8 RESTAURANTS AND HOTEL KITCHENS

Overview

The preparation of meals, snacks and drinks is a core tourism service undertaken in most types of accommodations, and in dedicated restaurants and bars. This chapter covers the main measures available to minimise environmental impacts attributable, directly and indirectly, to operations in restaurant and hotel kitchens. Many of these techniques are also applicable to smaller food and drink services such a bars or breakfast preparation in small bed and breakfast accommodations.

Catering establishments prioritise food quality, and operatives often work under high pressure. Water and energy efficiency measures have therefore traditionally been a low priority for such establishments. Few catering supervisors have any input into equipment selection, especially in terms of energy and water efficiency, whilst the behaviour of catering staff is largely determined by a need to deliver quality and service using the equipment available (Carbon Trust, 2011).

Supply chains

As shown in Figure 2.4 in section 2.2, upstream environmental impacts arising during the production and transport of ingredients used to prepare meals in restaurant and accommodation kitchens are greater than the environmental impacts arising directly from kitchen processes. Best practice in green procurement is described in section 8.1.

Waste management

Figure 2.4 in section 2.1 also shows that waste management can make a significant contribution to the lifecycle environmental burden of food value chains. Specifically, disposal of food in landfill leads to significant GHG emissions and other impacts such as land occupation and leachate. On average in UK restaurants, 0.48 kg of food waste is generated per diner (SRA, 2010). In addition, food waste contributes to unnecessary food production impacts. Best practice in the avoidance and management of waste is described in section 8.2.

Water consumption

For relatively water-efficient hotels with small restaurants that serve breakfast for all guests plus cover meals to conference and à-la-carte guests numbering no more than half the number of overnight guests, water consumption in bar and restaurant areas equates to approximately 15 % of total water consumption, or just over 20 L/gn (Scandic Hotels, 2012). This corresponds with modelled water consumption for hotels presented in Figure 5.3 (section 5). These values will be higher for hotels with larger restaurants serving a higher proportion of conference guests and walk-in diners. Bohdanowicz and Martinac (2007) refer to average water consumption of between 35 and 45 L per cover meal served in hotels. Water consumption in kitchens is dominated by dish washing. Best practice to minimise water consumption in kitchens, with an emphasis on efficient dish washing, is described in section 8.3.

Energy consumption

According to ÅF-Energikonsult AB (2001), kitchens represent 25% of total hotel energy consumption, through demand for cooking, appliances, refrigeration and ventilation. Bohdanowicz and Martinac (2007) refer to average energy consumption of between 4 and 6 kWh per cover meal served in hotels. However, this value varies considerably depending on the type of meal served. ÅF-Energikonsult AB (2001) estimate average energy consumption in hotel kitchens of between 1 and 2 kWh per meal. Best practice to minimise energy consumption in kitchens, with a focus on cooking, ventilation and refrigeration, is described in section 8.4.

References

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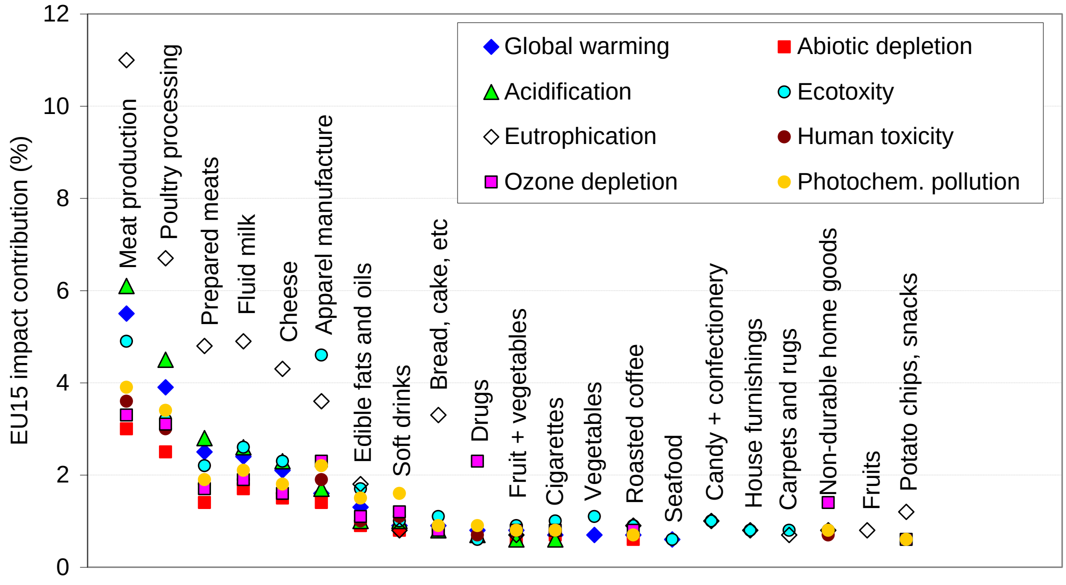
8.1 Green sourcing of food and drink products

Description

The product category 'food and alcoholic beverages' is the largest contributory group to major environmental pressures arising from production and consumption in the EU, accounting for 30 % of EU environmental pressure, and over half (58 %) of eutrophication pressure (EC, 2006). Figure 8.1 highlights the particular importance of meat and dairy production with respect to environmental pressure.



NB: Product groups are ordered according to global warming impact ranking
Source: derived from data in EIPRO study (EC, 2006).

Figure 8.1: The relative contribution of different product groups to eight environmental impacts in the EU-25

The upstream environmental impacts associated with the production of food and drinks consumed on accommodation and restaurant premises may be considerably greater than direct environmental impacts arising from on-site operations (see Figure 2.4 in section 2.2). Green procurement based on selection of lower environmental impact products is therefore an important mechanism for accommodation and restaurant managers to leverage environmental improvement. Although the environmental benefits of green procurement are often not reflected in environmental reporting, green procurement can be conveyed to clients as an important indicator of social responsibility and added value of the service provided.

In the first instance, collaboration amongst chefs, procurement and marketing personnel is recommended to develop a responsible menu offer that includes environmentally-driven objectives such as:

- appropriate portion sizing (also to reduce waste: section 8.2)
- high proportion of fruit, vegetables, cereals and pulses
- judicious portioning of meat and dairy products
- emphasis on seasonal produce (seasonal menus)
- local sourcing of fresh produce.

Procurement personnel may then seek the most sustainable brands or suppliers of the required main ingredients. Key criteria include: environmental certification, organic labelling, country or region of origin. The technical report for Retail Trade (EC, 2011) refers to relevant certification standards for green sourcing of various food products. These are summarised under 'Operational data', below. Nordic Swan ecolabel criteria for restaurants require documentation of the country of origin for all main ingredients (Nordic Ecolabelling, 2009).

An important component of best practice is the marketing of 'green' food and drink, in advertising and in menus, so that customers choose such products and are willing to pay any associated price premium.

There is overlap between this technique and green procurement to reduce waste from packaging (section 6.1) and measures to reduce organic waste (section 8.2). Local sourcing is also a factor that tour operators may influence to improve the sustainability of their packages at the (section 4.4).

Achieved environmental benefit

Products certified according to standards containing environmental criteria should be associated with reduced environmental 'hotspot' pressures, and lower overall lifecycle environmental pressures, compared with average non-certified products. The main features and achieved environmental benefits of common environmental standards for food products are described in Table 8.1.

Table 8.1: Widely-used third-party basic environmental standards applicable to product groups

Standard	Features	Main environmental benefits
Basel Criteria on Responsible Soy Production	Established in 2004 by Coop CH and the WWF, the BCRSP is composed of 37 criteria relating to environmental management, minimization of chemical inputs, and sustainable land use, for soy production	– Avoids agricultural encroachment into high conservation areas; – Reduces resource consumption; – Reduces soil erosion; – Reduces water and air pollution.
Better Sugarcane Initiative (BSI)	Comprises 48 metric benchmarks for sugarcane farmers and processors, based on five key sections, including Obey the Law; Production and Processing; Biodiversity and Ecosystems; Continuous Improvement. Contains rigorously defined, performance-based standards (BSI, 2010)	– Avoids agricultural encroachment into high conservation areas; – Reduces resource consumption; – Reduces soil erosion; – Reduces water and air pollution.
Common Code for the Coffee Community Association (4C)	Based on ten unacceptable practices, and a Code Matrix comprised of 28 principles for which 'green', 'yellow' and 'red' criteria have been defined (4C Association, 2010). Farmers and processors must achieve an average of 'yellow' across principles	– Avoids agricultural encroachment into high conservation areas; – Reduces resource consumption; – Reduces soil erosion; – Reduces water and air pollution.

Standard	Features	Main environmental benefits
Fairtrade (FT)	This exemplary social standard contains detailed requirements for land use and good environmental management practices for farmers, including biodiversity management and nutrient and pesticide application restrictions (Fairtrade, 2009)	– Avoids encroachment into high-conservation-value areas; – Reduces resource consumption; – Reduces soil erosion; – Reduces water and air pollution.
Global Good Agricultural Practice (GAP) and benchmarked standards	The GlobalGAP standard is widespread (94 000 certified producers in over 100 countries), and is primarily focused on food hygiene and health and safety. Environmental protection arises from site management and waste disposal 'musts' and various 'recommended' measures to reduce erosion and water use (GlobalGAP, 2009)	– Avoids excessive use of resources and bad environmental practices.
Organic (OC)	Organic certification is awarded by various organisations according in compliance with Commission Regulation (EC) No 889/2008 within the EU. At least 95 % of a product's agricultural ingredients must be organic. Detailed requirements and restrictions prioritise the use of internal resources in closed cycles rather than the use of external resources in open cycles. External resources should be from other organic farms, natural materials, and low soluble mineral fertilisers. Chemical synthetic resources are permitted only in exceptional cases.	– Maintains higher agricultural biodiversity; – Reduces resource consumption; – Improves soil quality; – Sequesters carbon in soil; – Reduces GHG emissions for some crops; – (see Table 8.2).
Marine Stewardship Council (MSC)	MSC certification is based on three principles and associated criteria that require fisheries to be sustainable. Specifically, MSC requires: (i) maintenance and re-establishment of healthy populations of targeted species; (ii) maintenance of the integrity of ecosystems; (iii) development and maintenance of effective fisheries management systems, taking into account all relevant biological, social, and environmental aspects; (iv) compliance with relevant laws and international agreements (MSC, 2010)	– Preservation of endangered fish species; – Maintenance of marine fishery ecosystem integrity and biodiversity.
National (or regional) Product Certification (NPC)	A number of certification schemes guarantee that products have been sourced within a particular European country or region, including the Red Tractor (Assured Food Standards, 2010) in the UK and Suisse Garantie (Suissegarnatie, 2010) in Switzerland.	– Avoids worst environmental management practices employed in some poorly regulated developing countries.
Rainforest Alliance (RA)	The Rainforest Alliance Certified seal (SAN, 2010) applies to over 100 types of crops and livestock from Africa, Latin America, Asia and Hawaii. Farmers must comply with at least 80 % of applicable social and environmental criteria from a list of 100 criteria within ten principles, including specific requirements for good environmental management	– Avoids encroachment into high-conservation-value areas; – Reduces resource consumption; – Reduces soil erosion – Reduces water and air pollution.
Red-listed fish (RLF)	Greenpeace, the IUCN and MSC have listed fish species from particular regions that are likely to come from unsustainable fisheries (Greenpeace, 2010; MSC, 2010).	– Preserves acutely endangered fish species.

Standard	Features	Main environmental benefits
Round Table on Sustainable Palm Oil (RSPO)	The RSPO standard (RSPO, 2007) is based on five principles, including environmental responsibility and good agricultural practice, and contains 39 and criteria regarding traceability and social and environmental performance.	– Avoids agricultural encroachment into high conservation areas; – Reduces resource consumption; – Reduces soil erosion; – Reduces water and air pollution.
Round Table on Responsible Soy (RTRS)	The RTRS standard (RTRS, 2010) was finalised in 2010 and is based on five principles, including environmental responsibility and good agricultural practice. Guidance is provided for 98 specified compliance criteria, including requirements for environmental monitoring and specific management plans that provide a framework for continuous improvement.	– Avoids agricultural encroachment into high conservation areas; – Reduces resource consumption; – Reduces soil erosion; – Reduces water and air pollution.
UTZ	Based on a code of conduct comprising 175 control points across 11 themes, including many relevant environmental requirements. Mandatory control points increase from 95 in first year of certification to 152 in 4th year of certification, and must be complied with where applicable to operations (UTZ, 2010)	– Avoids encroachment into high-conservation-value areas; – Reduces resource consumption; – Reduces soil erosion; – Reduces water and air pollution.

There remains considerable debate over the advantages and disadvantages of organic agricultural production relative to agricultural mainstream production. Lower yields for organic production incur indirect land use effects associated with compensatory production. These effects are difficult to assess as they are determined by global trade forces and secondary consumption effects (overall consumption may be reduced owing to the higher price paid for organic food).

Nonetheless, organic production has a number of benefits compared with average (non-certified) mainstream production (Table 8.2), particularly in relation to sustainability challenges such as high rates of soil erosion (Verheijen et al., 2009), dependence on finite abiotic resources (e.g. fossil fuels and phosphate rock), and crop breeding focussed on crop response to synthetic inputs. The comparative environmental performance of organic and mainstream agriculture is presented in more detail under 'Cross-media effects', below.

Table 8.2: Relative advantages of organic production compared with mainstream production from a farm system and product lifecycle perspective

Organic farm system advantages	Organic product lifecycle advantages(*)
– Higher on-farm biodiversity (Mäder et al., 2002; Nemecek et al., 2011) – Improved soil quality (organic matter and microbe content) (Mäder et al., 2002) – Higher rates of soil biological nutrient cycling (Mäder et al., 2002) – Soil carbon sequestration (IFOAM, 2009; Pimental et al., 2005) – Crop-breeding for good performance under low-input conditions (CoopCH, 2010)	– Lower abiotic resource depletion (Nemecek et al., 2011) – Lower energy use (Corré et al., 2003) – Lower ecotoxicity (Nemecek et al., 2011) – Lower GHG emissions for cereals, crops and some meat production (Hirschfield et al., 2008).
(*)per kg product.	

It is difficult to estimate the scale of environmental benefits achieved by green procurement for a typical establishment owing to the wide range of products and standards involved, and difficult-to-quantify product lifecycle benefits compared with average non-certified products. However, Table 8.3 indicates the possible magnitude of GHG emission reductions achievable from green procurement of a few types of products based on documented differences across varieties of these product types.

Furthermore, Figure 8.6 and Figure 8.5 (below) indicate the potential percentage reductions in environmental impact for sugar and fresh fruit and vegetables, respectively, with reference to carbon footprint and in a Swiss context.

Table 8.3: Potential GHG emission reductions arising from the sourcing of lower-impact options of three products

Product	Annual saving	Main source of saving	Reference
	kg CO_2 eq.		
1 000 kg fresh fruit and vegetables	11 500	Avoid air-freighted produce	Climatop (2009)
1 000 litres milk	1 720	Good on-farm management practices	Sainsbury's (2010)
1 000 kg sugar	280	More efficient feedstock (sugarcane instead of sugarbeet)	Climatop (2008)

Appropriate environmental indicator

Product standards and criteria

Table 8.4 indicates relevant standards and criteria for green procurement across broad product groups. The percentage of products procured that fulfil these standards and criteria is a relevant indicator of performance. Percentages may be expressed for each product group, as recommended for retail best practice in green procurement (EC, 2011), and/or as aggregated performance across all product groups. Nordic Swan (2009) propose the use of purchase value for calculation of percentages, as these data should be readily available from standard account keeping (it may be necessary to specify within the accounts which suppliers are associated with which environmental criteria or standards.

Table 8.4: Relevant product standards (and criteria) for broad product groups, classified as 'basic' and 'high' environmental performance

Product groups	Basic standard	High standard
Coffee, chocolate, tea		4C, FT, OC, UTZ
Dairy	GAP, NPC	OC
Fruit and vegetables	GAP (avoid airfreight, from heated greenhouses)	FT, NPC, OC (in season)
Fats and oils	GAP, NPC	RSPO, RTRS, OC
Grains and pulses	GAP, NPC	OC
Poultry, eggs	GAP, NPC	OC
Red meat	GAP, NPC, RA	
Fish and seafood(*)	RLF	ASC, MSC
Soft drinks	See sugar, below	
Sugar	GAP	BSI, FT, OC (cane sugar)
Water		(filtered) tap water

NB: ASC: Aquaculture Stewardship Council; BSI: Better Sugarcane Initiative; FT: Fairtrade; GAP: Good Agricultural Practice; MSC: Marine Stewardship Council; NPC: National (or regional) Production Certification; OC: Organic (labels such as BioSuisse, EU leaf, KRAV, Soil Association); RA: Rainforest Alliance; RSPO: Roundtable on Sustainable Palm Oil; RTRS: Round Table on Responsible Soy.

(*)all fresh and saltwater fish, fish eggs and shell fish
Source: Derived from EC (2011).

Benchmarks of excellence

Benchmarks of excellence for green procurement of food and drink products are:

BM: the enterprise is able to provide documented information, at least including country of origin, for all main ingredients[14].

BM: at least 60 % food and drink products, by procurement value, are certified according to basic or high environmental standards or criteria.

BM: at least 40 % food and drink products, by procurement value, are certified according to high environmental standards or criteria.

These benchmarks refer to aggregate percentages for all food and drink products purchased, expressed by purchase value. Data may also be expressed for particular product groups to demonstrate progress towards these overall benchmarks. Where products are produced onsite, percentages may be expressed based on equivalent purchase value. Figure 8.2 shows the performance achieved by a small 'vivienda rural' in Spain (described in more detail under 'Case studies', below). Meanwhile, Green Hotelier (2011) report that 60 % of food served in Fairmont

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[14] Nordic Ecolabelling (2006) define potatoes, pasta, meat, fish and beans, etc., as 'main ingredients'. Accompaniments and ingredients which form only a small part of the meal such as spices, salt, herbs, mustard, ketchup, dressing and food oil are not defined as main ingredients.

Copley Plaza's Oak Room Restaurant, in Boston, comprises local ingredients purchased from a farmer's market across the street.

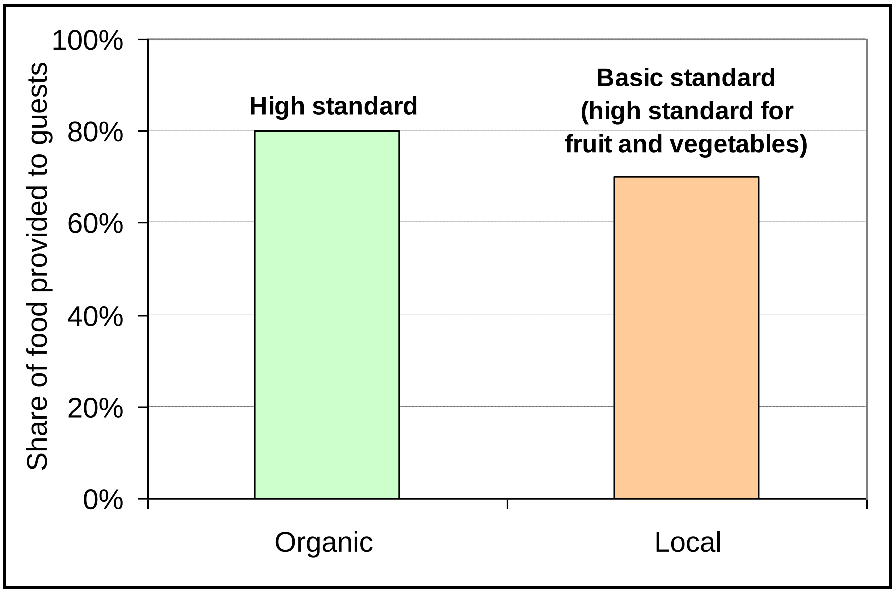


Figure 8.2: **Share of food and drink products provided to guests at the Huerta Cinco Lunas vivienda rural in Andalucia, Spain**

Meanwhile, at the destination level, the EC Tourism Sustainability Group recommend a minimum threshold of 25 % of food and drink products locally sourced from within destinations (see section 3.1).

Cross-media effects

Local sourcing versus certification

It is important to base green procurement decisions on the appropriate environmental indicators. For example, the environmental impact of fresh fruit and vegetables can be dominated by long-distance transport, especially air freight (Climatop, 2009), so that local sourcing is an appropriate green procurement criterion for fresh fruit and vegetables. Meanwhile, local or regional sourcing is not an appropriate indicator for sugar that is most efficiently produced from sugarcane in warm climates (Figure 8.6). For many products, the better environmental performance is most reliably assured by third-party certification with environmental standards. There may at times be conflicts between environmental and social sustainability objectives, for example in terms of local product options versus Fairtrade certified products from less economically developed countries.

Environmental standards

Certified environmental standards usually target environmental hotspots for particular products, and therefore are not associated with significant cross-media effects.

Organic production

To produce equivalent yields and protein content to non-organic 'mainstream' systems, organic systems have been calculated to require 35 % more land area (Corré et al., 2003). Greater land area requirements of organic systems may lead to increased GHG emissions and biodiversity loss at a global scale that counter direct environmental benefits (Burney et al., 2010: Brentrup et al., 2010), although displaced production is probably lower than 35 % owing to higher prices for organic food (Figure 8.4). Mainstream systems may include 'organic' management practices such as crop rotation, integrated pest management, and application of organic fertilisers (Goulding et al., 2009). The best mainstream systems are more eco-efficient than organic systems, but average organic systems have an advantage over average mainstream systems (Figure 8.4), except for some products such as beef (Hirschfield et al., 2008).

