicators

BOD_5, COD and ammonia concentration (mg/L) or specific factors such as g BOD_5/PE, COD/PE or NH_4-N/PE (where PE is the waste water treatment system load, expressed as person equivalent), and removal efficiency (% removed) for the parameters BOD_5, COD, ammonia, total phosphorous and total nitrogen, are appropriate environmental indicators.

Benchmark of excellence

The following benchmark of excellence is proposed:

BM: where it is not possible to send waste water for centralised treatment, on-site waste water treatment includes pre-treatment (sieve/bar-rack, equalisation and sedimentation) followed by biological treatment with >95 % BOD_5 removal, >90 % nitrification, and (off-site) anaerobic digestion of sludge where possible

Cross-media effects

The most important cross media effects is due to the energy consumption to operate the treatment plant (mainly electricity for aeration) and the excess sludge produced from biological treatment. However, on one hand adequate treatment without energy consumption is not possible and on the other hand, the described systems are energy efficient. Performance data for plants with sequencing batch reactors are presented below (operational data). Surplus sludge is unavoidable and has to be disposed of properly.

Operational data

Information is presented for an individual hotel, a campsite and for huts in the alpine region.

Individual hotel

The waste water from an individual hotel (Figure 6.18) is treated in a biological treatment plant designed for 33 m^3/d and 300 Person Equivalents (PE).

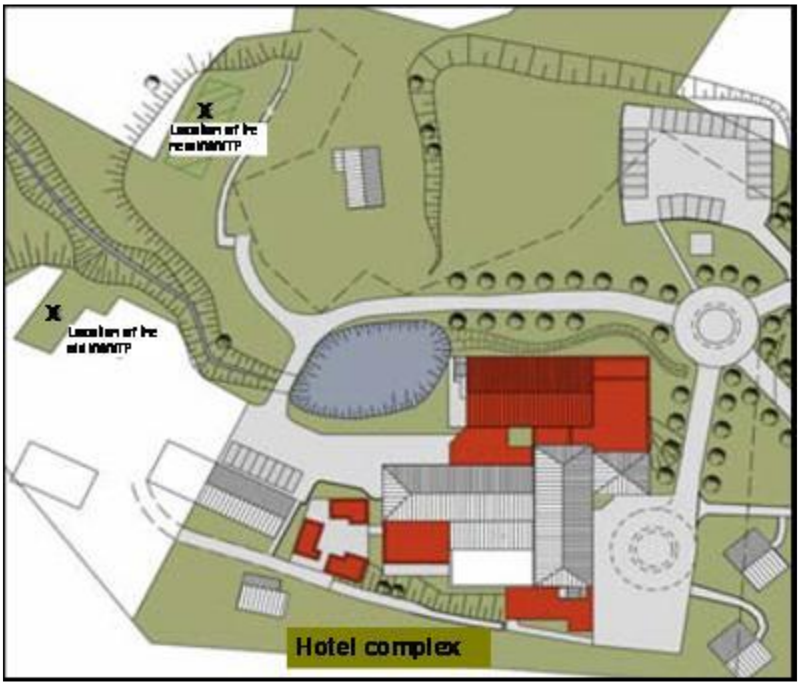


Figure 6.18: Location of the Hotel Schindelbruch and its waste water treatment plant in Stolberg/Germany

The layout of the plant is shown in Figure 6.19, consisting of a sedimentation tank to eliminate coarse particles and an equalisation tank to collect the waste water and to equalise its concentration and load. The biological stage is a sequencing batch reactor provided with forced aeration by compressors followed by a flow reducer to enable constant discharge flow (because of the discontinuous treatment process in the sequencing batch reactor).and the sampling manhole. Excess sludge is pumped to a collection tank from where it is transported to an external facility (anaerobic digester of a municipal waste water treatment plant).