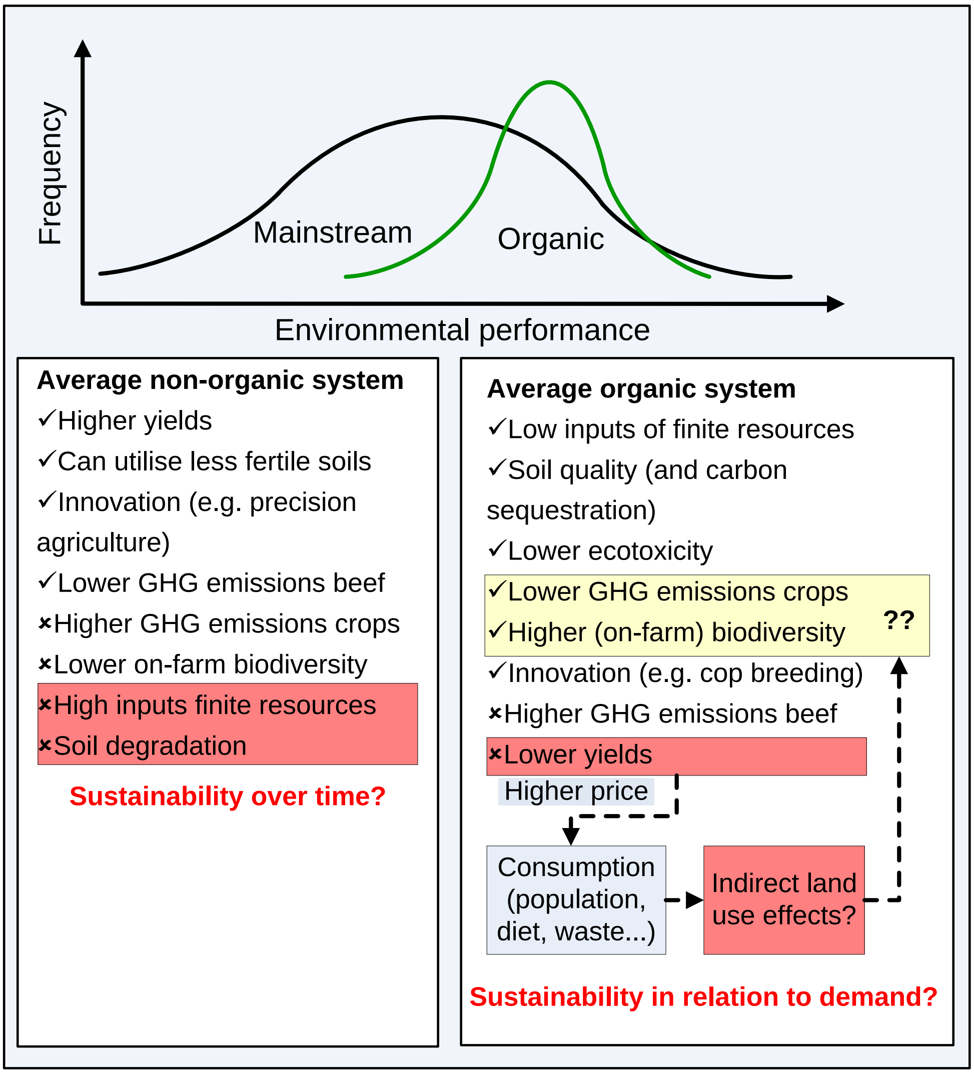


Figure 8.3: **The relative strengths and weaknesses of mainstream and organic production systems, and key sustainability issues**

Operational data

Identifying priority products and ingredients

Priority products can be identified by a basic audit of the ingredients included in the menu offer (e.g. taken from shopping or order lists). All ingredients used should be listed alongside basic information such as the source location and any certifications awarded. The basic list can be compared with documented environmental priority products, such as, for example, caviar or North Atlantic bluefin tuna (unsustainable stocks), palm oil (farming associated with deforestation and peat soil degradation), beef (high GHG footprint), out-of season green asparagus (often air-freighted).

Full lifecycle assessments (LCA) are not usually necessary, but information from lifecycle databases is useful. Free LCA software includes GEMIS and UMBERTO, for example, whilst the European Reference Life Cycle Database has been developed as an authoritative compilation of European lifecycle data. This and other guidance on LCA tools and databases are provided on a dedicated EC website: http://lca.jrc.ec.europa.eu/lcainfohub/index.vm

For the initial audit, it may be necessary and more efficient to contract third-party experts who should be able to quickly identify priority ingredients and relevant green procurement actions(local sourcing, appropriate certification, etc.). This could be the most expensive (but once-off) component of sustainable sourcing. Guidance on the identification of product improvement options is provided below.

Prioritisation should be based on ingredients with the highest environmental burden, which may include ingredients used in small quantities (e.g. caviar). Thus, a full screening of menu ingredients is important, but improvement may be performed in a step-wise manner, addressing high volume ingredients first.

Product assessment and relevant procurement criteria

Environmental hotspot stages and impacts vary across product groups, and, consequently, so do the most relevant environmental criteria to be considered in green procurement. Guidance on key hotspots and appropriate mitigation measures is provided in the technical report for the retail trade sector (EC, 2011) and websites such as Sustainweb in the UK (Sustainweb, 2011)). Table 8.4, above, summarises relevant criteria and standards across some major product groups. Here, some key product hotspots and relevant green procurement criteria are summarised for a few products as examples.

Beef

The production of beef is associated with particularly high environmental impacts (see Figure 8.1, above). Figure 8.4 displays a breakdown of GHG emissions arising from the supply of frozen beef.

The impact of production is dominated by animal husbandry owing to high emissions of the potent GHG methane from enteric fermentation within cattles' digestive systems. The manufacture of fertiliser applied to grass for grazing and silage, and crops used to produce concentrate food, accounts for a large portion of energy consumption, and fertiliser application gives rise to emissions of the extremely potent GHG nitrous oxide (Figure 8.4). Transport and chilling energy, and refrigerant leakage, make a minor contribution to lifecycle GHG emissions in the case of beef (unlike for fruit and vegetables). Hirschfield et al. (2008) suggest that organic certification is not a useful indicator of more environmentally friendly production for beef, and there are no existing standards that ensure eco-efficient beef production.

However, GHG emissions and overall environmental impact can be considerably higher where beef is produced on land recently cleared of forest or native vegetation, as occurs in Latin America. Therefore, best practice in green procurement is to avoid such beef. As summarised in Table 8.4, relevant criteria and standards for this purpose are (best first):

- local sourcing
- national production certification
- GlobalGAP certification
- Rainforest Alliance certification.

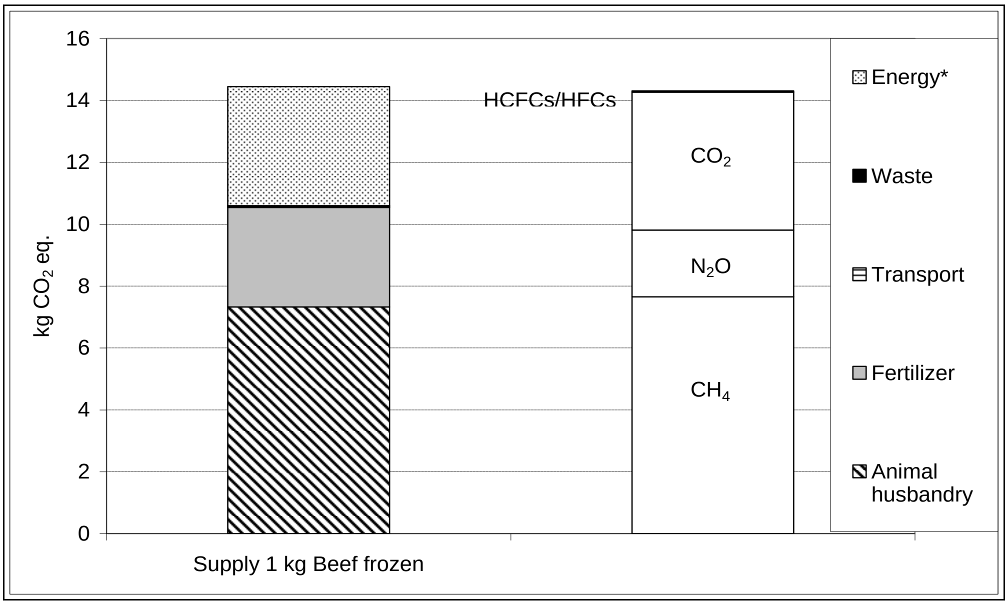
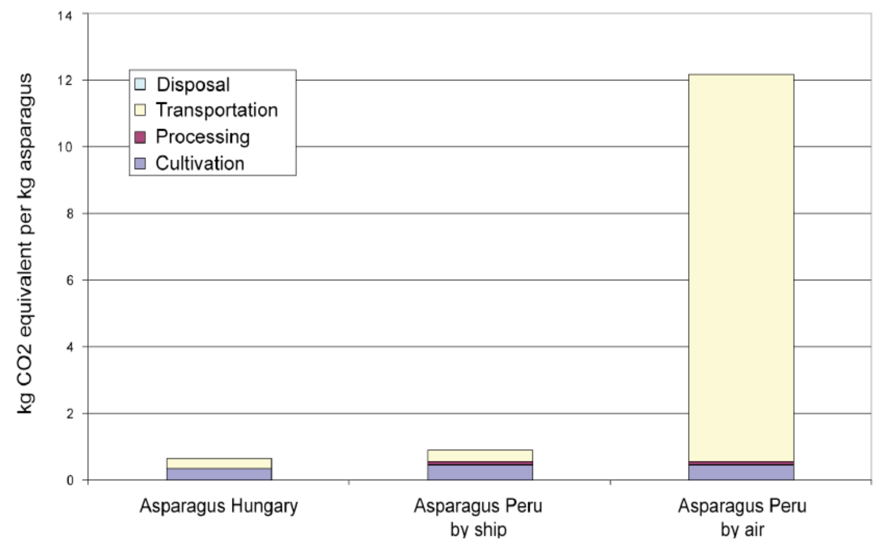


Figure 8.4: **The origins and composition of GHG emissions arising during the production and storage of 1 kg of frozen beef, based on average German conditions, calculated using the GEMIS LCA tool**

Fresh fruit and vegetables. The results of a lifecycle assessment for fresh green and white asparagus, from production to shop display, are presented in Figure 8.5, and provide an example of the main environmental impacts associated with fresh fruit and vegetables that may be sourced from geographically distant source regions outside of local production seasons. GHG emissions arising from the supply of one kg of asparagus ranged from 0.5 to 12 kg CO_2 eq. Cultivation is the largest source of emissions for asparagus transported by lorry and ship, but air transport completely dominates emissions for air-freighted Mexican and Peruvian asparagus. Cultivation impacts arise mainly from fertiliser application and manufacture, but also from manufacture of plastic sheeting, machinery fuel use, and soil carbon loss under tillage agriculture. Environmental impacts include: soil erosion, depletion of water resources and salinisation where irrigation is applied, eutrophication of water from nutrient run-off, eco toxicity effects from pesticide use, emissions of acidifying gases from fertiliser application, machinery use and transport.

Best practice in the procurement of fresh fruit and vegetables is to avoid air-freight and heated greenhouses, and to use the following criteria, as summarised in Table 8.4 (best first):

- Local sourcing
- Seasonal sourcing
- National production certification
- Organic certification
- Fair-trade certification (provided no air-freight)
- GlobalGAP certification.



Source: Climatop (2009).

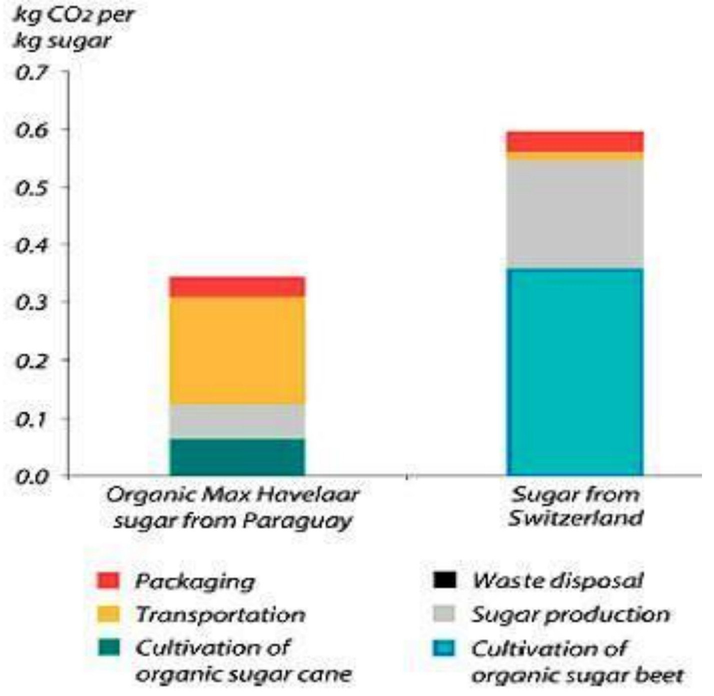
Figure 8.5: Breakdown of GHG emission sources for asparagus from different sources

Sugar

Lifecycle GHG emissions arising over the sugar supply chain, from production to retail display, are presented in Figure 8.6. Six types of sugar were compared, and the carbon footprint varied by a factor of two, primarily due to high cultivation emissions for sugar beet compared with sugarcane (two types of sugar presented in Figure 8.6). Cultivation emissions arise mainly from fertiliser application and manufacture, but also from machinery fuel use and soil carbon loss under tillage agriculture. Organic cultivation was found to result in significantly lower GHG emissions for sugarcane cultivation in Paraguay, but not for sugar beet cultivation in Switzerland or Germany. Additional impacts are similar to those listed for fresh fruit and vegetable production, above. Relevant green procurement criteria and standards include (best first):

- Better sugarcane Initiative certification
- Selection of cane- (rather than beet-) sugar
- Organic certification
- Fairtrade certification
- GlobalGAP certification.

Notably, because of the higher impact of beet sugar than cane sugar, national or local sourcing is **not** good practice for sugar in Europe.



Source: Climatop (2008).

Figure 8.6: Breakdown of GHG emission sources for different sugar products

Eggs

A case study on the carbon footprint of organic eggs was performed by the Product Carbon Footprint consortium (PCF, 2009). The production of six eggs was calculated to cause the emission of 1.18 kg CO_2 eq. (Figure 8.7), from the following sources:

- pullet-rearing and egg-laying farms (62 %)
- use phase – transport, cooking and eating (21 %)
- handling by retailers (10 %)
- supply transport (1.5 %).

Figure 8.7 demonstrates that GHG emissions from the egg laying farm are dominated by manure management and feed production (responsible for approximately 79 % of egg laying farm emissions). These stages also give rise to acidifying (ammonia) emissions and eutrophication (nitrogen run-off). The following GHG reduction options were highlighted in the PCF study (percentage reduction potentials in brackets): installation of biogas plant at egg-laying farms (14 %); consumers using egg boilers for cooking (11 %); using renewable electricity in regional warehouses and stores (9 %); customer shopping by bike or foot (4 %). Thus, restaurants can reduce the lifecycle environmental impact of eggs through efficient cooking (section 8.4), for example using egg boilers, and through optimising the delivery schedule (consolidating orders). Relevant selection criteria for green procurement include (most environmentally rigorous first):

- organic certification
- local sourcing
- national production certification
- GlobalGAP certification.

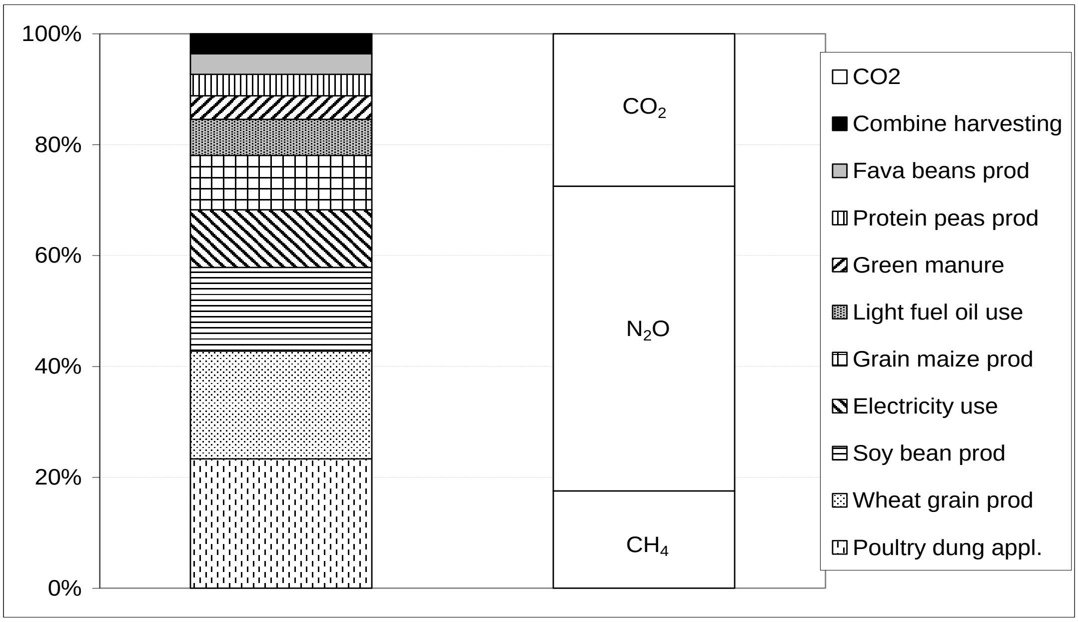


Figure 8.7: The contribution of processes and individual gases to GHG emissions on the egg-laying farm

Instigating green procurement

There may be considerable overlap with green procurement to minimise waste, including packaging waste (section 6.1) and organic waste (section 8.2). For example, avoiding bottled water wherever possible is best practice (see example of filtered water supplied in the five star Rafayel Hotel, in section 6.1).

Personnel from a range of departments should be included in green procurement decisions to ensure that they are practical and successful, but ultimately a single 'champion' is required to drive and coordinate green procurement efforts. Where an enterprise has a purchasing department, someone from within this department would be appropriate. This person has responsibility for identifying new opportunities and suppliers, monitoring supplier performance, and collaborating with staff, e.g. working with chefs to modify recipes or adopt new recipes based on local, seasonal and certified products. Seasonal products are usually available in good quality for two to three months at a time, and 90 % of menu offers may be planned using a calendar of seasonal food availability (Green Hotelier, 2011). The Travel Foundation (2010) suggest that green procurement performance by responsible staff is included as a criterion in reward systems (e.g. linked to bonus pay).

It is important to conduct some basic research and contact relevant authorities and agencies before embarking on a green procurement review. Local authorities, agencies or NGOs may organise, or be aware of existing initiatives for local green procurement. Some examples of free online guidance for sustainable sourcing in the UK are provided in Table 8.5. Many other sources are available.

Table 8.5: Examples of free online sustainable sourcing guidance in the UK

Organisation	Web link	Content
Sustainweb	http://www.sustainweb.org/	Extensive information on sustainable food and suppliers within the London region of UK.
Food Link	http://www.londonfoodlink.org	Similar to above.
Eat the Seasons	http://www.eattheseasons.co.uk	Provides timely advice on in-season produce to include in menu offers.
Soil Association	http://www.soilassociation.org	Information on organic food and suppliers.

The availability of local, seasonal and certified products may be limited. Procurement of such products may require a shift from one large supplier to a number of smaller suppliers. It may be necessary to sign longer-term contracts with smaller (local) businesses to build up capacity for particular products over time. It may be necessary to provide local farmers with advice on expected quality, packaging and health and safety standards. Payment periods may need to be shortened when working with smaller businesses: Travel Foundation (2010) suggest a payment period of no more than 15 days for small businesses.

Green marketing

Green procurement can be an important component of a value-added marketing strategy, for example centred on an ethical, sustainable, or local theme. Collaboration with local suppliers can differentiate the service offered by an accommodation or food and drink establishment, for example through the provision of bespoke products. To achieve this, information can be provided to customers on the origin of the food and any 'story' associated with it, for example on relevant menu pages. Photographs convey messages effectively and concisely (Green Hotelier, 2011). Cookery demonstrations or classes based on traditional local recipes may be provided. Such strategies can be highly effective for tourism marketing (Travel Foundation, 2010). The case study examples describing the Otarian restaurant chain and Le Manoir aux Quat'Saisons Restaurant, below, highlight how sustainable procurement can be used as an important marketing tool.

Case studies

Huerta Cinco Lunas (ES)

Huerta Cinco Lunas is a small 2.5 hectare farm in Andalucia certified as organic by Agrocolor (AGR-02/1033) that provides bed and breakfast accommodation in three rooms within a traditional Andalucian farmhouse ('finca'), renovated using local materials in the traditional style. From the organic garden (Figure 8.8), the owners produce a range of produce, including eggs laid by hens fed with organic waste from the kitchen (Table 8.6). Crops are fertilised using animal manure from a neighbouring organic farm compost from the kitchen. Weeds are controlled through manual weeding.

Table 8.6: Some of the produce grown on-site at Huerta Cinco Lunas

Fruit	Vegetables	Others
– apples – apricots – chestnuts – figs – lemons – oranges – peaches – pears – pomegranates – quinces	– chard – courgette, – cucumber – garlic – leek – lettuce – onions – peppers – potatoes – pumpkin, – tomatoes	– almonds – eggs – olive oil (150 L/yr)
Source: Huerta Cinco Lunas (2011).		

Breakfast provided to guests is comprised of approximately 80 % organic ingredients, many of which are produced onsite: marmalades and jams, eggs, fruits and vegetables. Purchased products include organic cereals, and non-organic bread, coffee, tea and milk. Including evening meals provided for guests on request, the overall share of locally sourced food in the offer is approximately 70 %.

Figure 8.8: Organic fruit and vegetable garden at Huerta Cinco Lunas

Le Manoir aux Quat'Saisons, Oxforshire, UK

Le Manoir aux Quat'Saisons is a Michelin two-starred restaurant in Oxforshire that places a virtue on the provenance of its food, especially the purity and freshness of ingredients. An on-site organic garden of 0.8 hectares provides 90 types of vegetable and 70 varieties of herb used in the kitchen.

A responsible fish sourcing policy involves collaboration with the Marine Stewardship Council, and comprises the following:

- to only use seafood products that are sustainable and responsibly fished
- to ensure the fishing methods used pose no threat to local marine aquaculture
- to avoid fish species during their spawning season
- to inform guests via the menu of the fishing method and origin of the species
- to inform guests whether the seafood is farmed or wild.

Fish from Cornwall are caught by day boats certified under the Responsible Fishing Scheme. Sea bass and Cornish hake are mostly line-caught; lobsters and brown crabs are caught using pots; turbot, brill, plaice and sole are caught by day boats using nets designed to avoid unsuitable by-catch and by vessels that avoid areas where young fish mature. Mussels are rope grown in the river Fal in Cornwall; sardines are caught in small ring nets by day boats; cockles and clams are hand-gathered on the coast of Dorset. Creel-caught langoustines and hand-dived scallops are caught off the western coast of Scotland. The menu is occasionally adapted to utilise by-catch species.