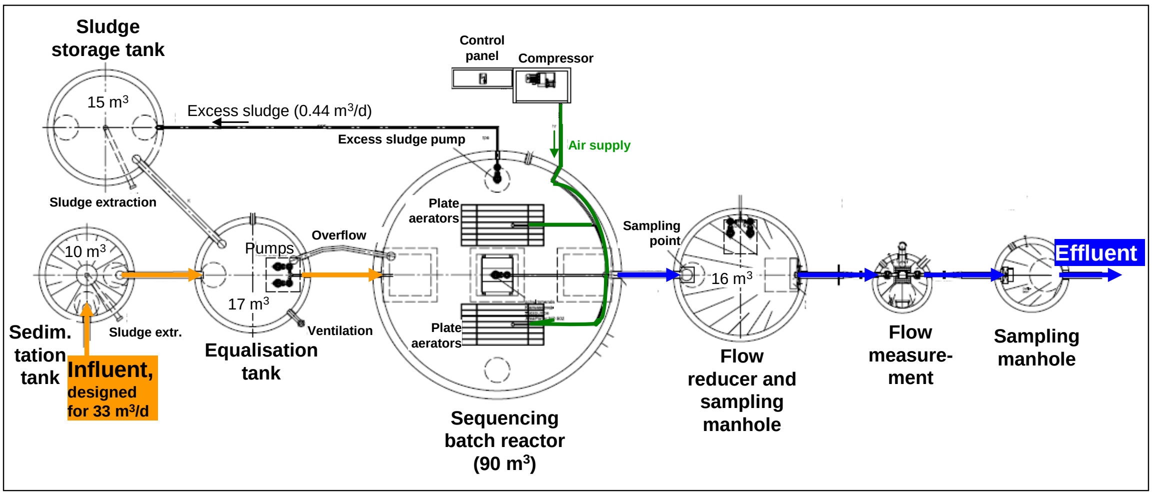


Figure 6.19: Layout of the biological treatment plant of the Hotel Schindelbruch, based on a scheme provided by Mall GmbH, it is designed for 300 person equivalents

The annual flow is about 12 400 m^3. The removal efficiency is 90 % for COD, more than 95 % for BOD_5, 81 % for NH_4-N, 77 % for total nitrogen and 44 % for total phosphorous. Available waste water analysis carried out by an independent and certified laboratory in 2011are compiled in Table 6.15.

Table 6.15: Analysis of the waste water after treatment for the plant of the Hotel Schnindelbruch

Sampling date	BOD_5			COD	NH_4-N	NO_3-N	org.N	total phosphorous
	influent	effluent	removal efficiency	effluent	effluent	effluent	effluent	effluent
	mg O_2/L	mg O_2/L	%	mg O_2/L	mg N/L	mg N/L	mg N/L	mg P/L
February 2011	220			60	1.1	6.2	7.3	2.4
March 2011	210			53	1.3	6.8	8.1	2.2
April 2011	238			78	1.4	6.8	8.0	2.0
May 2011	246	12.3	95.0	64	0.9	7.2	8.1	1.7
June 2011	266	12.7	95.2	62	1.1	6.5	7.6	1.4
September 2011	281	8.2	97.1	42	0.8	6.7	7.6	1.2
December 2011	294	6.8	97.7	39	0.6	6.1	6.7	1.1

The electricity consumption is about 25 kWh/d; about half of the consumption is used for the compressors to aerate the sequencing batch reactor.

The amount of excess sludge to be disposed of externally is about 0.45 m^3/d.

Campsite

The waste water from a campsite near the city of Glücksburg in the very North of Germany, close to the Danish border (Figure 6.20), is treated in a biological treatment plant designed to treat 135 m^3/day waste water in addition to 27 m^3/day ground water that infiltrates into the sewer system, and to serve 1 100 Person Equivalents (PE). In addition, the waste water from about ten private houses (approximately 30 PE) is also treated in the plant. In winter, the influent load is very low, and peaks in summer when the campsite is full of guests.

Figure 6.20: Location of the campsite Glücksburg / Holnis in the very North of Germany close to the Danish border

The layout of the plant is shown in Figure 6.21, consisting of a sieve and bar rack to eliminate coarse particles and an equalisation tank to collect the waste water and to equalise its concentration and load. The biological stage consists of two sequencing batch reactors provided with aeration air from compressors followed by two conditioning tanks and an effluent mixing sewer to enable constant discharge flow (because of the discontinuous treatment process in the sequencing batch reactor) and the sampling manhole. Excess sludge is pumped to a collection tank from where it is transported to an external facility (anaerobic digester of a municipal waste water treatment plant).

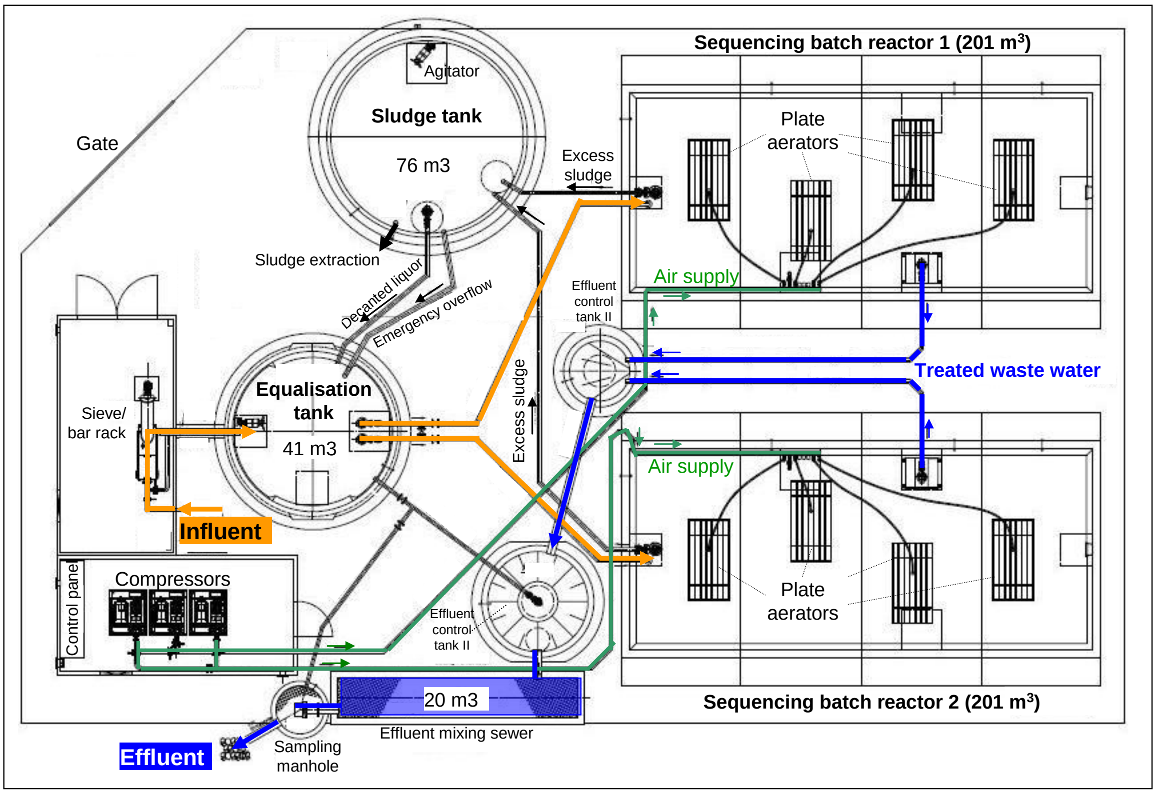


Figure 6.21: Layout of the biological treatment plant of the Campsite Glücksburg / Holnis, based on a scheme provided by Mall GmbH, it is designed for 1100 person equivalents (PE)

The annual flow is about 59 000 m^3. The removal efficiency for COD is more than 90 %, for BOD_5 more than 98 % and for ammonia about 95 %. Available waste water analysis carried out by an independent and certified laboratory are compiled in Table 6.16. The values are very low. As BOD_5 is removed below the detection limit, the ammonia content is expected to be at least below 0.5 mg NH_4-N/L.

Table 6.16: Analysis of the waste water after treatment discharged from the plant for the campsite Glücksburg / Holnis

Sampling date	Waste water temp	pH	COD	BOD_5	Total phosphorus
	ºC		mg O_2/L	mg O_2/L	mg P/L
03.03.2011	4.9	8.1	17	<3	0.1
25.07.2012	18.6	6.9	26	<3	2.5
24.102011	10.9	7.0	27	<3	5.7
07.03.2012	5.4	8.0	19	<3	1.4

The electricity consumption is about 80 kWh/day; more than half of the consumption is used for the compressors to aerate the sequencing batch reactors.