Otarian restaurant chain

Otarian is a restaurant chain that offers a 100 % vegetarian menu, substantially reducing the environmental burden of food compared with average restaurants serving meat (Otarian, 2011). Sourcing policy is based on the principle 'as close to home as sustainable' to reduce transport-related impacts, and air freight is avoided. Otarian cooperate with suppliers to reduce packaging, for example to avoid double packaging and difficult-to-recycle packaging such as bubble-wrap. Packaging is consolidated by using the same crates for different products, and by extensive (re)use of reusable crates and compostable packaging made from bagasse (a by-product of cane-sugar production).

Otarian have generated carbon footprint data for their entire menu, using the PAS 2050 standard, and use this information to calculate the 'carbon saving' associated with selecting one of the menu's vegetarian options compared with an equivalent meat-, fish-, or egg- containing dish. Customers can register carbon savings on a loyalty card as 'Carbon karma credits'. Carbon footprint information is also used to help the often local suppliers improve their environmental performance. In summary, Otarian provide a good example of sustainable sourcing and effective marketing of the value added achieved by such sourcing.

Thomson resort hotels jungle jams

Sensatori Resort and four other hotels contracted by Thomson Holidays on Mexico’s Yucatan peninsula provide guests with 'jungle jams' for breakfast. These jams are made by a cooperative of Mayan women from the peninsula. This was initiated by a project with the Travel Foundation (see section 4.3) that worked with the women, advising them on customer communications, how to launch the product and establish links with the hotels. Guests appreciate the opportunity to eat authentic, locally made papaya and cactus-fruit jams. In addition to environmental benefits arising from the use of sustainably harvested local produce, procurement of these jams achieve social benefits by empowering local women to earn a living from within their jungle villages (TUI Travel plc, 2011).

SuperClubs 'Eat Jamaican'

The 'Eat Jamaican' campaign was launched in November 2003 by several Jamaican associations and businesses to promote locally-produced goods to residents, visitors and exporters. SuperClubs is a global all-inclusive tour operator that engaged with the 'Eat Jamaica' campaign, coordinating local procurement and promotion of local food across its Jamaican hotels. In 2004, SuperClubs started working more intensively with Jamaican farmers to provide incentives and technical assistance programmes. The hotel also provided the Jamaican government with policy guidelines for initiatives that would benefit both the agricultural and tourism industries. Currently, SuperClubs purchases over USD 110 million worth of local produce annually. One challenge has been to ensure a continuous supply of high quality produce from local suppliers. SuperClubs resorts promote local produce as a unique tourist attraction, for example in 'Celebrating Jamaican Cuisine and Culture' weekend events that combine local culinary delights, music, arts and crafts (Travelife, 2011).

Applicability

As demonstrated above, any type of establishments offering food and drink can implement a green sourcing programme.

Economics

Following a review of food and drink supply chains, it is useful to initiate the green procurement programme by selecting cost-positive or cost-neutral options, such as local products, and move on to any products associated with a price premium as the programme develops. Additional product procurement costs should be considered in the context of marketing, and may be offset by increased turnover arising from marketing of value-added products and services, possibly in the context of a green marketing strategy.

On-site production of food can reduce procurement costs (though labour costs, etc., should be considered). Strattons Hotel and Restaurant in the UK grows fruit and vegetables on site, and uses eggs from laid by chickens kept on site, saving EUR 1 000 per year.

Driving force for implementation

The main driving forces for green sourcing include:

- corporate social responsibility

- food quality considerations
- product/service differentiation and green marketing
- securing reliable and stable supply chains
- improving local relations and reputation.

Reference companies

Strattons Hotel and Restaurant (UK), Gavarni Hotel (F); Huerta Cinco Lunas (ES); Le Manoir aux Quat'Saisons (UK); Otarian restaurant chain; Thomson Holidays.

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8.2 Organic waste management

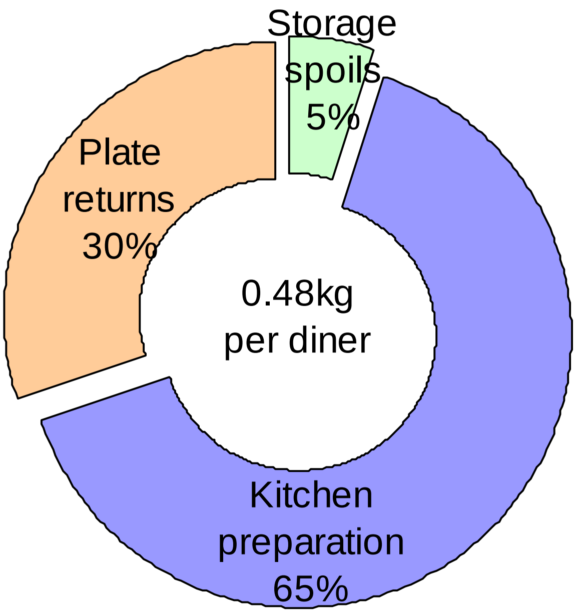
Description

Kitchens generate large quantities of organic waste, including peelings and trimmings, bones, uneaten returns from customer servings, out-of-date products, oil used for frying, etc. Organic waste can represent 37 % of residual waste generated by accommodation, and almost 50 % of residual waste generated by restaurants (WRAP, 2011). It is estimated that the UK hospitality industry disposes of 400 000 tonnes of avoidable food waste per year, at a cost of almost EUR 900 million (WRAP, 2011).

A study of UK restaurants by the Sustainable Restaurant Association (SRA, 2010) found that the average quantity of organic waste generated by restaurants was 0.48 kg per diner (Figure 8.9), dominated by kitchen preparation (65 %), followed by returns on customer plates (30 %). Spoilage of stored food made only a minor contribution (5 %). When assessing restaurant performance in terms of waste generation per diner, it is useful to distinguish between 'avoidable' and 'unavoidable' food waste (WRAP, 2011):

- **Avoidable food waste:** food waste that could have been consumed on site, such as plate returns, spoilage, etc.
- **Unavoidable food waste:** waste arising from on-site food preparation, such as peelings, rind, fruit cores, etc.

The ratio of these fractions can differ significantly across restaurants. For example, restaurants that buy in fresh food for on-site preparation, rather than buying in pre-prepared food, will generate more unavoidable organic waste (but may generate less packaging waste).



Source: SRA (2010).

Figure 8.9: Organic waste produced by UK restaurants

WRAP (2011) calculated that quick service restaurants recycle 55 % of waste, and other restaurants 39 %, indicating considerable scope for improvement. The characteristics of organic waste mean that it can be recycled into useful materials such as fertiliser and bioenergy. Best practice in organic waste management for kitchens is for managers to coordinate actions across all staff, from procurement, through commis chefs to chefs, cleaners and waiting staff, and marketing personnel, so that: (i) the amount of food waste generated is minimised, and; (ii) the quantity of organic waste sent to landfill is minimised. This involves:

- providing optimised offers on the menu;
- considering environmental criteria during procurement (section 2.2);
- careful storage (e.g. correct adjustment of refrigeration temperature: section 8.4);
- providing appropriately sized portions;
- careful food preparation to minimise and separate organic waste;
- separation of organic waste during plate scraping and prewashing;
- recovery of used oil for collection to produce biodiesel.

It is no longer permitted to use food waste from catering centres and restaurants for animal feed, and uncooked meat and animal by-products must be treated according to minimum standards that prohibit their inclusion in some processes such as small-scale composting (DEFRA, 2011). A Danish study carried out in 2004 analysed potential systems for the collection and treatment of food waste. Lifecycle assessment was used to rank the main options for organic waste disposal in the following order of declining preference (Table 8.7).

Table 8.7: Ranking of different organic waste management options in terms of environmental performance according to Miljøstyrelsen (2004)

Rank	Waste management option
1	Biogas production with central collection and pre-treatment (collection in bins)
2	Biogas production with decentralised collection and pre-treatment, respectively
3	Collection with ordinary mixed waste for incineration
4	Composting with decentralised collection and pre-treatment

Composting was rated the least preferred option because it does not generate energy and releases additional GHG emissions through methane production (Miljøstyrelsen, 2004). Composting may be viewed more favourably in terms of nutrient cycling, and is preferable to landfill which remains the dominant waste disposal option in some countries. Thus, best practice is to avoid landfill, and either:

(i) send for anaerobic digestion or incineration with energy recovery, or;

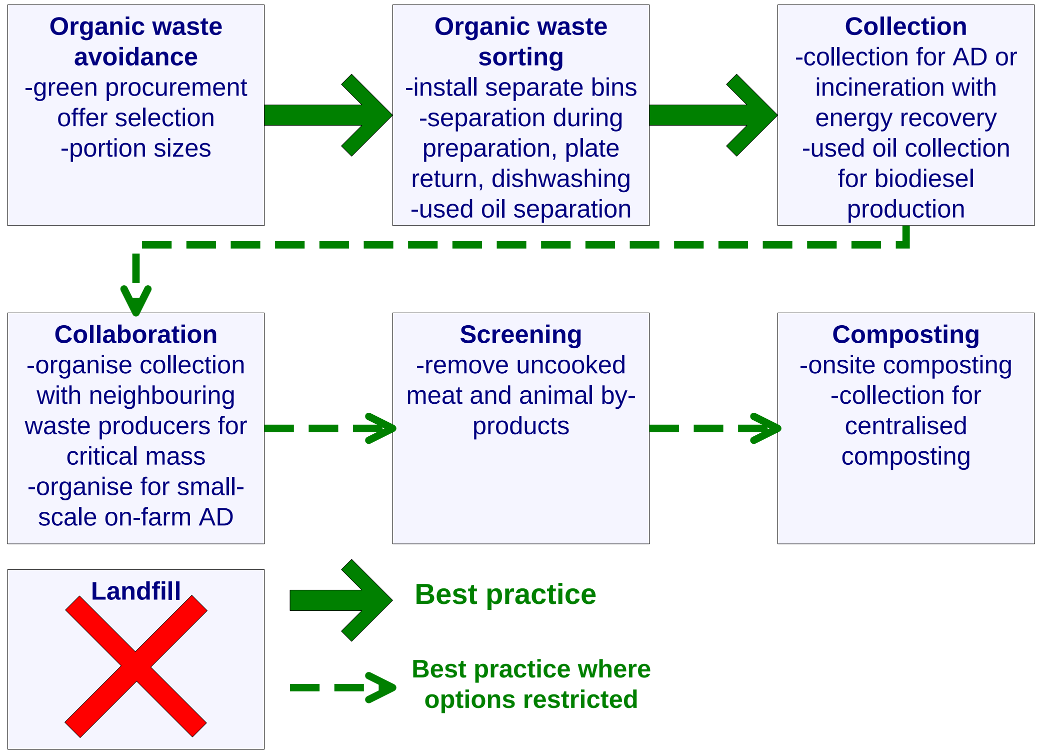
(ii) where first options are unavailable, perform on-site compositing or send for central composting.

Automated systems are now available for the efficient recovery and collection of used cooking oil to produce biodiesel. These systems considerably reduce the risk of accidents arising from handling hot oil, enable oil life to be prolonged by filtering, inform appropriate oil change frequency, and enable optimisation of collection and transport operations. Best practice for large kitchens is to send used cooking oil for biodiesel production using efficient (semi-automated) collection systems.

Figure 8.10 summarises the sequence of best practice in organic waste management for kitchens, depending on locally available options. Best practice is summarised as:

- avoidance
- separation
- anaerobic digestion or incineration with energy recovery

- composting.



NB: AD = anaerobic digestion.

Figure 8.10: Summary of best practice for organic waste management in kitchens

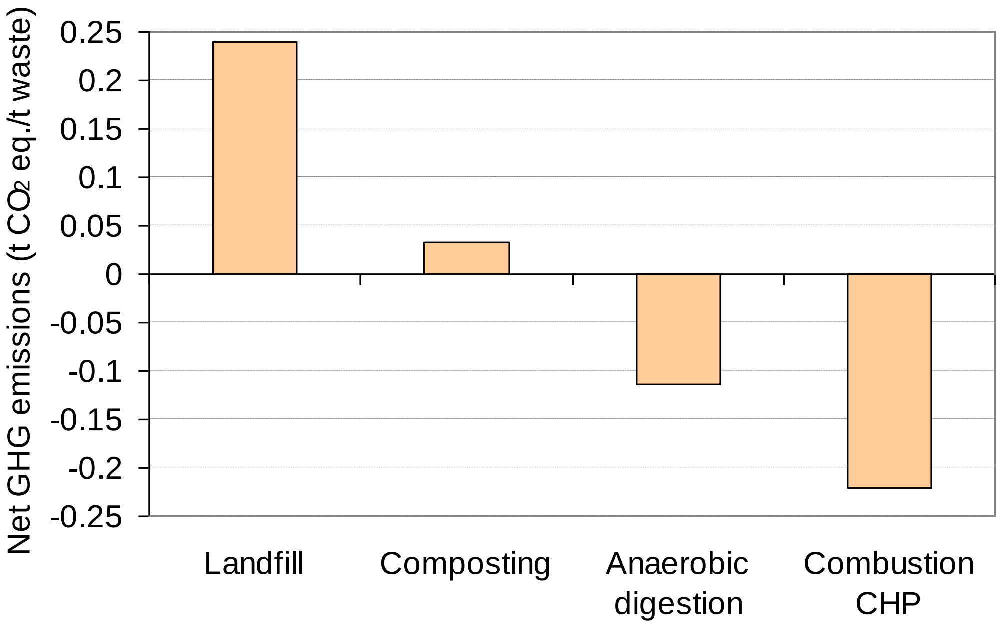
Kitchens also generate large quantities of non-organic waste, for example from food packaging, that should be avoided reused, sorted and recycled wherever possible according to best practice described in section 7.1 and section 7.2.

Achieved environmental benefit

Reducing waste

A survey of UK restaurants calculated that reducing the average quantity of food waste produced by 20 % would equate to an average reduction of 4.36 tonnes per year per restaurant. Reducing food waste reduces impacts associated with waste disposal (below) and the large impacts associated with food production (section 8.1). The environmental impacts avoided by diverting waste from mixed collection are heavily dependent on the management of mixed municipal waste, and will be greatest where landfill without methane flaring is employed and lowest where incineration with energy recovery is employed.

Figure 8.11 presents net GHG emissions arising from landfill, composting, anaerobic digestion and combustion in a combined heat and power plant – considering methane emissions, transport and avoided fossil fuel consumption for energy generation. Net GHG emissions from landfill depend heavily on how the site is managed, and can be substantially higher than indicated in Figure 8.11. One tonne of organic waste can generate up to 1.3 t CO_2 eq. of methane emissions during anaerobic decomposition in a landfill without mitigation measures (Lou and Nair, 2009). However, in modern European landfill sites most of the decomposition gas is captured and used to generate electricity, considerably reducing GHG emissions.



Source: SRA (2010), ORA (2011), PDM (2011).

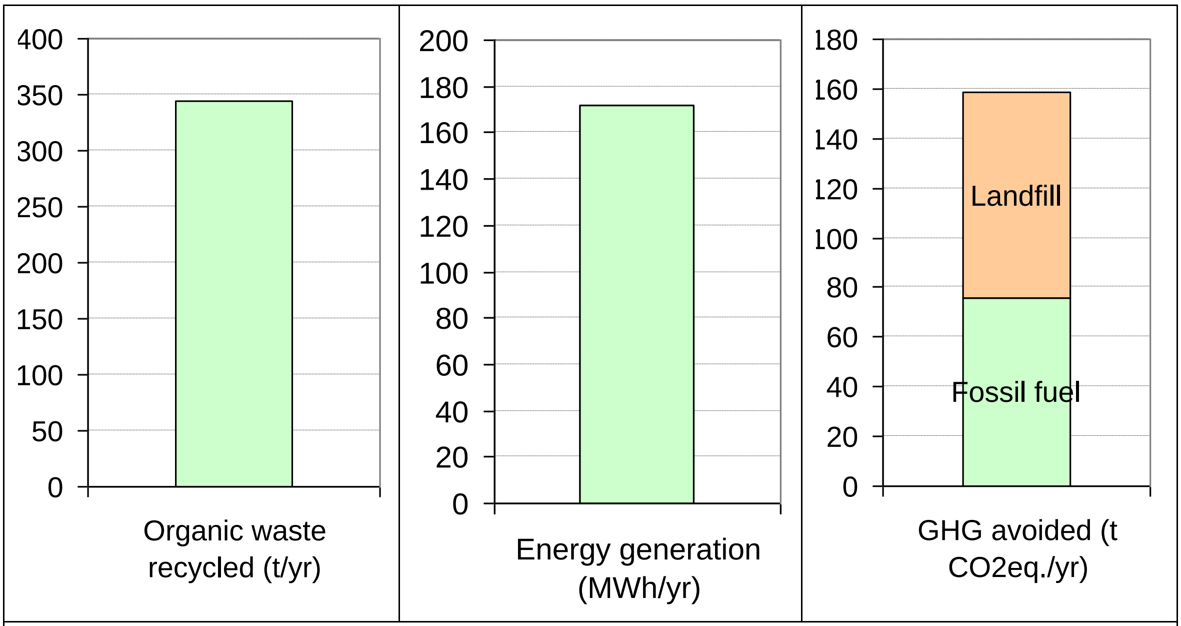
Figure 8.11: **Net GHG emissions from landfill, composting and anaerobic digestion of organic waste, per tonne and per average UK restaurant**

Energy recovery

Anaerobic digestion yields approximately 2.5 GJ of biogas (108 Nm^3) per tonne of organic waste (Fruergaard and Astrup, 2011), that may be used to substitute fossil fuels for electricity and/or heat generation and/or transport (biogas from one tonne organic waste equivalent to 70 litres of petrol). Compared with disposal in a modern landfill, anaerobic digestion avoids approximately 0.35 t CO_2 eq. per tonne organic waste. Nutrient-rich digestate improves and sequesters carbon in soil, and substitutes fertiliser (avoiding production impacts) when applied to agricultural soil in accordance with crop nutrient requirements.

Incineration with energy recovery does not retain nutrients or have soil improvement benefits, but produces more energy (almost 4 GJ of combined heat and power per tonne of waste) (Fruergaard and Astrup, 2011), avoiding up to 0.46 t CO_2 eq. per tonne organic waste compared with disposal in a modern landfill.

Figure 8.12 shows the energy generated (172 MWh) and GHG emissions avoided (158 t CO_2 eq.) from incineration of 344 tonnes per year of organic waste arising from The Savoy hotel and affiliated restaurant (Simpsons in the Strand). Avoided GHG emissions are based on the alternative disposal of organic waste in landfill.



NB: Annualised values based on data for January to August 2011.

Figure 8.12: Energy generation and carbon dioxide emission avoidance associated with combustion of organic waste from The Savoy to generate heat and electricity, compared with the alternative option of landfill

Composting

The main benefits of composting **compared with landfilling** organic waste are:

- a reduction in GHG emissions (lower methane generation under aerobic decomposition)
- a reduction in land appropriation for landfills
- avoidance or reduction in waste transport (for on-site or nearby composting)
- recycling of nutrients, especially phosphorus (a finite resource), and avoidance of fertiliser manufacture
- soil improvement and carbon sequestration.

Compared with disposal in a modern landfill, composting avoids approximately 0.21 t CO_2 eq. per tonne organic waste (SRA, 2010; ORA, 2011). Further benefits may be realised from soil carbon sequestration: although situation-specific and difficult to quantify, they have been estimated at 0.18 t CO_2 eq. per tonne of compost (Lou and Nair, 2009).

Compost produced from 50 % hotel kitchen waste and 50 % hotel garden waste (by weight) was found to contain 1.5 % nitrogen, 0.5 % phosphate and 1 % potash (potassium) (Envirowise, 2008). Compared with windrow composts, vermicomposts retain a higher proportion of nitrogen owing to lower process temperatures.

Appropriate environmental indicators

Indicators

The appropriate environmental indicator for waste generation intensity is:

- the quantity of unavoidable organic waste generated, expressed in kg, per dining guest.

Restaurants in UK generate on average 0.48 kg food waste per diner. Two large German restaurants within a theme park serve, respectively, 470 000 and 315 000 dining guests annually. They generate 0.26 and 0.36 kg organic waste per diner, respectively.

The appropriate indicator of environmental management for organic waste is:

- the percentage of organic waste sent for anaerobic digestion or alternative energy recovery;
- the percentage of organic waste composted on site or sent for composting, where the alternative waste disposal option is landfill.

Note that the term 'cover' is often used in the food and drink service industry to signify one dining guest.

Benchmarks of excellence

The benchmark for organic waste management is:

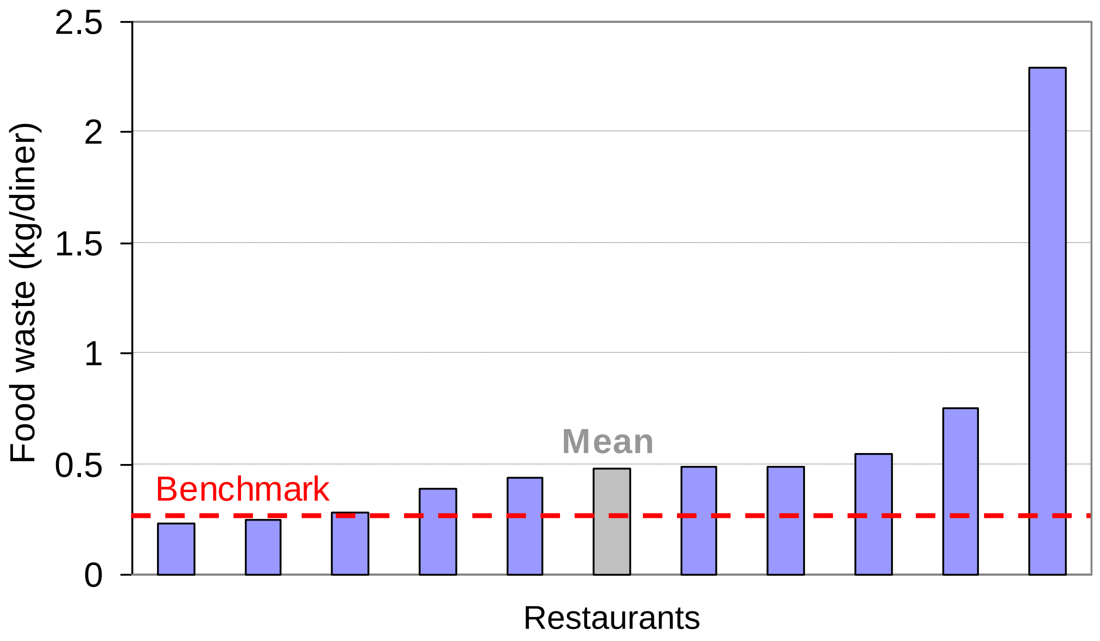
BM: ≥95 % of organic waste separated and diverted from landfill, and, where possible, sent for anaerobic digestion or alternative energy recovery.

For example, The Savoy hotel in London separates all organic waste and sends for combustion in a CHP plant, and the Otarian restaurant chain ensure that 98 % of all restaurant waste is recovered as compost, is recycled or is reused.

Data on waste generation per cover are scarce. However, data for UK restaurants (Figure 8.13 and WRAP, 2011) and German hotels (see above) would support the following preliminary benchmark of excellence for accommodation and restaurant kitchens:

BM: total organic waste generation ≤0.25 kg per cover, and avoidable waste generation ≤0.18 kg per cover.

Owing to the scarcity of data, this benchmark is conservative, and more ambitious targets may be appropriate for some enterprises.



Source: Derived from data in SRA (2010).

Figure 8.13: Food waste generation per cover in UK restaurants, and proposed benchmark of excellence

Cross-media effects

Anaerobic digestion is often performed in centralised plants, necessitating the transport of wet organic waste and giving rise to transport-related impacts that are typically small compared with waste disposal impacts. Fruergaard and Astrup (2011) estimate diesel consumption of 7.2 litres per tonne of organic waste collected for anaerobic digestion, compared with 3.3 litres per tonne for incineration in more widespread incineration plants with energy recovery (Danish situation). Compared with incineration, emissions of methane are higher from anaerobic fermentation owing to leakage that has been reported at rates of between 0 % and 10 % of methane produced (Eggleston et al., 2006). This is more likely to be a problem in small-scale plants. In the Otelfingen plant described below, no waste water is discharged, and air from all the buildings is evacuated via a biofilter.

The cross-media effects from composting are greenhouse gas emissions (methane and nitrous oxide), odours, dust emissions and leachate. Leachate is a particular problem for open-air composting beds: one mm of rain falling on one m^2 of compost bed produces up to one litre of leachate. Areas under outdoor composting should be sealed with an impermeable membrane and leachate collected for use as a fertiliser. However, these impacts are comparable with those of landfill, whilst composting leads to nutrient recycling and soil conditioning benefits.

Operational data

Waste minimisation and separation

A survey of organic waste generation, including information on sources (e.g. spoilage of stored food, preparation, and plate returns), should be used to inform appropriate avoidance actions. Portion sizing may be reduced without impacting on customer satisfaction. The quantity and type of food returning on customers' plates can be used as a guide for portion sizing and menu planning. Menu planning to avoid waste should be performed in combination with green procurement (section 8.1). One pub-restaurant in Tipperary, Ireland, reduced the amount of food waste generated by over one-third through reducing portion sizes (Irish EPA, 2008). Boxes or bags can be offered to diners to take home food servings that they cannot eat.

Separation of non-organic waste fractions is also important in kitchens, as elaborated for general areas in section 6.2 and displayed for one large hotel kitchen in Figure 8.14.

Figure 8.14: Kitchen non-organic waste sorting in Scandic Berlin

Food preparation accounts for the majority of food waste. Organic waste bins should be conveniently positioned for easy access at all stages of food preparation, plate return and washing. Biodegradable bags made from, e.g. corn starch can be used to collect food waste where necessary, as these breakdown during composting and anaerobic digestion. The sequence below presents an example of organic waste recovery throughout kitchen operations, from food preparation to plate washing, for The Savoy in London.

1. Food preparation

Bins are placed next to chefs during food preparation to separate offcuts and peelings, etc., at source.

2. Plate return

Food scrapings from returned plates separated from other waste (rather than placed in mixed bins, or the sewer via a macerator).

3. Prewashing

Food residues are rinsed off crockery and utensils during prewashing and captured in a sieve (also reduces drain blockages).

Separated organic waste can then be placed in large separate waste bins for collection to centralised or decentralised anaerobic digestion plants, or alternatively if other options are not available, for centralised or on-site composting (see below). Food close to its use-by date may be used for staff meals, given to staff to take home, or donated to charities. Food past its use-by date should be placed in organic waste recycling bins for separate collection. Waste bins containing organic waste may be chilled, especially in urban locations, to prevent odour and vermin problems (e.g. Scandic Berlin, 2011).

In the case of The Savoy, organic waste is sent to a combined heat and power plant (fluidised bubbling bed reactor) to generate heat and electricity (see Figure 8.12). The electricity generated from the hotel's waste is sufficient to supply 10 % of the hotel’s rooms.

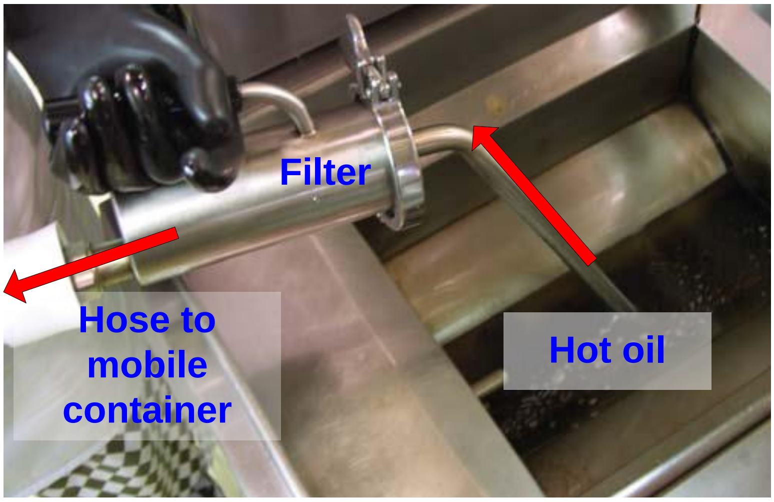
Recovery of used cooking oil

Prior to sending organic waste for anaerobic digestion or composting, it should be screened to separate out useful organic fractions such as cooking oils, fats and grease. Oils can be stored in secure containers for collection by companies specialising in the production of biodiesel, or animal feed, soap or cosmetics production. Oils can also be recovered from oil traps that should be fitted to kitchen drains.

The Savoy in London has one main kitchen serving the restaurants, one large canteen kitchen serving the 600+ staff, and three kitchens for banqueting services. These kitchens generate 600 litres of used oil every month. During a recent refit, a semi-automated cooking oil management system was installed. This system comprises:

- a central storage tank with automatic level recording that is connected via telemetry to the collection company's monitoring system
- a mobile container on wheels with a hose resistant to high temperature oil
- an oil filter and lance that attach on to the hose (Table 8.8)
- a contract with PDM 'Oilsense' that includes:
    - provision of equipment and oil collection as required for a monthly fee
    - payment for oil collected (EUR 0.30 per litre, index linked to diesel prices).

Table 8.8: Operation of the Oilsense used oil collection system



1. Oil extraction from fryers

2. Removal of filter debris

3. Emptying separated water and rinsing of filter

Source: PDM Group (2011).

The system operation is summarised in the following three steps.

Step	Description
1	Oil is changed at appropriate intervals, informed by data received from analyses of collected oil (see below). Hot cooking oil is removed from fryers by inserting a lance attached to a mobile vacuum container, or 'pot', (like a vacuum cleaner) via a filter and hose (Table 8.8). Safely removing hot oil reduces fryer degreasing requirements, keeps pipe-work clear, and offers flexibility in terms of timing (e.g. oil from a single fryer can be changed in five minutes between use).

2	The oil is transported in the pot to a depository point, where it is expelled into a pipe feeding a central collection tank (typically 1 000 to 2 000 litres capacity). Used oil may also be returned to fryers after filtration, potentially prolonging necessary change intervals. In the case of The Savoy, owing to the high standards expected in the restaurants, cooking oil is changed daily from the main kitchen, and transferred to the canteen kitchen for reuse. The filter removes debris that can be discarded to an organic bin, and separates water that can be emptied into a sink during rinsing (Table 8.8).
3	Upon receiving telemetry data that indicates the collection tank is full, the collection company dispatches a tanker to collect the filtered oil (25 % less volume owing to prior removal of debris and water), thus optimising collection transport. A sample is taken from each batch collected and a number of chemical parameters are analysed to ensure the oil is suitable for biodiesel production. Results for the free fatty acid concentration are returned to the client to inform them of the quality of collected oil, and facilitate the optimisation of change frequency (free fatty acid concentrations in used oil range from 1.5 % to 9.5 %, but should be below 5 %).

This system is also installed in fast food restaurants across the UK with a centralised collection incorporating piping from the fryers directly to the collection tank (oil is changed at the push of a button). The system is being expanded to deliver fresh cooking oil via tanker, thus reducing packaging and transport.

Operational details relating to central anaerobic digestion plants with energy recovery and central composting are presented in section 3.3 in relation to destination management.

Composting

Prior to composting, organic waste should be screened to separate bones, uncooked meat and animal by-products not suitable for on-site composting (EC 1774/2002; DEFRA, 2011), and reusable organic fractions such as cooking oils, fats and grease. Oils can be stored in secure containers for collection by companies specialising in the production of biodiesel, or animal feed, soap or cosmetics production. Kitchen waste suitable for composting includes: fruit and vegetables, bread, rice, potato peels, kitchen roll, coffee and tea filters, potted plants, meat without the bone, fish, dairy products, egg shells and egg boxes. The screened organic waste may then be collected and taken to centralised composting facilities (e.g. Figure 3.18), or composted on site. Some local authorities and private companies across Europe collect organic waste for composting.

To initiate on-site composting, it is recommended to introduce only garden waste at the beginning, then when the system has been established, to slowly include kitchen waste. Closed vessels should be used for kitchen waste to avoid vermin and odour problems, and can generate quality soil conditioner within 3 – 4 weeks during warmer months (Compost doctors, 2010). Commercially available enzyme supplements may be sprayed onto the food waste to enhance microbial performance. To ensure that material is hygienically treated, the temperature of the compost should be monitored and should be maintained above 60 ºC.

Modern small-scale automated compost systems are available that use monitored information on temperature and moisture to determine the frequency of automated turning. These often include two chambers so that waste can be added to one batch whilst the other matures. The Tower Hotel in Perthshire, Scotland, installed an automated system that consumes less than four kWh per day to generate composted material in around 14 days (compared with 12 – 18 months for the basic compost heaps it replaced). Output is screened for size: material greater than 25 mm is returned for further composting and the finer fraction is stored for maturation for a further two months before use on the hotel grounds. Kitchen vegetable waste is collected in biodegradable bags and six litre bins. In the first year after installation in 2006, the system processed 2.5 m^3

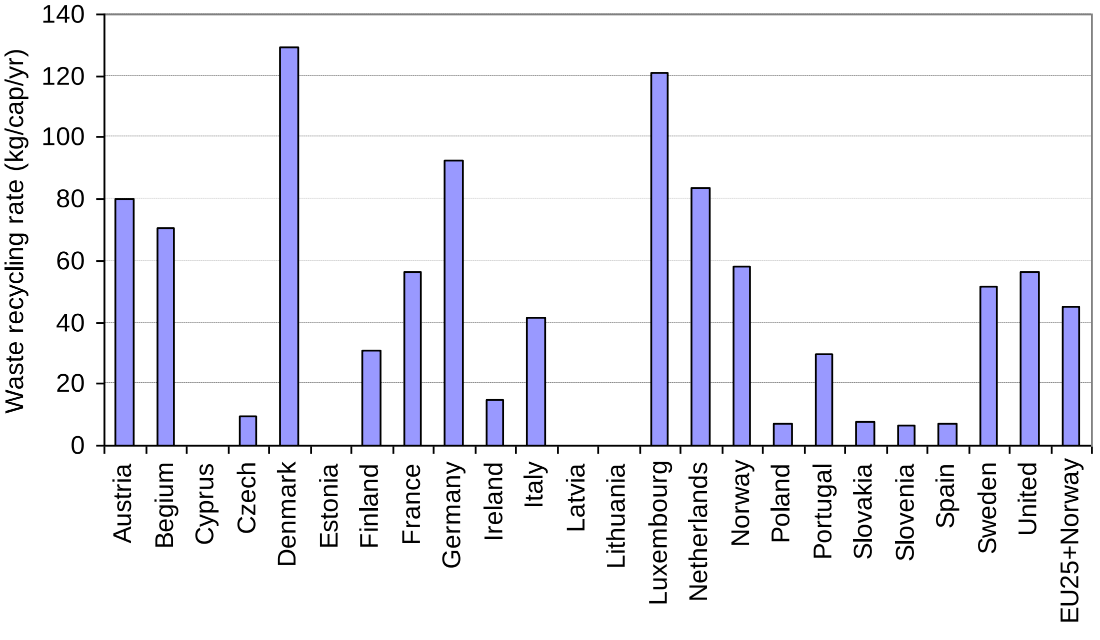
(1.25 tonnes) of vegetable waste from the hotel kitchen, and a further 6 m^3 (1.25 tonnes) of garden waste to produce 1.5 tonnes of compost.

Vermicomposting, based on selected species of earthworms, may be used to accelerate the decomposition of organic wastes into useful compost by aerobic microorganisms such as fungi and bacteria. Unlike composting, effective vermicomposting requires temperatures below 35 ºC (to avoid the death of earthworms). Hence vermicomposting systems require waste to be applied frequently in thin layers of a few centimetres to beds or boxes containing earthworms. Vermiculture may also be large-scale and centralised. Automated reactor systems have been installed which allow waste to be fed from a gantry above the reactors while finished vermicompost is collected from the base using breaker bars. Such a vermicomposting system was installed in 1991 at Montelemar, France to process organic matter from the town's household waste stream. Mixed waste is sorted and then pre-composted for 30 days before being vermicomposted for 60 days by an estimated 1 000 million earthworms. Approximately 27 % of town's total waste stream is converted in a number of reactors to good quality vermicompost which is then bagged and sold.

Applicability

Anaerobic digestion

Some local authorities and private companies across Europe collect organic waste for treatment in centralised anaerobic digestion plants. However, the provision of recycling services for organic waste varies considerably across European countries, and in some cases is poor – reflected in low rates of recycling (Figure 8.15).



Source: ETC/SCP (2010).

Figure 8.15: Organic waste recycling rates across European Member States plus Norway

Where collection to centralised anaerobic digestion facilities is not provided, hotels may enter into agreements with local farmers operating small-scale biogas plants. For example, the Hilton Slussen Hotel in Stockholm sends its waste to a nearby farmer for anaerobic digestion.

Composting

Where neither centralised nor decentralised anaerobic digestion, nor collection for incineration with energy recovery, is available, accommodation and restaurants may either send waste for composting, or, if outdoor space and compost demand is sufficient, compost waste on site. Legislation varies across EU member states with regard to decentralised composting. There may be requirements for the area where composting takes to be paved or sealed for soil and groundwater protection, and for a risk assessment to be performed if the site is within 250 m of a sensitive receptor.

Uncooked meat and animal by-products are subject to regulations including EC 1774/2002 laying down health rules concerning animal by-products not intended for human consumption. For example, the UK's Animal By-products Regulation prevents the decentralised composting of raw meat and other uncooked products of animal origin owing to risk of animal diseases such as Foot and Mouth. Hotels and restaurants may compost their own kitchen waste for use on site provided that livestock are not present (DEFRA, 2011).

Economics

Avoided food purchasing

Minimising organic waste through careful meal preparation and appropriate menu offers reduces the quantity of food that is purchased. This can result in substantial economic savings – greater than those achieved through avoiding landfill. It has been estimated that a 20 % reduction in organic waste arising from UK restaurants would result in an economic saving of more than EUR 2 300 per restaurant per year, on average, in avoided food costs (SRA, 2010). This is equivalent to EUR 530 per tonne waste avoided.

Oil collection

Used kitchen oil generates a small income when collected for biodiesel production. Clients of the 'Oilsense' system described above receive a payment of EUR 0.30 per litre, index linked to diesel prices. Compared with less sophisticated used oil collection systems, the semi-automated 'Oilsense' system is self-financing. Clients with kitchens pay a flat monthly fee for the equipment (no upfront installation cost), and can reduce costs through: (i) reduced handling requirements (less staff time); (ii) fewer accidents handling hot oil; (iii) receipt of oil quality data that can be used to optimise change intervals.

Landfill and incineration

Most European countries impose a landfill levy that is increasing every year. In Ireland, the landfill levy was EUR 50 per tonne in 2011, rising to EUR 75 per tonne in 2012. In the UK, the landfill tax was EUR 65 per tonne in 2011, rising to EUR 100 per tonne in 2014, and these incurred charges are further subject to Value Added Tax. Collection and transport fees are charged in addition to such levies, so that total cost of waste disposal to landfill is typically in the region of EUR 100 to EUR 150 per tonne. In Switzerland, the costs for mixed waste incineration, including transport, are between 110 and 150 EUR per tonne. In Germany, two hotels in Freiburg are charged EUR 116 per tonne for the disposal of organic waste, translating into annual costs of EUR 12 094 and EUR 11 222, and a cost per dining guest of around EUR 0.025 to 0.035, respectively.

Charges for separated organic waste are usually considerably lower than charges for mixed residual waste. In Denmark, the respective charges are EUR 30 and EUR 130 (Affald Og Genbrug, 2011). In addition, separating organic waste can reduce the required frequency for residual waste collection. The Savoy in London reduced mixed waste collection frequency from four-times to twice per week following the removal of food waste from the mixed waste stream, saving EUR 12 000 per year in landfill charges and EUR 12 000 per year in waste collection charges.

Following the introduction of a brown bin service, one large Irish hotel reduced the volume of waste sent to landfill by 70 %, saving EUR 21 000 per year. These savings included avoided compactor rental (lower volume of mixed waste requiring compacting) (Irish EPA, 2008).

Anaerobic digestion

Sending organic waste for anaerobic digestion is comparable in price to sending it for landfill or incineration (SRA, 2010), but it will become cheaper as landfill charges increase (see above). For the Swiss plant mentioned above, a gate fee of approximately EUR 70 per tonne plus transport costs of between 15 and 45 EUR per tonne are paid by the waste generators, including hotels and restaurants. This is lower than Swiss incineration costs of 110 to 150 EUR per tonne referred to above. In Switzerland, the operators of biogas plants receive 11 cents/kWh of electricity fed to the public grid. In case other organisations buy credits for certified eco-electricity, the operator may receive another 6.5 cents/kWh.

Composting

Composting organic waste where other options are not available avoids above-mentioned collection and landfill charges, but incurs equipment and management costs for which subsidies may be available. Compost may be used on site for soil conditioning and fertilisation, reducing expenditure on soil conditioners and fertilisers. A cost-benefit analysis was performed for an automated composter unit comprising a two-chamber composting system capable of handling up to 100 litres or 50 kg of waste per day and with an electricity demand of 900 kWh per year (Smartsoil, 2011). The significant investment is paid back within nine years, assuming waste disposal costs of EUR 115 per year (Table 8.9). It is likely that waste disposal costs will continue to increase annually, thus resulting in shorter payback times.

Table 8.9: Calculation of annual savings and payback period for installation of an automated composting unit

Factor	Cost	Benefit
Equipment cost (EUR)	22 000	
Power supply[1] (EUR/yr)	135	
Savings on waste reduction[2] (EUR/yr)		2 100
Savings on purchase of plant nutrients (EUR/yr)		500
Simple payback time	9 yrs	

[1] Assumes EUR 0.15 / kWh
[2] Assumes EUR 115/tonne collection and disposal cost
Source: Ecotrans (2006); Foodwaste.ie (2010); Smartsoil (2011).

Driving forces for implementation

Driving forces for implementing organic waste separation and composting or collection for anaerobic digestion include:

- national targets to reduce biodegradable municipal waste disposed of in landfills, as required by Article 5 of the Landfill Directive (1999/31/EC)
- regulations regarding the treatment of animal by-products, including EC 1774/2002, preventing landfill and restricting small-scale composting
- environmental responsibility
- differentiated charges for collection of organic waste for anaerobic digestion and incineration or landfill (see above)
- avoided collection and disposal charges (on-site compositing)
- voluntary EMS or ecolabel criteria
- environmental marketing – waste management is a visible demonstration of environmental commitment.

Reference organisations

Reference organisations providing examples of best practice are referred to throughout the above text. A few specific examples are compiled in Table 8.10.

Table 8.10: Examples of best practice in organic waste management

Organisation	Actions
Hilton Slussen hotel, Stockholm	This hotel has separated organic waste and sent it for biogas production since 1997. The residue is sent to farmers outside Stockholm for use on their fields.
The Hilton/Scandic hotel group	Many of these hotels send waste for anaerobic digestion, and an increasing number of company cars are run on biogas (Waste Management World, 2011).
Huerta Cinco Lunas, Cadiz, Spain	This small rural accommodation uses kitchen waste for chicken feed and composting, to produce organic fruit, vegetables and eggs on site for guest consumption (see section 8.1).
The Savoy, London	Aspects of the food waste programme being implemented at the five-star Savoy Hotel, London, are referred to throughout this section and in section 6.2 (recycling of used corks).
The Tower Hotel in Perthshire, Scotland	On-site composting using an automated composting system is described above.

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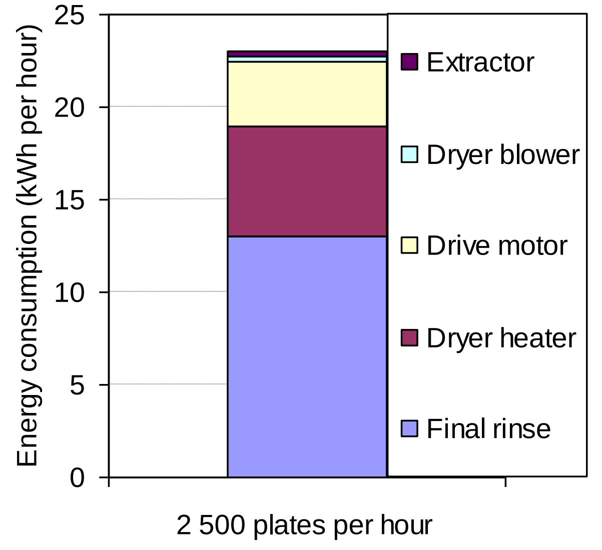
8.3 Optimised dishwashing, cleaning and food preparation

Description

Dish washing is the most water-demanding process occurring in kitchens, accounting for approximately two-thirds of water consumption. Virtually all commercial kitchens use automatic dishwasher appliances, and many use high pressure rinsing with pre-rinse spray valves (PRSVs) to remove large particles of food and grease off dishes, pots and pans before they are placed in the dishwasher. Standard PRSVs consume around 15 litres of water per minute, typically account for 30 % of kitchen water use, and can easily and cheaply be replaced with low-flow nozzles that produce a more efficient high-pressure spray pattern and use less than 6 L/min, saving up to 570 L hot water per day in a typical SME kitchen. Sensor- or trigger-activated PRSVs can also significantly reduce wastage by ensuring that water only flows when required to wash dishes.