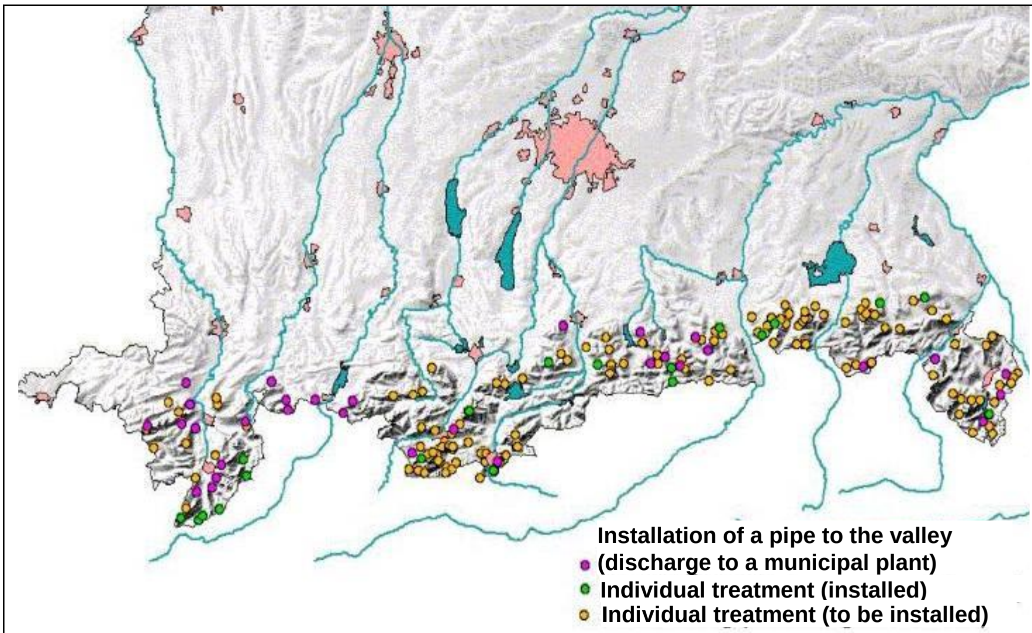
The amount of excess sludge to be disposed of externally is about 1.1 m^3/day.

Huts in the alpine region

There are cases where the installation of a waste water pipe down to the valley to discharge the waste water to a municipal waste water treatment plant may be the best solution. Figure 6.22 shows two examples for this option.

Figure 6.22: Installation of a pipe to discharge waste water down to the valley to a municipal waste water treatment plant, (BLU, 2000)

Figure 6.23 shows that, as of the year 2000, this option had already been realised in many cases in the Bavarian alpine region, but for many others, individual solutions are required.



Source: BLU (2000).

Figure 6.23: Waste water disposal of huts in the Bavarian alpine region, (BLU, 2000)

There are cases where water availability is limited or where treatment is more difficult, especially at high altitude. In these cases; it may be appropriate, to use separation toilets to collect urine separately to be transported to other facilities as well as dry toilets for faeces (Figure 6.24).

NB: the fall down pipe on the left is located immediately below the toilet.

Source: Jäger (2009) and Abegglen (2004).

Figure 6.24: Separation toilet (on the left) and separate dry collection of faeces (on the right)

Permeating liquid is collected and discharged to the grey water treatment system. The room of the dry toilet is vented to minimise odours. Then, the residual grey water from kitchen and bath room can be filtered in a sack filter and treated in a reed bed plant (Figure 6.25). In this way the load and waste water emissions are minimised.

Source: Jäger (2009).

Figure 6.25: Example for a reed bed filter for the treatment of grey water from a hut at 2 245 m above sea level, designed for 30 PE60

Where no segregation is needed or carried out, treatment according to the scheme in Figure 6.17 is required. The available pre-treatment systems are compiled in Table 6.17 with brief summaries of their applicability, properties and characteristics. They have to be selected according to the individual circumstances and conditions.

Subsequent to pre-treatment, biological treatment and in many cases also tertiary treatment has to be applied. The applicability, properties and characteristics of the different available techniques are compiled in Table 6.18.