Dishwashers use approximately 60 % less water than washing by hand. Nonetheless, commercial dishwashers are responsible for around one third of water consumption in kitchens, and a large portion of energy consumption. Average water use efficiency in commercial dishwashers has improved from 4.6 L per rack in the late 1990s to 3.8 L/rack in 2010, but varies considerably across types and models – the most efficient models use less than 2.0 L per rack (Alliance for Water Efficiency, 2011). Figure 8.16 displays a breakdown of energy consumption in an efficient modern conveyor-type machine suitable for hotel and restaurant kitchens (Meiko, 2011). Total energy consumption of 23 kWh per hour is dominated by heating of the final rinse water (56 %) and dryer air (26 %). Energy consumption is thus strongly related to water consumption (in this case 260 L per hour), and both are minimised through the following features:

- recycling of rinse water to wash and prewash cycles
- recovery of 20 % of wash water through filtration for rinsing
- optimised circulation of drying air
- recirculation of 65 % of drying air
- recovery of heat and moisture from vented drying air to preheat rinse water.



Source: Meiko (2011).

Figure 8.16: Operational energy consumption in an efficient dishwasher processing 2 500 plates per hour

Selection of an efficient and appropriately sized dishwasher can reduce water and energy consumption for dish washing by over 50 %, and is a key aspect of best environmental management practice in kitchens. Additional best practice measures related to the installation and operation of dishwashers include connection to the hot water supply, maximising loading rates, correct programme setting, and green procurement of chemicals. Table 8.11 summarises best practice measures to minimise water (and energy) consumption in kitchens.

Table 8.11: Important measure to reduce water (and energy) consumption across kitchen processes

Aspect	Measure	Description
Dish washing	Efficient pre-rinse spray valves	Install or retrofit PRSVs nozzles to produce a maximum flow of 6 L/min. Install or retrofit sensor- or trigger- activation.
	Efficient dishwashers	Select an appropriate size and type of efficient dishwasher with water consumption ≤2 L per rack (tunnel dishwasher).
	Heat recovery	Install heat-recovery.
	Optimised loading and programming	Maximise dishwasher loading, and set programmes to optimise water, chemical and energy consumption (e.g. avoid prewash).
	Green procurement of chemicals	Avoid environmentally harmful chemicals and select ecolabelled dishwasher chemicals.
Food preparation	Low flow sink taps	Install efficient taps, or retrofit with pressure regulators and/or aerators to achieve flow rates ≤12 L/min.
	Efficient food preparation techniques	Avoid use of continuously flowing water to defrost and wash food.
	Replace older boiler steam cooker and water-cooled wok ranges	Replace old boiler steam cooker with modern boilerless version using ≤8 L water per hour. Replace wok ranges that require water cooling.
Cleaning	Efficient floor cleaning	Avoid the use of hosepipes for floor cleaning (use a mop or water-broom).
	Efficient cleaning of food surfaces	Use correct dilution volumes and select ecolabelled cleaning products.
	Avoid tablecloths	Purchase tables with attractive wipe-down surface that can be used without tablecloths.

Fittings can be modified to reduce the scope for wastage. In particular, infrared sensors can be used to control sink taps according to requirements, and easy-to-operate triggers on PRSVs ensure water flows only on demand. Other equipment that can reduce water consumption includes:

- 'connectionless' or 'boilerless' steamers that recycle steam condensate in heated water reservoirs and that eliminate the need for condensate cooling water, reducing water consumption from over 100 to less than 10 L/hour
- mops or water brooms used instead of hosepipes to wash floors (Alliance for Water Efficiency, 2011)

- air-cooled rather than water-cooled ice makers (Smith et al., 2009).

Basic practice is to avoid water wastage through use of continuous flows to cool refrigeration condensors (Accor, 2007). The flow rate on automatic potato peelers should be minimised, and liquid organic waste disposal units avoided.

Staff training is critical to minimising water consumption in kitchens. Chefs often have little awareness on water or energy conservation, and small changes in food preparation can lead to significant reductions in water consumption. Examples of actions that can significantly reduce water consumption in kitchens include:

- avoiding the use of continuously flowing water to thaw food
- avoiding the use of continuously flowing water to wash food
- avoiding quenching and refreshing of partially cooked vegetables (can be removed from the pan just before they are done and placed directly onto plates for serving up).

Achieved environmental benefit

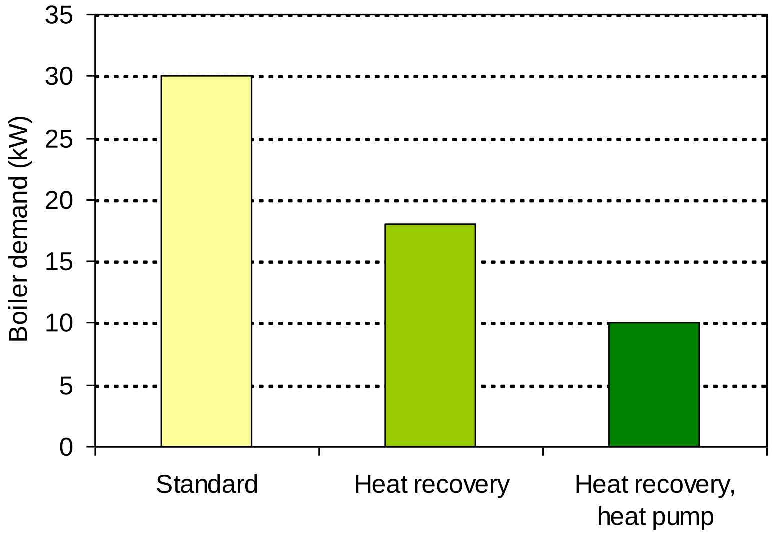
Achievable water savings are referred to in Table 8.12. Installing efficient PRSVs and dishwashers can achieve the greatest annual water savings. Replacing boiler steamers with boilerless steamers (where relevant) can also result in high annual water savings.

Table 8.12: Water savings achievable following implementation of best practice measures

Measure	Achievable reduction in specific consumption	Typical SME annual saving
Efficient PRSVs	67 % (from 15 to 5 L/min)	200 m^3
Efficient dishwasher	50 % (from 4 to 2 L/rack)	150 m^3
Low flow sink taps	40 % (from 20 to 12 L/min)	50 m^3
Efficient steam cookers	92 % (from 100 to 8 L/ hour)	200 m^3
Waterless thawing	100 % (from 10 hrs per week under running water)	10 m^3
Source: Smith et al. (2009); Alliance for Water Efficiency (2009; 2011); Karas (2005).		

Chemical dosing in dishwashers is based on water consumption, so that chemical consumption is proportionate to water consumption. Chemical-saving systems that use an extra prewash cycle and deionised water for rinsing can reduce chemical dosing by up to 80 %, equivalent to 400 litres per year for a water-efficient machine.

Machines incorporating heat recovery and heat pumps have considerably lower water-heating energy requirements compared with standard machines. Heat recovery can reduce energy consumption for water heating by around 40 %, and heat pumps by an additional 45 %, so that the most efficient machines consume two-thirds less energy for water heating than standard machines (Figure 8.17). Measures that reduce heating energy consumption during washing can also reduce the cooling demand in kitchens, thus reducing energy consumption in the HVAC system.



Source: Kromo (2011).

Figure 8.17: Energy savings from heat recovery and heat-pump on a flight-type dishwasher

Appropriate environmental indicator

Indicators

Table 8.13 lists relevant indicators of best practice to minimise water consumption in kitchen areas.

Table 8.13: Relevant indicators of best practice across environmental aspects

Aspect	Indicators of best practice
Monitoring	– Kitchen water consumption is monitored separately and recorded at least once per month(*)
Dish washing	– Waste grinders not used – PRSVs are fitted with trigger operation and have a maximum flow rate of ≤6 L/min – New stationary (under-counter or hood type) dishwashers have rated water consumption ≤3 L per rack – Tunnel dishwashers are installed with heat recovery and heat pump – Dishwashers are connected to hot water supply, or to a dedicated gas boiler in the case of tunnel washers – New conveyor dishwashers have rated water consumption of ≤2 L per rack equivalent – Dishwasher racks are filled before loading into the dishwasher
Food preparation	– Sink taps are installed with foot pedal or sensor operation and have maximum flow rate ≤12 L/min – Steam cookers consume ≤8 L water per hour of operation – Thawing under running water is avoided
Cleaning	– Use of hose to wash floor is avoided – Cleaning agents do not contain the following: alkylphenolethoxylates (APEO) and alkylphenol derivatives (APD), dialkyl dimethyl ammonium chloride (DADMAC), linear alkylbenzene sulphonates (LAS), reactive chlorine compounds (exemption if required by authorities for hygiene reasons(*) – At least 70% of the purchase volume of chemical cleaning products (excluding oven cleaners) for dish washing and cleaning are ecolabelled(*)
(*) Nordic Ecolabelling (2009) criteria.	

Benchmarks of excellence

Data on specific water consumption in kitchens are sparse. Business Link (2011) suggest 25 L per cover (dining guest) for a luxury catering facility, and 15 L per cover for buffets in function rooms, whilst ITP (2008) suggest 35 L per cover for luxury accommodation. Benchmarks from these sources have been found to be consistently high compared with benchmarks derived from best performers described in other techniques. Kitchen water consumption from two Scandic hotels (Scandic Hotels, 2011), representing the preparation of restaurant meals and breakfasts, translate into kitchen water consumption of approximately 13 L per cover, if breakfast is assumed equal to one cover. A preliminary benchmark of achievable performance is therefore total kitchen water consumption ≤13 L per cover.

However, in light of low data availability on kitchen water consumption, the following benchmarks of excellence are proposed in the first instance:

BM: implementation of a kitchen water management plan that includes monitoring and reporting of total kitchen water consumption normalised per dining guest, and the identification of priority measures to reduce water consumption.

BM: installation of efficient equipment and implementation of relevant efficient practices described in this document, as far as possible within demonstrated applicability and economic constraints.

BM: at least 70 % of the purchase volume of chemical cleaning products (excluding oven cleaners) for dish washing and cleaning are ecolabelled.

The benchmark for total chemical use in accommodation enterprises (see housekeeping section 5.3) is also applicable for this technique where kitchens are located on accommodation premises.

Cross-media effects

Measures that reduce water consumption also reduce energy consumption associated with water treatment and pumping, and water heating in the case of hot water. Low flow PRSVs, optimal loading of dishwashers, efficient food preparation and efficient cleaning are therefore not associated with cross-media-effects.

In terms of replacing older dishwasher machines, approximately 90 % of the lifecycle impact of white goods arises during operation, compared with 10 % during manufacture and disposal. Therefore, it is usually more environmentally responsible to replace an older dishwasher with a more efficient one rather than pay to have it repaired (Environment Agency, 2007).

In dishwasher selection and programming, there may be a trade-off between reducing energy and reducing chemical consumption. Low temperature dish washing can considerably reduce energy consumption but requires higher concentrations of detergent. Commercial systems available to minimise chemical consumption consume energy by: (i) incorporating an additional 'scouring' spay before the wash cycle; (ii) applying reverse osmosis to rinse water so that no rinse agent is required. However, the relative savings in chemicals (80 %) are high compared with the modest relative increase in energy consumption.

Operational data

Dishwasher selection

There are many types and sizes of dishwasher, including under-counter or over-counter stationary front-loaders, stationary and pass-through hood-type, rack conveyor machines and large flight type (continuous conveyor) machines that may employ single or multiple wash tanks and use hot water above 82 ºC (high-temp machines) or chemicals (low-temp machines) to achieve final rinse dish sanitisation.

In the first instance, it is important to decide on the machine capacity required. Machine capacities are usually expressed as the maximum number of 'baskets' or 'racks' that can be processed in one hour. One standard rack measures 500 mm by 500 mm, and can hold 18 standard plates, or the serving ware for 4 covers. A full wash cycle ranges from 1 minute in conveyor pass-through machines up to two hours in some under-counter machines (but commercial under-counter machines are available with cycles of a few minutes). Timing varies depending on the programme selected. Conveyor machines usually have at least two belt speed settings, for normal and dirty work: slower (more intensive) settings are typically designed to ensure a minimum contact time of 2 minutes with water at ≥82 ºC, as recommended in the German commercial dishwasher hygiene standard – DIN 10510. It is important to note that maximum quoted capacities are theoretical for the shortest programme times, and do not consider: (i) the time taken to load and unload machines (for door-type machines); (ii) typical incomplete rack filling; (iii) more intensive programmes (Dishwashers Direct, 2011). Compliance with the DIN 10510 standard can reduce capacity by 30 % to 50 % compared with maximum quoted capacity (Meiko, 2011). Selection of an appropriate type and size of machine depends on the peak washing demand and the maximum time available to work through this demand (assuming sufficient serving ware is available). Table 8.14 provides an approximate guide.

Table 8.14: Recommended dishwasher types for different meal serving rates

Meals per hour	Dishwasher type	Racks/hour
≤100	Under-counter	35
100 – 500	Hood	125
500 – 2000	Conveyor (rack)	450
2 000+	Conveyor flight (rackless)	1 000
Source: Restaurant Report (2011).		

For dish washing in smaller kitchens, hood-type dishwashers are appropriate. Older hood-type dishwashers typically have separate wash and rinse tanks, uninsulated hoods, are not configured for connection to hot-water supply pipes, and often require a manual prewash of dishes to remove debris. Newer hood-type dishwashers (Figure 8.18) have insulated hoods that guide steam away from operators when opened, and typically integrate additional systems such as water treatment, thermostat-controlled prewash functions, and drying functions.

Source: Meiko (2011).

Figure 8.18: A modern hood type dishwasher

Critical aspects to consider when selecting a new dishwasher include: (i) equipment lifetime; (ii) rated electricity (and other heat energy) consumption; (iii) rated water consumption; (iv) rated chemical consumption; (v) service and maintenance requirements. In terms of environmental performance, the primary indicator of a commercial dish washing machine efficiency is **water efficiency** as this is closely related to energy and chemical consumption (see Figure 8.16). Table 8.15 provides an indication of good performance for different types of dishwashers, in terms of idle energy (to keep tank water hot) and water use per rack. Energy Star criteria have not yet been developed for very large flight-type conveyor dishwashers, but Koeller et al. (2010) present data indicating that the most efficient quartile of such machines use the equivalent of 1.1 L/rack (single tank) and 0.76 L/rack (multiple tank).

Table 8.15: Energy star criteria (maximum idle energy and water consumption) for high temperature dishwashers

Dishwasher type	Idle energy rate(*)	Water use
Under counter	≤0.9 kW	3.8 L/rack
Stationary single tank	≤1.0 kW	3.4 L/rack
Single-tank conveyor	≤2.0 kW	2.6 L/rack
Multi-tank conveyor	≤2.6 kW	2.0 L/rack

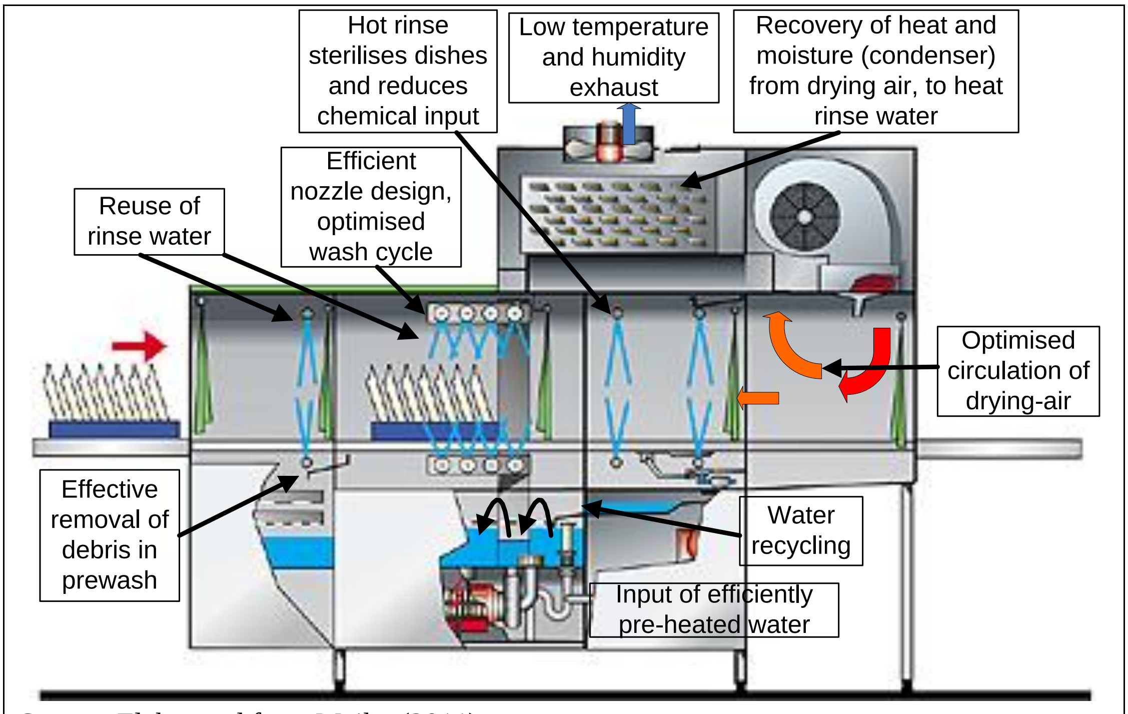
(*)energy used by tank heater only.
Source: Koeller et al. (2010).

The following specifications are highly recommended for commercial dishwashers:

- rinse-water recycling for wash and prewash (multiple tanks)
- rated water consumption ≤2.5 L per basket (tunnel type) or ≤3.5 L per basket (hood type)
- drying air heat recovery system
- at least 20 mm of insulation

- at least two speed settings for standard and dirty dishes (tunnel type dishwashers)
- automatic process control in response to loading (tunnel type dishwashers).

Figure 8.19 displays some key efficiency features for a rack-loaded tunnel-type dishwasher. Efficient machines recirculate 50 – 70 % of blower air following heat recovery and condensation to heat rinse water, and enabling direct venting of relatively cool and dry exhaust air at street level (e.g. Savoy Hotel, London). Recent design advancements include water filtration and recycling to the first rinse cycle, reducing water consumption by up to 20 %, or to a prewash 'scouring' cycle that considerably reduces detergent requirements in the wash zone. Additional considerations are the heat source and type of sterilisation system (heat- or chemical-ased). Commercial machines are available with electric, gas or steam heating options. Gas heating can reduce primary energy consumption by approximately 50 % compared with electric heating, except where the establishment generates or purchases genuine 'green' electricity (see section 7.6). Large conveyor machines are available with a heat pump that can reduce energy consumption for water heating by 50 %.



Source: Elaborated from Meiko (2011).

Figure 8.19: Schematic representation key efficiency features for a rack-loaded tunnel dishwasher

Many manufacturers of commercial dishwashers offer modular systems that enable close matching of installed equipment to requirements and user specifications. Smaller front-loading or hood-type machines may be installed to wash glasses, and hood-type machines to wash pots and pans. Similar selection criteria apply to these as to dishwashers described above. Various public agencies offer energy and water efficiency information to guide efficient procurement.

Figure 8.20: **A conveyor-type dishwasher with heat recovery installed in The Savoy**

Optimised dishwasher installation and operation

Some factors to consider when installing commercial dishwashers are elaborated below.

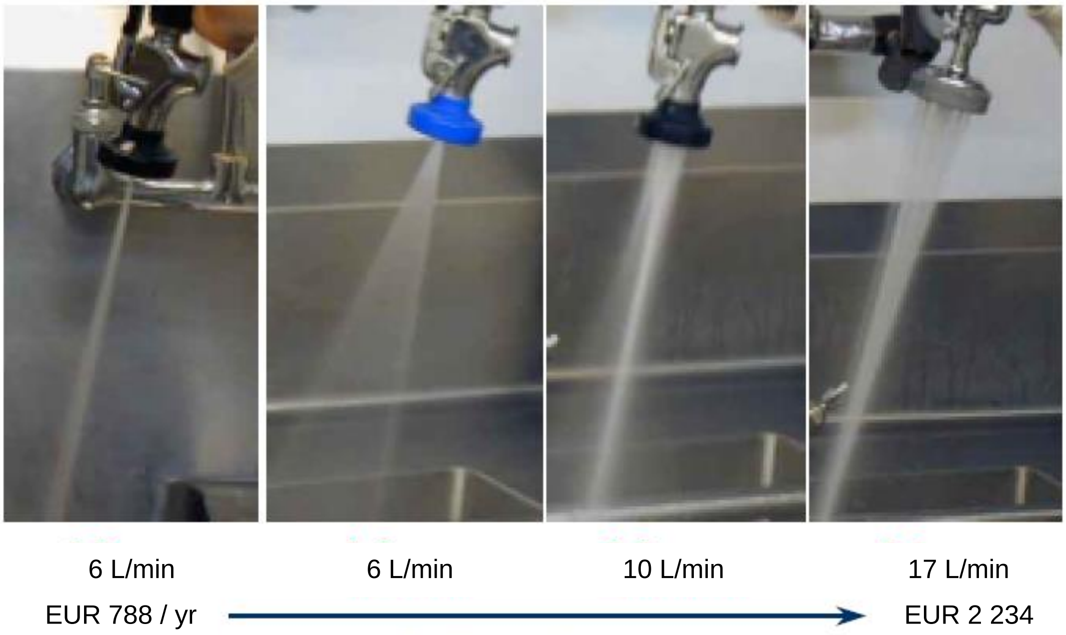
- For dishwashers that use electricity to heat the rinse water, it is preferable to connect the dishwasher to the hot water system, minimising top-up heating.
- Minerals dissolved in standard supply water leave an 'unclean' finish on washed dishes and glasses, and cause scaling (blockage of nozzles and filters) in dishwashers, leading to inefficient operation and high maintenance requirements. It is recommended that commercial dishwashers are either specified or retrofitted with built-in water softeners or supplied with water conditioned in centralised onsite equipment (section 5.1). Owing to the sensitivity of dish and glass washing to water mineral content, some hotels install a dedicated high-performance water conditioner for the kitchen water supply (e.g. Scandic Berlin, 2011).
- High temperature and humidity exhaust air must be vented outside, either at a minimum height above ground level or following condensation, according to various national regulations. Recovery of heat and moisture from exhaust air avoids the installation of long vent pipes or separate condensers.

Staff training to ensure correct loading of dishwashers is critical for efficient machine operation and effective washing. It is worth investing in sufficient serving ware to enable any stock-piling necessary to ensure full loading. Some key points for efficient dish washing are listed in Table 8.16. Food remains on all serving ware should be scraped off into appropriate organic recycling bins (section 8.2), and dishwasher racks loaded as fully as possible. The standard of washing required (e.g. DIN 10510) may dictate the wash programme (conveyor speed) in the first instance. Commercial machines use automated dosing systems, and typically consume 3 ml of detergent per litre water, and 0.3 g rinse aid per litre water (Meiko, 2011). Monitoring of chemical use can help to identify any problems with these systems, and is required to report and benchmark overall chemical consumption (see Fig. 6.x in section 5.3). Similarly, it is important to monitor and check water and energy consumption for early indications of problems, and to inspect dishwashers for correct fill levels (detergents, rinse agents, ion-exchange salts, etc.), functioning instrumentation (thermometers, pressure gauges), and leaks. Water contained in wash tanks should be dumped at intervals specified in manufacturer instructions.

Table 8.16: Some key points to ensure efficient operation of dishwashers

Stage	Key points
Prewash	– Modern dishwashers do not require manual prewashing of serving ware (simply scrape plate contents into appropriate bins: see section 8.2) – pots and pans should be prewashed by soaking and application of high-pressure sprays – collect the serving ware into large batches with similar wash requirements – fill baskets/racks completely
Wash	– where possible in small kitchens, time dishwashers to operate during off-peak electricity demand times (at lower tariffs) – ensure that the dishwasher settings are optimised in relation to how dirty the serving ware is – ensure that the correct chemical dosing is applied
After wash	– if there is a long time between wash intervals, turn the dishwasher off – check the filters and check if there is salt in the machine if there is not a reverse osmosis unit installed – for hood-type dishwashers, ensure that the hood is fully closed to minimise heat loss – check for leaks – regularly check rinse nozzles for wear

Where pots, pans and other utensils are washed in a standard dishwasher, it is necessary to prewash them by soaking in water to soften residues and by using a PRSV. Modern efficient PRSVs use one-third of the flow of older versions, and achieve effective residue removal through high-pressure single-jet spray patterns (Figure 8.21). Trigger operation ensures water flows only when required. Waste grinders should be avoided, and can be replaced with simple mesh baskets that fit inside sinks and capture solid waste materials. These can be emptied directly into organic waste bins.



Source: Modified from Fisher (2006).

Figure 8.21: Examples of PRSV spray patterns and flow rates, and associated annual operating costs assuming three hours per day operation

Food preparation and cooking

Water consumption during food preparation can be reduced through the installation of efficient equipment, in particular sink taps with a maximum flow rate of 12 L/min and operated by foot pedals or sensors (e.g. passive infrared sensors). Flow rates can be reduced without changing tap fittings, through installation of pressure regulators and/or aerators (see section 5.2). Leaks are a common problem in kitchen sink areas, and rubber seals in tap fittings can be replaced with inexpensive ceramic valve retrofits to reduce the occurrence of leaks (O'Neill, 2002).

Staff training is important to reduce water used during washing, although the potential for bad practice can be reduced through the installation of appropriate fittings, especially trigger-activated PRSVs and pedal- or sensor-operated taps. It is important to check that such systems are not being by-passed, for example by jamming PRSV triggers.

Thawing frozen food under running water should be avoided. Thawing food on the bottom shelf of the refrigerator has the added benefit of increasing the operational efficiency of the refrigeration unit. Care must be taken to avoid cross-contamination that can occur by, for example, placing frozen food above ready-to-eat food. Dedicated thawing units thaw food five times faster than a refrigerator, and are appropriate where quicker thawing times are required (Travel Foundation, 2011).

Where old boiler steam cookers are installed, it is worth investing in new boilerless versions that use considerably less water and energy (see 'Economics' section, below). Well insulated wok ranges do not require cooling water. Basic good practice is to avoid or replace wok ranges that require water cooling and can use up to 1 850 L water per day (Energy Star, 2011).

Cleaning

Best practice in kitchen cleaning is similar to best practice in room cleaning described in section 5.3. Key points are to

- avoid use of water hoses to clean floors (use mop or alternative such as a water-broom);
- ensure correct cleaning chemical dilution ratios (display clear instructions and use automatic dosing machines);
- monitor and report all chemical use on a monthly basis;
- avoid environmentally damaging chemicals as defined by Nordic Swan (2009):
    - alkylphenolethoxylates (APEO) and alkylphenol derivatives (APD);
    - dialkyl dimethyl ammonium chloride (DADMAC);
    - linear alkylbenzene sulphonates (LAS);
    - reactive chlorine compounds (exemption if required by authorities for hygiene reasons);
- purchase ecolabelled chemicals where possible.

Applicability

Installation of water-efficient fittings, such as trigger-operated low-flow PRSVs and pressure restrictors or aerators, and water-efficient cooking devices such as boilerless steamers, is universally applicable. Optimised dishwasher loading and maintenance is also universally applicable.

Hood-type dishwashers are suitable for small to medium-sized restaurants, tunnel dishwashers are suitable for large kitchens. Green procurement is usually implemented when replacing an old dishwasher. It may be cost effective to replace older dishwashers before they reach the end of their working life: consider the cost savings of replacing any machines over 15 years old (Carbon Trust, 2007).

Economics

PRSVs and taps

Good quality efficient PRSVs can be retrofitted for less than EUR 50, and have a lifetime of 5 years. Annual savings range from hundreds to thousands of euro (Figure 8.21), resulting in payback times of a few months.

The installation of pressure regulators and aerators is associated with very short payback periods of months, and the installation of new tap fittings and sensor controllers is associated with relatively short payback periods of a few years (see section 5.2).

Dishwashers

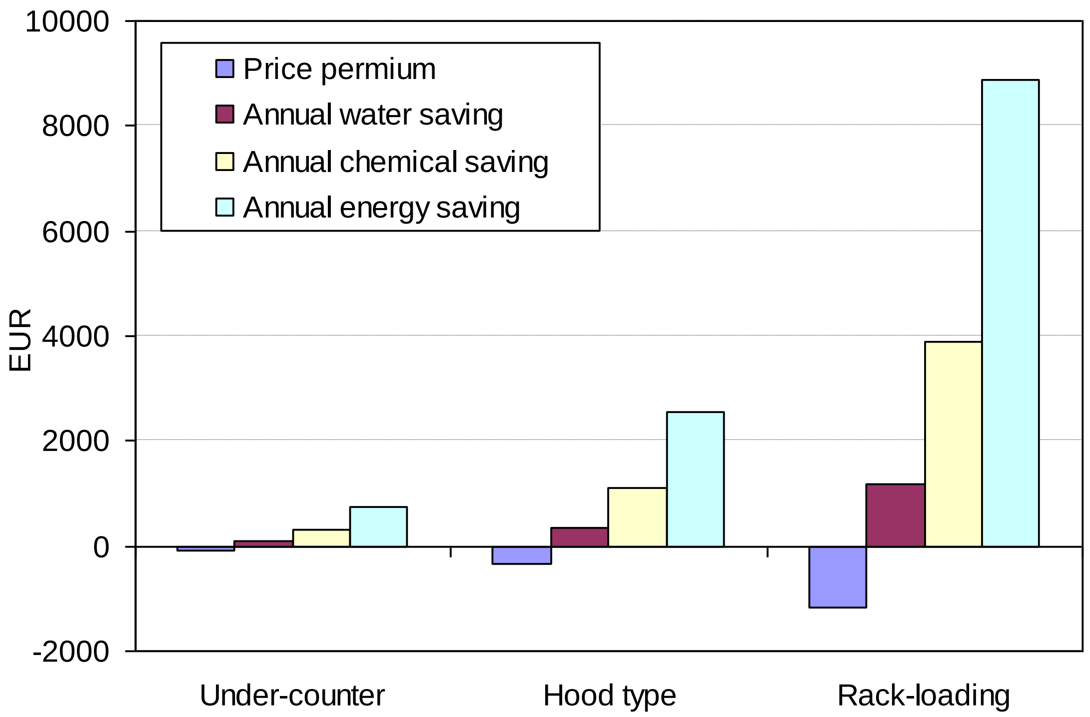
The life expectancy of commercial dishwashers ranges from around 10 years for small under-counter types to over 20 years for large conveyor-types (Koeller et al., 2010). Prices vary widely depending on specifications, capacity and manufacturer. Table 8.17 displays the cost range for low- and high-end machines. Durability and reliability are important factors that have a significant effect on capital depreciation and maintenance costs, and can justify considerable price premiums.

Table 8.17: Example purchase prices for different types and sizes of dishwasher

Type	Capacity	Price range
	Plates (racks) per hour	EUR
Front-loading	60 – 540	1 500 – 5 000
Hood-type	720 (40) – 2 160 (120)(*)	2 500 – 22 000(*)
Rack-conveyor	1 440 (80) – 2 700 (150)	7 500 – 70 000
Flight-type conveyor	1 400 – 7 200	20 000 – 125 000

(*)Pass-through hood type.
Source: Meiko UK (2011); Warewashers (2011).

The price premium for efficient models is highly variable. Koeller et al. (2010) quote dishwasher prices for machines in the US at the low end of prices quoted in Table 8.17, and refer to price premiums in the region of 20 % for the most efficient machines that qualify for Energy Star rating. Water savings associated with such machines, compared with average dishwasher water consumption, would lead to a payback time of a one to two years. Assuming that water savings result in an energy saving equivalent to heating the same quantity of water to 90 ºC, payback times are months (Figure 8.22). In addition to water, energy and chemical savings, efficient machines may be associated with reduced labour costs.



NB: Price premium, annual loading rates and water savings derived from Koeller et al. (2010) as difference between Energy Star and average dishwashers; energy savings based on avoided water heating to 90 ºC; water price of EUR 2/m^3, chemical price of EUR 2/L, and energy price of EUR 0.10/kWh.

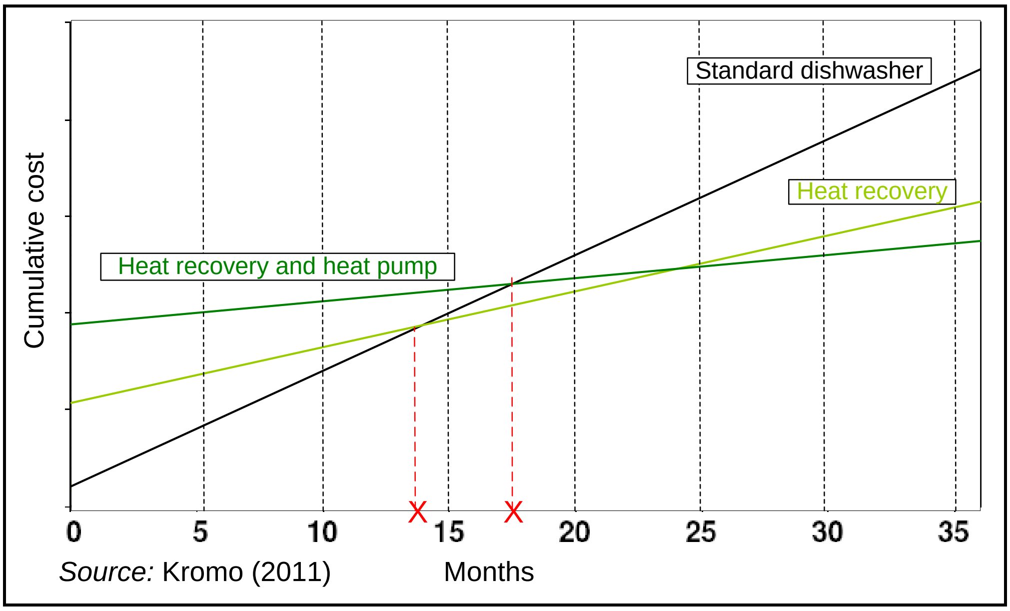
Figure 8.22: Price premium and annual water/chemical/energy savings associated with efficient dishwashers

Table 8.18 presents cost and payback data for optional modules that enhance energy and chemical use efficiency on high-end dishwashers. Simple payback periods range from 1.3 to 6.8 years depending on chemical and energy prices. Figure 8.23 provides an example of shorter payback times of 14 to 18 months for energy saving features on a different make of dishwasher.

Table 8.18: An example of cost and payback period for optional modules on a large (150 rack-per-hour) tunnel dishwasher, assuming 6 hour per day 365 day per year operation

Module	Cost (EUR)	Consumption saving	Consumable price in EUR	Annual saving (EUR)	Payback period (yrs)
Heat recovery condensing unit	3 500	6 kWh/hour	0.10/kWh	1 314	2.7
			0.20/kWh	2 628	1.3
Additional spray and reverse osmosis to reduce detergent	14 500	0.79 L/hr chemicals	2/L	3 469	4.2
			3/L	5 203	2.8
Heat pump	10 500	7 kWh/hour	0.10/kWh	1 533	6.8
			0.20/kWh	3 066	3.4
	20 500	18 kWh/hour	0.10/kWh	3 942	5.2
			0.20/kWh	7 884	2.6

Source: Meiko UK (2011).



Source: Kromo (2011)

Figure 8.23: Payback time for heat recovery and heat pump components of a large flight-type dishwasher compared with standard boiler specification

For tunnel dishwashers with a heating energy demand greater than 5 kW, installation of a dedicated gas boiler to supply hot water can considerably reduce energy costs. Installation costs start at around EUR 2 000 for a 6 kW boiler, and pay back in as little as one year (Meiko, 2011).

Steam cookers

Replacing an old boiler steamer with a new boilerless steamer can reduce annual water and energy costs by EUR 403 and EUR 767, respectively (at a water price of EUR 2/L and an electricity price of EUR 0.10/kWh). Maintenance cleaning costs will also be reduced, resulting in a maximum basic payback of three to four years on the entire purchase price of around EUR 4 000.

Chemicals and laundry

As for housekeeping (section 5.3), green procurement of chemicals incurs a price premium in the region of 20 %, but this is relatively small compared with other costs such as labour, and can be more than offset by ensuring efficient dishwasher operation and training staff in efficient cleaning methods.

Strattons Hotel and Restaurant in the UK bought tables made from FSC-certified oak wood, and set these tables for meals without tablecloths. Estimated savings in laundry costs are over EUR 2 000 per year for this small premises (Envirowise, 2008). Similarly, Scandic Berlin do not use table cloths (see Figure 6.7 in section 6.1)

Driving force for implementation

Installation of efficient PRSVs with trigger activation, sink taps with pedal- or sensor-activation, and efficient new dishwashers can considerably reduce operational costs and pay back quickly (see above). In addition, these measures can improve working conditions and increase productivity.

Green procurement of ecolabelled detergents and cleaning chemicals is driven by CSR and worker safety considerations.

Reference organisations

The Savoy, London; Scandic Berlin hotel; Strattons hotel, Norfolk.

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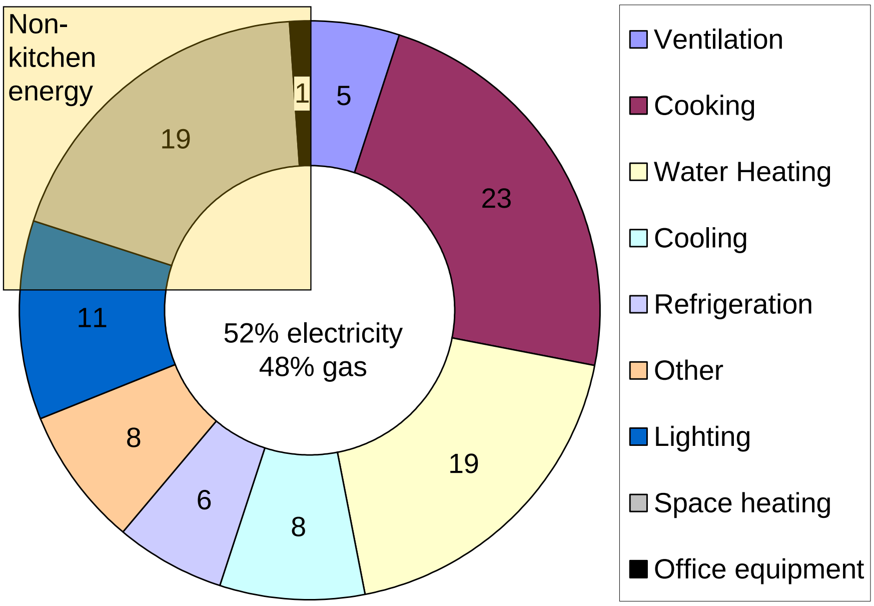
8.4 Optimised cooking, ventilation and refrigeration

Description

Water and energy efficiency measures have therefore traditionally been a low priority for kitchen managers. Operational optimisation is usually focussed on delivering service quality (Carbon Trust, 2011). Consequently, as little as 40 % of the energy consumed in kitchens goes into useful processes such as cooking, food storage and washing: much of the remainder is lost as waste heat (Carbon Trust, 2007). Therefore, there is considerable scope for improvement in the energy efficiency of kitchens serving stand alone restaurants or hotel guests. Figure 8.24 shows that, excluding processes attributable to the dining area, the main energy consuming processes in kitchens are:

- cooking
- water heating
- cooling and ventilation
- refrigeration
- lighting.



Source: Data from Carbon Trust (2011).

Figure 8.24: Breakdown of energy consumption in a catering business

Other energy users include electric motors and control systems, for example those installed in dishwashers. The main measures associated with efficient energy management in kitchens are summarised in Table 8.19. There is considerable overlap with other BEMP techniques described elsewhere in this document. Most water heating is dedicated to dish washing, and this process is addressed in the previous section (section 8.3). A considerable amount of heat is generated in kitchens, which consequently have a high specific cooling demand per m^2. This heat may be directed to other parts of the building or recovered in a centralised heat-exchanger prior to external venting, as described in section 7.3 that addresses optimisation of building HVAC systems. Efficient lighting installation and control is addressed in section 7.5.

The focus of this BEMP technique is on the following measures referred to in Table 8.19 that are specific to kitchens:

- installation of efficient cookers
- efficient cooking techniques
- efficient ventilation control
- installation of efficient refrigeration systems
- efficient maintenance and operation of refrigeration systems.

Installation of efficient equipment can save a considerable amount of energy, especially over equipment lifetimes of ca. 20 years. For example, gas flame hobs, or induction hobs that induce heating of ferrous pots and pans through electromagnetism, consume considerably less energy than standard electric hobs. Training kitchen staff in efficient management practices is an integral component of best practice that can reduce catering energy consumption by up to 25 % (Carbon Trust, 2007).

Table 8.19: Best environmental management practice measures to reduce kitchen energy consumption

Aspect	Measures	Description
Management	Appoint kitchen energy champion	– An appropriate person working in the kitchen may be appointed as an 'energy champion' with responsibility for monitoring energy consumption and ensuring continuous implementation of energy efficiency measures.
Cooking	Install efficient cookers	– Installation of induction or gas hob cookers. Installation of boilerless steamers (section 8.3).
	Efficient cooking techniques	– Correct sizes of pots and pans used and matched to hobs – Careful planning of food preparation – Avoid unnecessary use of quenching.
Water heating	Install efficient dishwashers and use efficiently	– Installation of appropriately sized efficient dishwashers that recycle rinse water, recover heat from drying air and waste water, and use heap pumps or gas. Optimum loading (section 8.3).
	Efficient water heating source	– Use of heat pumps (section7.4) or renewable energy sources (Section 7.6).
Cooling and ventilation	Optimised HVAC system	– Heat recovery and efficient distribution within centralised building HVAC systems (section 7.3). – Appropriate temperature control.
	Efficient ventilation control	– Variable speed fans controlled by air management system, and insulated hoods.
Refrigeration	Installation of efficient refrigeration system	– Appropriate sizing and positioning of refrigeration storage. – Adequate installation and air-tightness. – Correct capacity compressors and efficient motors. – Heat recovery. – Use of low global warming potential refrigerants.
	Efficient maintenance and operation	– Regular maintenance and seasonal adjustment of compressors, careful temperature control, efficient stocking and use (e.g. not leaving doors open)
Lighting	Efficient fittings	– Installation of correct lighting capacity (lumens) provided by low-energy sources (florescent tubes and LEDs in kitchen) (section 7.5).
	Lighting control	– Use of motion sensors to control lighting in areas such as walk-in refrigeration, and efficient control by staff.

Achieved environmental benefit

Cooking equipment and operations

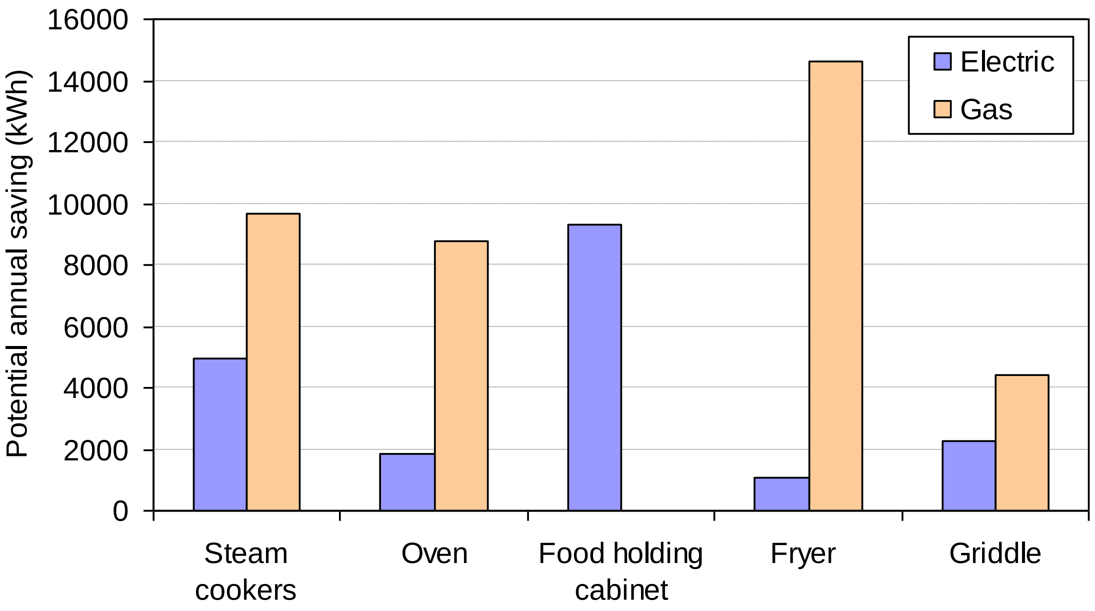
Table 8.20 lists the energy savings achievable from the implementation of key measures to improve the efficiency of cooking. In commercial kitchens where hobs are often left on continuously, the automatic cut-out function of induction hobs and installation of gas hobs with pot sensors can result in large savings (Tyson, 2010).