As already indicated above, biofilm plants have been proven to be most appropriate. If they are not applicable, due to local circumstances, activated sludge systems are recommended. Concerning biofilm reactors, priority is for reed bed filters. In case they are not applicable, e.g. because of the altitude, priority may be given to trickling filters. Concerning waste water treatment for individual huts in the alpine region, a compilation is provided under operational data. Due to the climate conditions, the treatment plants should be established in a building. In the alpine region, tertiary treatment should be applied. For this purpose, in principle, simple systems such as mechanical biofilters and reed bed filters have been proven to be appropriate (IEVEBS, 2010a and b).

For a long time, the disposal of sludge from biological treatment remained problematic. Now, different options are available such as filter sack systems, reed bed plants, solar dryers and composters (Günthert, 2007; Günthert, 2008). Depending on legal requirements and individual permits as well as on the availability of land, it is also possible to apply the processed sludge on land close to the hut.

Table 6.17: Applicability, properties and characteristics of available pre-treatment techniques for waste water from huts in alpine regions (IEVEBS, 2010a and b)

		Pretreatment systems			
		Sedimentation plants	**Dewatering press**	**Dry toilets**	**Filter sack plants**
Applicability	**Spreading onsite permitted**	+	+	+	+
	Spreading onsite not permitted				
	in case of supply and disposal via a road	++ Transport in vaccum tank	+ space and weight minimised transport	+ space and weight minimised transport	+ space and weight minimised transport
	in case of supply and disposal via helicopter or cable lift/cable car	o wet sludge has to be dewatered for transport	+ space and weight minimised transport	+ space and weight minimised transport	+ space and weight minimised transport
	Limited tap water / water for use availability	in case of water shortage, dry toilets are recommended			
	Cost-intensive energy supply	++ usually no energy consumpt.	o const. energy consumpt.	o energy for aeration	++ low or no energy consum.
	Plant size				
	< 50 PE_{60}	++	++	++	++
	50 - 100 PE_{60}	++	++	+	o
	> 100 PE_{60}	++	+	o	-
Properties and charateris.	**Ease of operation and maintenance**	++	-	-	o
	Reliability	++	-	+	++
	Average assessment by operators	+	o	o	o

Legend: PE_{60}: Population Equivalent (60 g BOD_5/d)
++: very good/very highly appropriate; +: good/highly appropriate: o: satisfactory/appropriate

Table 6.18: Applicability, properties and characteristics of available biological treatment techniques for waste water from huts in alpine regions (IEVEBS, 2010a and b)

		Biofilm processes				Activated sludge systems			Waste water lagoon
		Reed bed filter	Trickling filter	Mechanical biofilter	Rotating biological contactor	Conventional activated sludge system	Sequencing batch reactor	Membrane bioreactor	
Applicability	**Type of supply (applicability due to transport costs/efforts)**								
	Roadway	+	++	++	++	++	++	++	+
	cable lift / helicopter	+ / - no inoculation required	++ no inoculation required	++ no inoculation required	++ no inoculation required	++ transport costs low but annual inocluation with activated sludge required	++ transport costs low but annual inocluation with activated sludge required	++ transport costs low but annual inocluation with activated sludge required	+ / - no inoculation required
	Above sea level								
	< 1800 a.s.	++	++	++	++	++	++	++	++
	> 1800 a.s.	o	++	++	++	++	++	++	+ / -
	Summer and winter operation	+ / -	++	++	++	++	++	++	+ / -
	Energy efficiency (low consumption)	++	+	+	o	+ / -	+ / -	+ / -	++
	Open country topography (steep, bedrock)	+ / -	++	++	++	++	++	++	+ / -
	Legal requirements	in case of adequate dimension and combination with appropriate tertiary treatment, all systems usually meet the performance requirements							+ / -
	Plants above 150 PE_{60}	+ / -	++	++	++	++	++	++	+ / -
Properties and characteristics	**Treatment performance (tertiary treatment**	o longer start-up phase	o longer start-up phase	o longer start-up phase	o longer start-up phase	+ shorter start-up phase with inoculation (see above)	+ shorter start-up phase with inoculation (see above)	+ shorter start-up phase with inoculation (see above)	o longer start-up phase
		Provided well-done planning and regular maintenance, these systems, in adequate combination with pre-treatment systems and tertiary treatment, usually meet the legal performance requirements							+ / -
		signific. reduction of germs, in case tertiary treatm. is demanded, e.g. a UV plant can be added	in case there is a demand for tertiary treatment, an additional treatment stage (e.g. UV plant) can be provided					in case of tert. treatm. demand, add. germ removal ist not needed. A UV plant can be applied to be on the safe side.	in case of tert. treatm. demand, a UV plant has to be added
	Ease of operation and maintenance	++	+	+	+	o	o	data not available	++
	Reliability	++	+	o	o	o	o	data not available	++
	Assessment by operator	++	+	+	+	+	o	+	++
	Assessment of total costs (capital value)	1800 - 3900 EUR/PE	2200 - 3900 EUR/PE	3300 - 5700 EUR/PE	2700 - 5300 EUR/PE	4900 - 7900 EUR/PE	3600 - 4400 EUR/PE	no info due to low number of available plants	no info due to low number of available plants
	Investment costs	average	average	high	low	low	low	average	very low
	Reinvestment expenses	very low	low	low	low	high	high	high	very low
	Operation costs	very low	low	low	average	high	high	high	very low