Table 8.20: Environmental benefits achievable for key efficient cooking measures

Measure	Environmental benefit
Replace electric hob with induction hob	15 – 20 % reduction in cooking energy 50-80 % reduction in total energy consumption(*)
Replace electric hob with gas hob (optimised burners)	30 % reduction in primary energy consumption
Replace gas hobs with new hobs controlled by pot sensors	50 – 80 % reduction in total energy consumption(*)
Replace uninsulated food heating unit with insulated model	70 % reduction in energy
Replace conventional oven with convection oven	30 %reduction in energy consumption
Use a combi oven or pressure cooker instead of conventional oven	50 – 70 % reduction in energy consumption
Use microwave instead of oven or hob to (re)heat food	70 – 90 % reduction in energy consumption
(*)In commercial kitchens where hobs typically not switched off between uses by operatives *Source:* USDE (1997); Fisher (2006); Tyson (2010); EC (2011).	

Figure 8.25 indicates annual energy savings achievable by selecting the most efficient (Energy Star labelled) models of kitchen equipment. Potential savings are higher for gas appliances owing to a greater performance differential across these appliances, and reach up to 14 000 kWh per year per appliance for a gas foyer.

Of additional note, high savings have been reported for induction cookers, owing to their efficiency and the fact they automatically switch off when no pot is detected. Restaurant Le Premier in Århus (Denmark) reduced energy consumption by 90 % following the replacement of hotplates with induction cookers, from 7 MWh to 0.7 MWh per year (Horesta, 2000).



NB: Based on difference between average performance of existing appliances in US and performance of Energy Star appliances.

Source: Energy Star (2011).

Figure 8.25: Potential annual energy savings achievable by purchasing an efficient oven compared with average performance of existing appliances in the US

Ventilation

Halving the fan speed can reduce motor energy consumption by 87 % (Carbon Trust, 2011d). Variable speed processor-controlled fans can reduce ventilation energy consumption by approximately 60 % (Fisher, 2006; Green Hotelier, 2011). Replacing conventional pole fan motors with electronically commutated motors can reduce motor energy consumption by up to 65 % (Carbon Trust, 2011d).

Refrigeration

Table 8.21 lists the energy savings achievable from implementation of key measures to improve the efficiency of refrigeration operations. These are maximum achievable benefits: actual savings are strongly dependent on specific circumstances, and some measures are only applicable only under certain conditions.

An annual leakage rate of 20 % has been reported for refrigeration systems in the UK, associated with an 11 % loss in system efficiency. For a system using 5 kg of R404a refrigerant, refrigerant leakage of 20 % would equate to GHG emissions of 3 260 kg CO_2 eq. per year (see Figure 8.27 below). Good leak detection and prevention can reduce leakage rates to almost zero, saving considerable GHG emissions and additional energy consumption (Table 8.21).

Energy saved by heat recovery depends on the size of the refrigeration system, the efficiency of the heat recovery, and the heating energy displaced, but can be significant. For example, if heat recovery from refrigeration pre-heats incoming water by 15 °C on average, the heating energy required to reach a water temperature of 60 °C will be reduced by 30 %.

Table 8.21: Environmental benefits achievable by measures to improve refrigeration performance

Measure	Achievable environmental benefit
Installation of system that uses hydrocarbon or natural refrigerants	Up to 30 % reduction in carbon footprint of refrigeration(*)
Installation of strip curtains in cold room entrance	Up to 25 % reduction in energy
Installation of oversized compressors	Up to 10 % reduction in energy consumption
Installation of heat recovery	Up to 10 % of system energy recovered (benefit depends on displaced energy source)
Installation of intelligent defrost controls	Up to 9 % reduction in energy consumption
Installation of electronically commutated fan motors	Up to 5 % reduction in energy
Regular inspection and maintenance to detect and repair refrigerant leaks	Up to 37 % reduction in carbon footprint of refrigeration(*), including 11 % reduction in energy consumption
Careful control of refrigeration temperature	Up to 10 % reduction in energy consumption (2 % saving for every one degree rise)
Maintenance and cleaning of condensers and evaporators	10 % reduction in energy consumption
Adjusting the condensing temperature during cooler periods	10 % reduction in annual compressor energy consumption (up to 30 % during cool periods)

(*)Assumes refrigerant leakage can account for 30 % of system carbon footprint
Source: Carbon Trust, (2007; 2009; 2011b; 2011c; 2011d).

Appropriate environmental indicator

Cooker selection

Comparing the efficiency of cooking appliances is complicated as there are no widely accepted standardised measurement methods relevant for different types of cookers and food. Ultimately, cooking efficiency relates to the quantity of energy absorbed by the substance being cooked divided by primary energy consumed, but this is not readily measurable. For hob cookers, primary energy efficiency depends on: (i) the energy source (primarily electricity or gas) and the electricity generation process; (ii) transfer efficiency from energy source to pot or pan; (iii) heat loss from pot or pan; (iv) standby or pilot light consumption; (v) user control. These features are determined by a combination of:

- cooker type and design (selection)
- energy source
- user behaviour.

Table 8.22 provides a summary of typical characteristics of different types of hob oven. Whilst energy consumption for given tasks, or for equivalent oven capacity, is the most convenient indicator of oven efficiency, the carbon footprint of one kWh delivered heating energy is the most appropriate indicator to compare the environmental performance of gas and electric powered cookers under specific conditions owing to a wide variation in the source and carbon footprint of electricity.

DEFRA (2011) calculate that lifecycle emissions for consumed electricity in the UK average 0.59 kg CO_2 eq./kWh. Natural gas combustion lifecycle emissions are 0.22 kg/kWh net energy content. Applying these values to standard electric, induction and gas hob heat transfer efficiencies results in emission factors of 0.79, 0.66 and 0.44 kg CO_2 eq./kWh heating, respectively, indicating that gas hobs would be the preferred choice from an environmental perspective. However, in countries where electricity has a small carbon footprint, or where genuine green electricity is consumed (section7.6), induction hobs may be the preferred choice from an environmental perspective (Table 8.22; Figure 8.26).

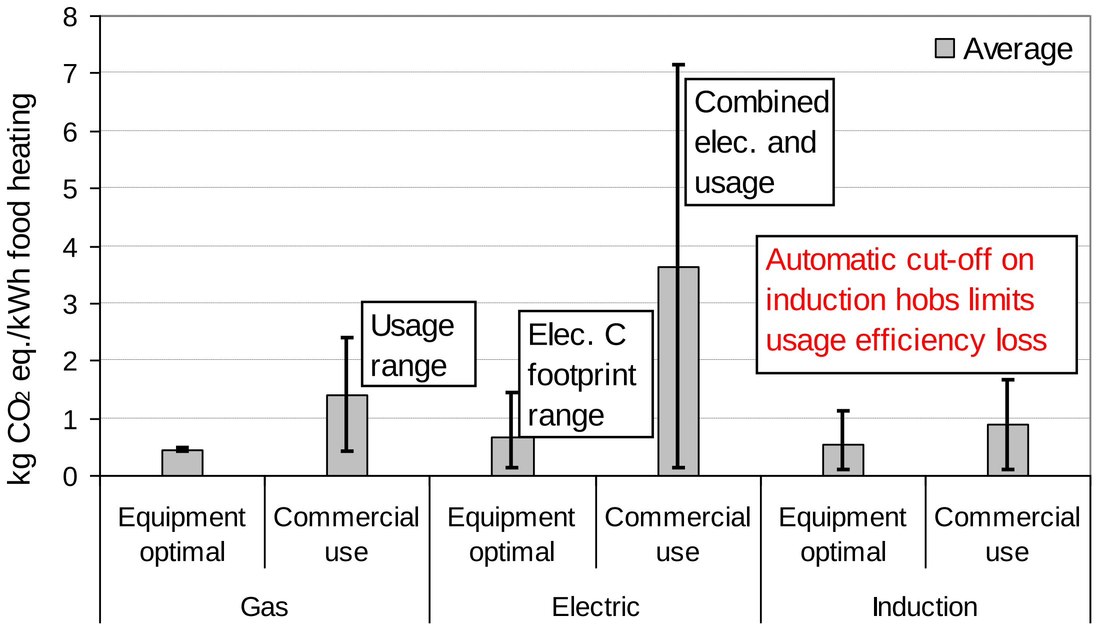
Table 8.22: Typical efficiency characteristics of different types of hob oven

	Gas hob	Electric hob	Induction hob
Heat transfer efficiency	50 %	75 %	90 %
Primary energy ratio	1.1	2.5	2.5
CO_2 eq. factor (kg/kWh heating)	0.44	0.13 – 1.33(*)	0.11 – 1.11(*)

NB: Electricity from coal-fired power stations has a carbon footprint of 0.80 – 1.00 kg CO_2 eq. per kWh, electricity from combined cycle gas power stations has a carbon footprint of approximately 0.5 kg CO_2 eq. per kWh, whilst electricity from nuclear power stations or renewable (e.g. wind) sources has a carbon footprint <0.10 kg CO_2 eq. per kWh.

Source: CEC (2011); CESA (2011); DEFRA (2011).

An important consideration is user behaviour. Fisher (2006) note that whilst the heat transfer efficiency of a gas hob ranges from 20 % to 60 %, utilisation efficiency typically ranges from 5 % to 15 %. Induction hobs automatically switch off when no pot is present, potentially saving a large amount of energy in commercial kitchens where hobs may be left on continuously with low utilisation rates (Figure 8.26).



NB: Based on values displayed in Table 8.22, and average electricity carbon footprint of 0.5 kg CO_2 eq./kWh. Commercial use ranges based on 100 % and 25 % utilisation rates, except for induction hobs.

Figure 8.26: Carbon footprint per kWh heating delivered to the pot from different types of hub, under optimal and average commercial use conditions

In the US, the Energy Star label is awarded to more energy efficient appliances (typically the top 25 % of performers). Energy Star eligibility criteria for commercial kitchen equipment provides an indication of good performance levels (Table 8.23).

Table 8.23: Energy Star eligibility criteria for cooking appliances

Appliance	Energy source	Idle energy rate	Cooking efficiency	Test method
Steam cookers (6 pan or larger)(*)	Electric	≤0.8 kW	≥50 %	
	Gas	≤3.7 kW	≥38 %	
Ovens	Electric (half size)	≤1.0 kW	≥70 %	ASTM 1496
	Gas	≤3.8 kW	≥44 %	
Convection ovens		≤1.6 kW	≥70 %	ASTM F1496
Food holding cabinets	Electric	0.14 kW/L		
Fryers (standard)	Electric	≤1.0 kW	≥80 %	ASTM F1361-07
	Gas	≤2.6 kW	≥50 %	
Fryers (large vat)	Electric	≤1.1 kW	≥80 %	ASTM F2144-09
	Gas	≤3.5 kW	≥50 %	
Griddles	Electric	3.44 kW/ m^2	≥70 %	ASTM F1275
	Gas	8.26 kW/m^2	≥38 %	ASTM F1605
(*)Described in section 8.3 in relation to water consumption *Source:* Energy Star (2011).				

Best environmental management practice for the selection of new cooking equipment is to:

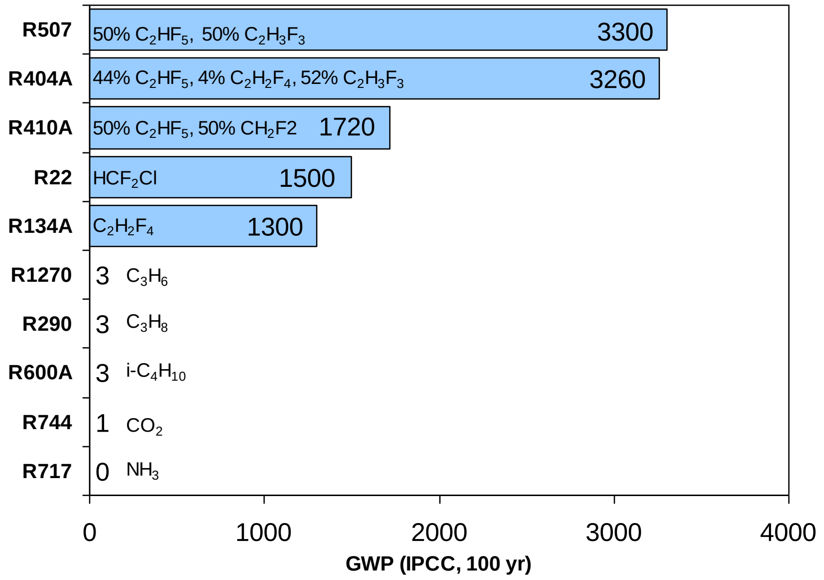
- select the most efficient available options based on the: (i) rated cooking (heat transfer) efficiency (%); (ii) idle energy consumption rate (kW); (iii) carbon footprint (kg CO_2 eq./kWh heat transfer) calculated from the most relevant available electricity carbon footprint data.

Specifically, in the case of new hob ovens, best practice is to:

- select either: (i) induction hobs; or (ii) gas flame hobs with pot sensor control.

Refrigeration systems

Refrigerant leakage contributes significantly to the environmental impact of refrigeration systems owing to the high global warming potential (GWP) of traditional CHFC refrigerant gases. The appropriate environmental indicator to assess the impact of the refrigeration system, and to select the most environmentally sound refrigerant, is the GWP per kg (Figure 8.27). Leakage (top-up) rates of refrigerants can be multiplied by their GWP, and added to the carbon footprint of electricity consumed by the refrigeration equipment where these data are available, to calculate the annual carbon footprint of refrigeration systems.



N.B: CHFCs include R507, R404A, R410A, R134A; HCFCs include R22; hydrocarbons include R1270, R290, R600A and natural refrigerants include CO_2 and NH_3.

Source: EC (2011).

Figure 8.27: Global warming potential of different types of commercial refrigerant

The EU Energy label for domestic appliances calculates energy consumption per unit capacity of fridges and freezers, accounting for additional functions, but is not applicable to commercial equipment. The US Energy Star calculates maximum energy consumption (minimum efficiency) thresholds for commercial fridges and freezers expressed as daily consumption for different capacity ranges (Energy Star, 2011). For solid door upright cabinets of 1.4 m^3 capacity or greater, these translate into energy consumption limits of:

- ≤1.14 kWh/L/yr for fridges
- ≤3.6 kWh/L/yr for freezers.

Best environmental management practice for the selection of new refrigeration equipment is to:

- select the most efficient available options based on the specific energy consumption, measured in kWh/L/yr.

In the case of cold room installation, best environmental management practice is to:

- install a system that uses hydrocarbons, ammonia or carbon dioxide refrigerants
- install an efficient system considering: (i) rated energy consumption (kWh/m^3yr); (ii) operation carbon footprint (kg CO_2 eq./m^3/yr) based on refrigerant leakage GWP and the most relevant available carbon footprint data for electricity consumption.

Best practice for measuring the performance of refrigeration systems is to:

- monitor and report at least annually: (i) energy consumption (kWh/m^3yr); (ii) refrigerant leakage rate (kg and % per year); (iii) carbon footprint (kg CO_2 eq./m^3yr) of refrigeration systems.

Benchmarks of excellence

Energy consumption will vary considerably depending on the type of food prepared and the type of establishment. ITP (2008) propose an 'excellent' benchmark of less than 4 kWh per cover for total energy consumption. Catering for a sustainable future group (CSFG, 2006a;b) propose a 'good practice' benchmark for operational (kitchen process) energy consumption of

6.1 kWh per cover in fine-dining restaurants, and 1.9 kWh per cover in cafeteria restaurants. Electricity data from hotels in Germany and the UK indicate electricity consumption of 1.2 and 3.1 kWh per cover, whilst Farrou et al. (2009) suggest average additional energy consumption of 1.2 kWh per meal in Mediterranean hotels.

There are insufficient data available to derive a robust benchmark of excellence for specific energy consumption in kitchens, although as a guide final energy consumption of less than 1.5 kWh per cover appears achievable across mid-range accommodation kitchens. The benchmarks of excellence proposed for this technique are:

BM: implementation of a kitchen energy management plan that includes monitoring and reporting of total kitchen energy consumption normalised per dining guest, and the identification of priority measures to reduce energy consumption.

BM: installation of efficient equipment and implementation of efficient practices described in this technique, including: (i) induction hobs or gas flame hobs with pot sensor control; (ii) commercial fridges and freezers with specific energy consumption of ≤1.14 and ≤3.6 kWh per L volume per yr, respectively.

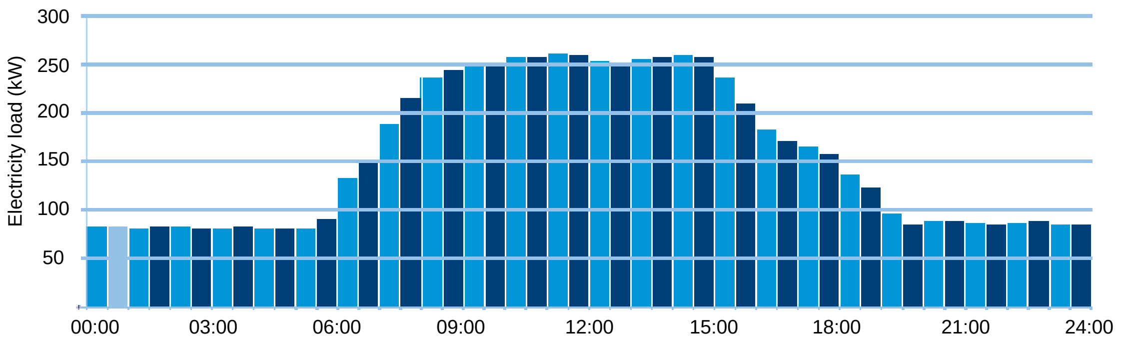
Cross-media effects

Reducing primary energy consumption and lifecycle CO_2 emissions by selecting gas instead of electric ovens leads to indoor air emissions of nitrogen oxides. The concentration can be kept below harmful levels through appropriate extraction.

Operational data

Monitoring and ventilation control

Energy consumption needs to be monitored if it is to be effectively controlled. Unnecessary consumption can be detected by continuous monitoring systems. For example, extraction, lighting and heating systems should shut off outside operating hours. Failure to do this, and leaving large equipment switched on or on standby, can elevate off hours 'baseline' energy consumption. Figure 8.28 provides an example of a daily consumption pattern for a catering establishment.



Source: Carbon Trust (2011a).

Figure 8.28: Daily pattern of electricity consumption in a catering establishment

Centralised building management systems continuously record electricity consumption in different areas and provide the detailed type of daily electricity use data shown in Figure 8.28 for restaurants, or restaurant and kitchen areas within hotels. Similar data can also be obtained more simply through installation of a data logger at the electricity meter. Data loggers may be directly attached to a computer, or information may be periodically downloaded from them on to a laptop or memory storage device and transferred to a computer.

The simplest electricity monitoring applicable to small enterprises involves recording monthly energy consumption data from electricity and other fuel bills, expressed in kWh. Data may be provided for daytime and night-time electricity where this is charged at different rates (Table 8.24), providing some insight into the sources of electricity demand: night-time consumption indicates baseline consumption by refrigeration systems and machines on standby (also dishwashers if these are programmed to work overnight); daytime consumption includes cooking, dish washing, ventilation and lighting consumption. Monthly or annual aggregated electricity consumption can be divided by the number of cover meals served to benchmark performance (Table 8.24).

It may be worth installing individual energy meters and data loggers on large energy-consuming equipment, such as dishwashers and ovens, to monitor performance and identify maintenance requirements or opportunities for savings.

Table 8.24: An example of monthly energy consumption data for the restaurant area of a hotel

Month	kWh day	kWh night	Covers(*)	kWh / cover
March	21 148	6 707	7 750	**3.6**
April	16 873	6 160	7 500	**3.1**
May	17 358	6 642	7 750	**3.1**
(*)estimated 250 cover per day				

Selecting efficient cookers

Food safety and quality are the two main priorities for catering enterprises, and kitchen staff should be consulted on equipment selection – kitchen staff will have a good understanding of equipment requirements. Kitchen staff may also be able to provide advice on where savings are possible, or they may be resistant to change. It is important to clearly describe the reasons and (efficiency) benefits of new equipment selection (Green Hotelier, 2011).

Hobs

Six-hob ovens (hobs and oven combined) are the common workhorse of commercial kitchens. Ovens are responsible for up to 25 % of kitchen energy consumption (Horesta, 2000; Figure 8.24), and typically have a 20-year lifetime. It is important to select the right oven in terms of food quality, convenience, lifetime energy consumption and costs, and also lifecycle environmental performance. The most efficient types of hob oven are: (i) gas flame; (ii) induction. Table 8.25 highlights some key characteristics of these two options. New commercial gas hobs must comply with minimum efficiency and safety criteria specified in the EN203-2-1 standard (EC, 2009).

Table 8.25: Characteristics of gas, standard electric and induction hob ovens

	Gas hob	Induction hob
Advantages	– Quick heat-up – Low equipment cost – Gas cheaper than electricity – Gas has low primary energy demand compared with electricity	– Quick heat-up and good controllability – No power draw when pots removed – Few installation requirements – No indoor air quality issues or precautions – No hot surfaces
Disadvantages	– Pilot lights use up to 6 kWh per hob per day – Indoor air emissions (NO_x, CO) – Requires gas supply – Requires additional cooling and ventilation – Low output settings limited	– High equipment cost – Electricity more expensive than gas – Electricity associated with high primary energy demand – Requires iron-based cooking pots and pans (e.g. stainless steel)

The lifecycle environmental efficiency of different oven types can be compared using a basic carbon footprint method – for induction ovens based on the carbon footprint of consumed electricity provided by electricity suppliers or estimated from national statistics (see 'Appropriate environmental indicator' section and Table 8.22, above). Electronic ignition systems for commercial gas hobs have yet to be proven under commercial operations, so the consumption of gas pilot lights (up to 6 kWh per day) should be accounted for.