Legend: PE_{60}: Population Equivalent (60 g BOD_5/d)

++: very good/very highly appropriate; +: good/highly appropriate: o: satisfactory/appropriate; + / -: sufficient/of limited suitability

Applicability

The different techniques described for the biological treatment of waste water from individual hotels, campsites and huts in the alpine region are applicable without limitations. There are different options depending on the individual circumstances, but in principle the described techniques for pre-treatment and biological treatment are applicable to all cases of the aforementioned categories.

Economics

Plant for the Hotel Schindelbruch (described above)

Investment costs: 145 000 EUR net (turn key); i.e. 500 – 1 000 EUR/PE. The operational costs are as follows

- Electricity: 5.9 EUR/PE (price for one kWh: 0.21 EUR)
- External sampling and analysis: 4.9 EUR/PE
- Maintenance: 3.2 EUR/PE
- Repairs: 4.6 EUR/PE
- Personal costs 7.0 EUR/PE
- Disposal costs for sludge and residues from sedimentation: 14.2 EUR/PE

This is in total 39.8 EUR/PE, equivalent to 0.96 EUR/m^3.

Plant for the campsite Glücksburg / Holnis described above

Investment costs: 540 000 EUR net (turn key), i.e. also 500 – 1000 EUR/PE. The investment was made by the city Glücksburg as it is competent for the discharge of waste water. The campsite operator has to pay a fee on the basis of each cubic meter of waste water discharged to the plant.

The operational costs are as follows

- Electricity: 5 900 EUR (price for one kWh: 0.21 EUR), equivalent to 5.4 EUR/PE
- External sampling and analysis: 8.1 EUR/PE
- Maintenance: 1 EUR/PE
- Repairs: 3.5 EUR/PE
- Personal costs (20 hours/month): 7.7 EUR/PE (35 EUR/working hour)
- Sludge disposal costs: 7.9 EUR/PE (21 EUR/m^3 sludge)

This is in total 33.6 EUR/PE, equivalent to 0.63 EUR/m^3.

For the installation of a waste water pipe down to the valley to discharge the waste water to a municipal treatment plant, the following costs have been reported (although these values are now more than 10 years old, and will now be higher): 45 – 340 EUR/m (average: 160 EUR/m) and 350 – 4 100 EUR/PE (average: 1 400 EUR/PE) (BLU, 2000).

No detailed figures for the different treatment techniques of the waste water from huts in the alpine region could be identified.

Concerning sludge processing techniques, investment costs between EUR 7 000 and EUR 25 000 have been reported (Günthert, 2008).

Driving force for implementation

On one hand, legal requirements represent one of the most important driving forces to implement the techniques described. On the other hand, an awareness of environmental damage and responsibility to operate tourist accommodation in a sustainable manner are also relevant driving forces to go beyond regulatory requirements.

Reference applications

See the examples presented above under operational data.

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