A general rule is that gas hobs are the preferred environmental option where grid electricity is sourced largely from fossil fuels, but induction cookers are the preferred environmental option where electricity is from renewable sources.

If selecting a gas hob, best practice is to specify a model with built-in sensors that cut-off the flame heating when a pot is removed and relight when a pot returns, achieving a similar benefit to the induction hob automatic cut-off function.

Ovens

As with hobs, gas ovens are generally more efficient than electric ovens. Some other features relevant to the selection of an efficient oven are:

- appropriate sizing – oversized ovens should be avoided;
- convection ovens use a fan to circulate warm air evenly throughout the oven, reducing energy consumption by 30 %;
- variable speed fans that cut out when the door is opened reduce energy consumption;
- 'combi' ovens offer convection, steam and a combination of the two to cook food using up to 50 % less energy;
- combi-ovens are available with heat recovery from exhaust air to incoming water;
- good insulation of casing, solid doors, triple-glazing of viewing windows, and robust door seals can reduce energy consumption by around 40 %.

As referred to in section 8.3, boilerless steamers are considerably more energy and water efficient than boiler steamers. Forced convection and high levels of insulation are important features. Energy performance standards established for commercial kitchen equipment by the US EPA for the award of the front-runner Energy Star label may provide guidance on good performance when selecting an oven (see Table 8.23 under 'Appropriate environmental indicators' above).

Grills and griddles

In busy commercial kitchens, grills are often left on full power continuously. Grills are available that detect when food is placed underneath and start up automatically. Grills with short start-up times may be gas powered or powered by infrared elements. Automatic grill control combined with fast heat-up can offer energy savings of over 70 % (Green Hotelier, 2011). Bright chromium-plated steel and various coatings reduce radiative heat losses from grill surfaces, saving up to 30 % energy compared with dark surfaces (EC, 2011). Grills with multiple heat zones offer greater opportunities to match the heating area in use with varying cooking requirements. Energy Star minimum energy performance criteria are referred to in Table 8.23.

Fryers

Fryers are available with highly insulated pans, efficient burner and heat-exchanger designs, and filtration units combined with usage monitors that extend oil life and signal the appropriate time for oil changes. Energy Star minimum energy performance criteria are referred to in Table 8.23.

Efficient cooking techniques

Compliance with relevant food safety regulations are paramount. According to UK food safety regulations (UK Government, 1995), hot food should be held for service (or displayed) above a temperature of 63 ºC unless a risk assessment has determined that a lower temperature poses no risk to health.

Within food safety and quality parameters, there is considerable scope for energy reduction by appropriate operation and maintenance. Oven usage in commercial kitchens has a greater impact on cooking efficiency than equipment efficiency (Fisher, 2006) – although some equipment features such as hob sensor control can mitigate bad practice by operators. Staff **liaison and training** is essential.

In the first instance, it is important to plan for requirements. For example, for kitchens serving breakfast in hotels, if 100 people are anticipated, prepare food for the first 40, the next 20 and so on, in order to avoid unnecessary cooking of excess food (important for waste avoidance: section 8.2), and to avoid unnecessary maintenance heating for large quantities of cooked food.

Keys points to reduce energy consumption during cooking are listed below (Green Hotelier, 2011; Carbon Trust, 2011a; CEC, 2011).

- Where appropriate for heating or reheating small quantities of food, a microwave uses 70 – 90 % less energy than a conventional oven.
- Where relevant, use a combi oven or a pressure cooker to reduce cooking time and energy use by 50 to 75 %.
- Use the correct equipment for the job – utensils, pots and pans must be appropriately sized for the heating ring or oven used. A 15 cm pan on a 20 cm burner will waste over 40 percent of the energy.
- Avoid over-filling saucepans and kettles and use lids to retain heat.
- When pans are used to boil liquids, turn hobs down to the minimum to simmer.
- Switch off grills, fryers and hobs immediately after use. Electric hobs can be switched off before cooking is finished.
- Make a note of cooking equipment preheat times and keep these on display. Preheat only where necessary.
- Keep hot storage of cooked food to a minimum, both to reduce energy use and to retain the quality of the food.
- Switch on equipment only when necessary – discourage staff from routinely switching **all** equipment on at the start of a shift irrespective of whether it is necessary.

- Avoid opening oven doors unless absolutely necessary – every time an oven door is opened the temperature drops by approximately 14 ºC.
- Switch off extraction fans when they are not being used.
- Periodically check oven door seals for damage, and replace where necessary.
- Check thermostats on all equipment and replace where false readings are given.
- A blue flame indicates that a gas oven is operating efficiently. A yellowish flame indicates an adjustment is needed.

Ventilation control

Firstly, heating and cooling energy consumption in kitchen and dining areas can be minimised through optimisation of the HVAC system (section 7.3) and ensuring that temperature settings are adjusted correctly to meet the requirements of distinct zones. Carbon Trust (2007) recommend setting thermostats to 16 – 18 ºC in kitchens and 22 – 24 ºC in dining areas. It is important to reduce or shut down heating or cooling during periods when kitchen and dining areas are not in use.

Ventilation fans often operate continuously at full capacity. The installation of variable speed fans controlled by a micro-processor connected to air quality and temperature sensors is simple, inexpensive and associated with a short payback time (see 'Economics'). Air quality sensors and fans should be located close to main emission sources (hobs and fryers). The replacement of conventional fans with electronically commutated fans (with brushless motor, transforming AC to DC current for motor operation) can result in further energy savings.

Installation of efficient refrigeration system

It is important to zone kitchen and storage areas into warm and cool areas. Refrigerators and freezers should not be placed close to heat sources such as cookers, dishwashers, radiators or windows, or in cool rooms where heat from the compressors will warm the room.

Stand alone units

When selecting stand-alone refrigeration units, it is important to ensure the size is sufficient to cope with peak storage demands without restricting air circulation, but not excessively large so that unnecessary cooling energy is consumed. Features such as high levels of insulation (50 mm thickness), durable and effective door seals, and electronically controlled evaporator valves and condenser fan motors can reduce energy consumption by 30 % compared with less efficient models (US EPA, 2010). Cabinets may be selected with multiple compartments and doors: matching these options with typical use requirements can save energy by minimising heat loss through open doors. As an indicator of more efficient fridge cabinet performance, the US Energy Star is awarded to solid door upright fridge cabinets with annual energy consumption of ≤1.14 kWh per litre capacity (for cabinets of 1.4 m3 capacity or greater). The equivalent figure for freezer cabinets is 3.7 kWh per litre capacity (Energy Star, 2011).

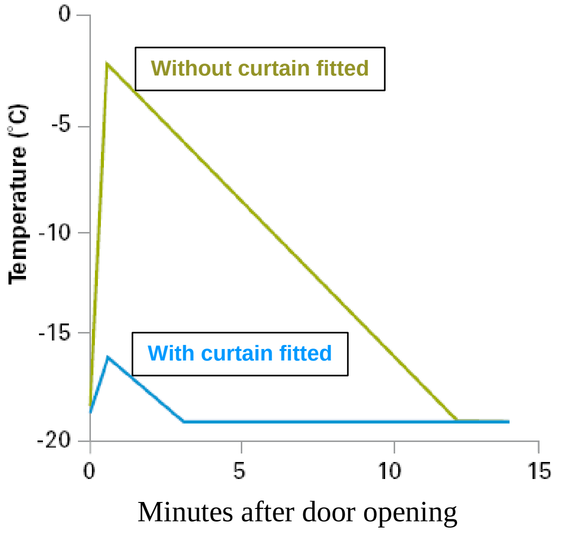
Cold rooms

In larger restaurants and hotels, cold rooms may be used for storage of chilled and frozen foods. Compared with stand-alone refrigeration units, cold rooms require additional attention and maintenance. Table 8.26 summarises best practice measures for cold rooms.

Table 8.26: Best practice measures to reduce energy consumption in cold rooms

Energy loss	Best practice measures
Open doors are responsible for approximately 30 % of heat gain in cold rooms.	Install plastic strip curtains. Fit automatic doors or self-closing doors, or train staff to minimise door opening. Inspect and maintain door seals.
Heat gain through the insulated envelope and air flow through gaps are responsible for approximately 20 % of heat gain.	Ensure high quality insulation is installed in walls, ceiling and floors. Ensure insulation envelope is airtight, and has a good vapour seal on the outside.
Evaporator fans are responsible for approximately 15 % of heat gain.	Replace conventional fan motors with electronically commutated motors.
Evaporator defrost is responsible for approximately 15 % of heat gain.	Fit defrost-on-demand controller.
Lights are responsible for approximately 10 % of heat gain.	Install motion sensors to control lights and ensure low energy LED lights are fitted.
Occupants and associated equipment are responsible for approximately 10 % of heat gain.	Train staff to plan stacking and food retrieval from cold rooms, and minimise time in the cold room.
Source: Carbon Trust (2011d).	

One of the most simple and effective ways to reduce heat gain in cold rooms, and associated energy demand, is to install strip curtains (Figure 8.29).



Source: Carbon Trust (2011d).

Figure 8.29: Effect of a strip curtain fitted to cold room entrance

Practical considerations for implementation are detailed below.

- When installing strip curtains, consider investing in thicker insulated curtains for freezer rooms. Ensure there is good overlap between strips and that there are no gaps to the sides or at the bottom of the entrance.
- Regularly check door seals for damage. Also, check for ice accumulation within the store room, which can indicate warm moist air is entering.

- When deciding whether to fit electronically commutated motors, check the type, capacity and usage rate of existing evaporator motors in order to ascertain the potential energy saving. If the existing motor is single speed and demand is variable, there will be additional efficiency benefits from installation of a variable speed motor in conjunction with a controller. Depending on the condition of the fan assembly, it may be worth replacing this too in order to maximise the efficiency gain (Carbon Trust, 2011d).
- When installing condensers, it is important to balance installation cost against lifetime energy costs. Installing a condenser 30 % larger than necessary for a cold room can reduce energy consumption by 10 %.

Alternative refrigerants

Use of environmentally preferable hydrocarbon or ammonia refrigerants requires the installation of systems with indirect cycles owing to the flammability and toxicity, respectively, of these refrigerant types. The coefficient of performance, COP, of the ammonia refrigeration cycle is usually higher than from that of other refrigerants, resulting in additional energy savings.

Carbon dioxide refrigeration systems operate at high pressure, over 100 bar (10 times higher than the pressure range of other refrigerants) for medium temperature systems, but cycle smaller refrigerant volumes. In addition, at heat sink temperatures above 25 °C, CO_2 refrigerant performance becomes transcritical and the COP is reduced for medium temperature (plus cooling) systems, potentially limiting the application of CO_2 as a refrigerant for such systems in warm climates. Use of carbon dioxide systems for low temperature (freezer) systems is not constrained in this way, and is energy efficient (EC, 2011).

Heat recovery

Heat can be recovered from condensed refrigerant and transferred to the building's HVAC system. Recovery of low grade (20 ºC to 40 ºC) from compressors can be achieved simply by ducting the warm compressor cooling air into the HVAC system exhaust (prior to heat exchanger where it heats incoming air). Recovery of high grade (60 ºC to 90 ºC) heat can be achieved by inserting a heat exchanger into the refrigerant line between the compressor and the condenser to heat water for use in the restaurant/hotel – following top-up heating if required (Figure 8.30).

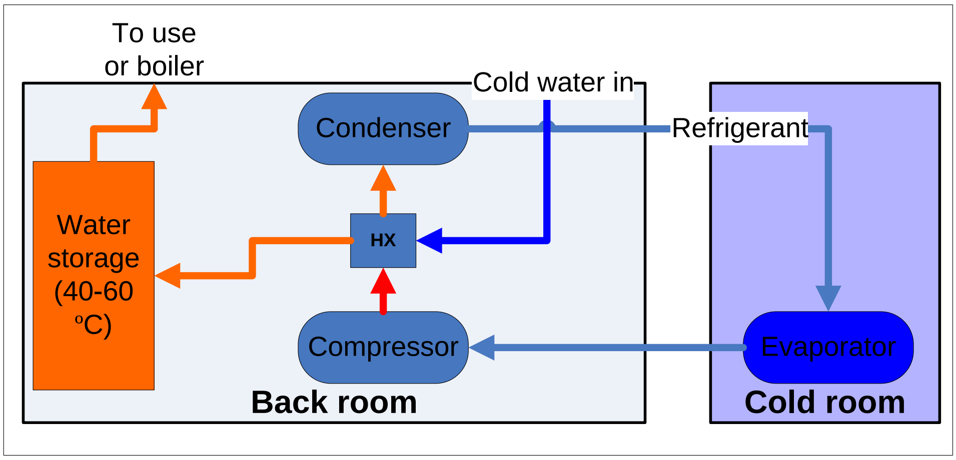
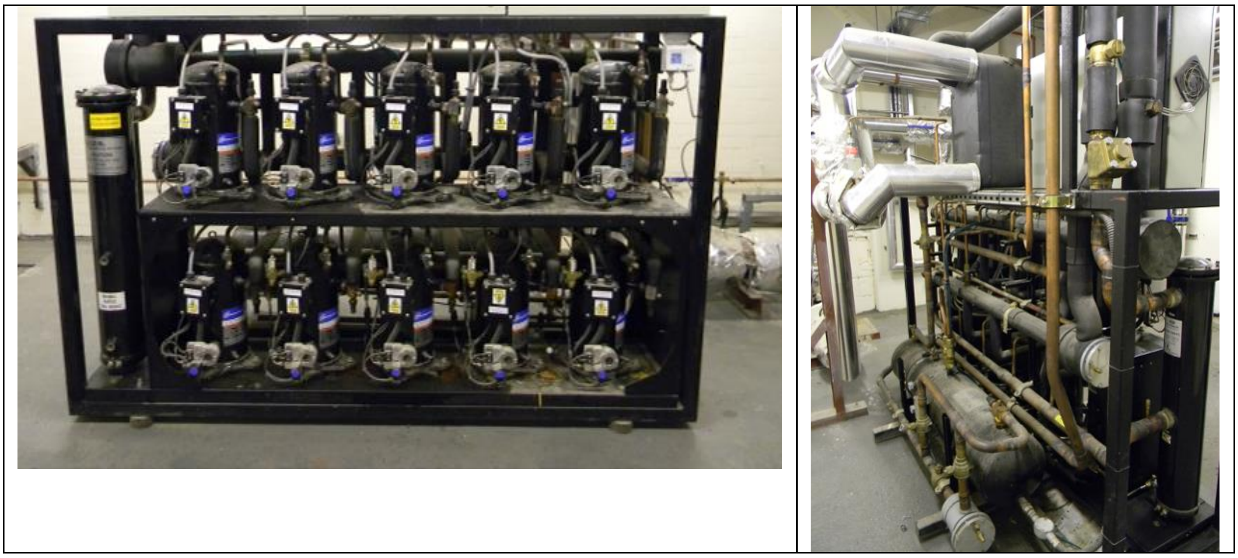


Figure 8.30: High-grade heat recovery from refrigerant between compressor and condenser

Retrofitting high grade heat recovery systems is more expensive than installing them during initial refrigeration system installation. A compressor electric load of 30 kW or more is required to achieve an acceptable payback for retrofitting (Carbon Trust, 2009). The Savoy recently installed such a system, although no energy data are available for it yet (Figure 8.23).

Condensing temperature should be set to optimise refrigeration system COP (see above), not to increase water heating.

Table 8.27: Centralised refrigeration compressors (left) and heat exchange from high temperature refrigerant exiting the compressors to the hot water system (right) in The Savoy



Maintenance and operation of refrigeration

Maintenance of refrigeration equipment by trained technical staff is essential to achieve and maintain efficient operations. Important maintenance procedures requiring technical personnel are listed below.

- Check systems have the correct amount of refrigerant and inspect for leaks. EC Regulation 842/2006 requires operators of cooling systems containing fluorinated gases to take precautions against leakage, including recovery of gases during servicing and maintenance, regular checks by qualified personnel, and installation of automatic leak detection on very large systems (above 300 kg refrigerant). EC Regulation 1005/2009 is aimed at phasing out the use of ozone-depleting substances, and applies to HCFC refrigerants such as R22. It includes stringent rules on the detection of leaks, and bans the use of virgin HCFCs for maintenance of refrigeration systems from January 2010.
- Compressors and condensers should be inspected annually and pipework should be checked to ensure it is secure and insulated. Condensers may be cleaned thoroughly during inspection (removing dirt from between the fins). Consider fitting a removable screen to condenser units to protect condenser fins from airborne dirt – these can be periodically removed and washed.
- Seasonal control of condensing temperature. Every degree reduction in temperature lift between the evaporator and condenser reduces compressor energy consumption by around 4 % for plus cooling (chill) systems, and 2 % for minus cooling (freezer) systems. Systems are often set to run all year at a maximum temperature specified to cope with the warmest summer conditions. Where this is the case, significant compressor energy savings can be made by requesting a technician to reduce the condensing temperature during cooler conditions (Carbon Trust, 2011b).

Kitchen staff can take a number of measures to minimise refrigeration system energy consumption. It is of paramount importance to maintain food at temperatures (and in conditions) specified by food suppliers and set out in food safety regulation (e.g. UK Government, 2005). General UK guidelines for the storage of food and drink requiring chilling are summarised in Table 8.28. Wastage of perishable food incurs a large environmental burden owing to high inputs and environmental impacts arising during food production (see section 8.1), and therefore should be minimised. However, it is often possible to reduce energy consumption for refrigeration by precisely adjusting the temperature to the required level in order to avoid over-cooling. Maintaining a temperature just 1°C lower than needed can increase cooling costs by 2 % (Carbon Trust, 2007).

Table 8.28: UK guidelines for food storage temperature

Temperature code	Products	Storage temperature
L1	Ice cream and frozen foods	– 18 ºC
L2	Frozen foods	– 18 ºC
M0	Poultry and meat	+1 ºC to +4 ºC
M1	Meat and dairy	+1 ºC to + 5 ºC
M2	Processed meat and dairy	+1 ºC to + 7 ºC
H1	Produce, canned and bottled drinks	+1 ºC to + 10 ºC
H2	Canned and bottled drinks	–1 ºC to + 10 ºC
Source: Carbon Trust (2007).		

Some key points for food storage are listed below (Carbon Trust, 2011c).

- Keep non-perishables such as canned drinks cool (e.g. away from direct sunlight) and place in refrigerator to chill prior to serving.
- Do not overfill refrigerators (there has to be room for the cool air to circulate) and keep doors closed.
- Ensure that defrost procedures are followed, at least every two months.
- Check door seals on cold rooms, fridges and frozen food stores and replace if damaged.
- Keep evaporator coils clean and free of dust.

Applicability

Most of the measures described above are applicable to all commercial kitchens, except measures to reduce energy consumption in cold rooms, which are applicable only to large restaurants and hotels. Selecting efficient new equipment is applicable when installing new equipment, and may also inform decisions on the timing of equipment replacement. Table 8.29 summarises the applicability of measures to reduce kitchen energy consumption.

Table 8.29: Conditions relating to the applicability of energy-saving measures, and relevance for SMEs

Measures	Conditions	SMEs
Install efficient cooking equipment	Applicable to all enterprises when selecting new equipment (may bring forward replacement of older equipment). Consider electricity carbon footprint and typical use patterns when comparing alternatives.	Yes
Efficient use of cooking equipment	Applicable to all enterprises.	Yes
Installation of variable-speed ventilation fans	Applicable to all enterprises.	

Select efficient refrigeration cabinets	Applicable to all enterprises when selecting new equipment (may bring forward replacement of older equipment).	Yes
Install efficient cold room systems	Applicable to large restaurants or hotels when installing or replacing cold rooms and associated refrigeration systems.	No
Use hydrocarbon or natural refrigerants	Applicable to large restaurants or hotels when installing or replacing refrigeration systems.	No
Install heat refrigeration system recovery	Applicable to large restaurants or hotels at any time, though cheaper if fitted when installing or replacing refrigeration systems.	Yes
Maintenance and efficient use of refrigeration equipment	Applicable to all enterprises.	Yes

Economics

Energy consumption accounts for 4 – 6 % of operating costs for caterers, approximately equivalent to typical profit margins (Carbon Trust, 2011a). Modest reductions in energy costs can therefore significantly improve profitability. There has so far been relatively little attention on energy efficiency in commercial kitchens, and there are many opportunities to reduce energy consumption in the average kitchen, sometimes with minimum financial investment.

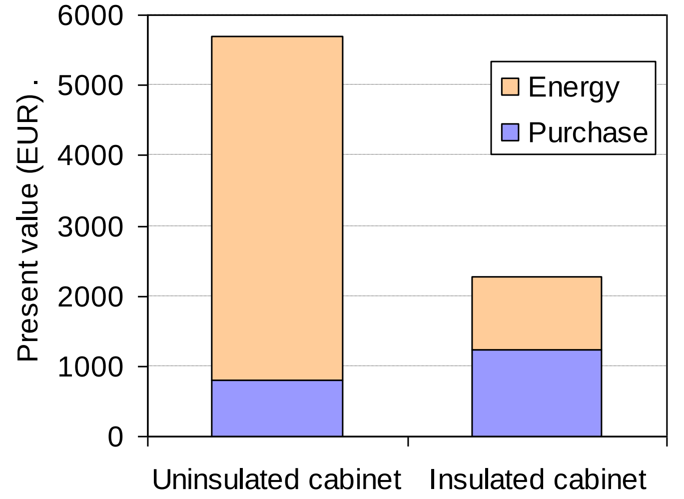
For larger investments in new efficient equipment, government financial assistance may be available. The UK Enhanced Capital Allowance scheme allows businesses to deduct the capital cost of energy-saving equipment from taxable profit in the year of purchase (http://etl.decc.gov.uk/). Refrigeration equipment such as evaporative condensers and refrigeration control systems are included in this scheme.

Monitoring

A good multifunction electricity meter costs EUR 330 to purchase (Carbon Trust, 2011a), and this can be paid back within a few months through the identification and implementation of energy saving opportunities typical to most commercial kitchens.

Cooking equipment

The cost of energy consumption over equipment lifetime is usually considerably higher than the purchase cost, and selecting equipment with the lowest purchase price often results in high costs over time (Figure 8.31).



EUR 0.10/kWh energy cost, 5 year lifetime, 3 % discount rate.
Source: Modified from Fisher (2006).

Figure 8.31: Lifetime purchase and energy costs for an uninsulated and insulated hot food holding cabinet

Despite lower efficiency at the point of use and higher idle energy use rates, energy prices typically favour gas over electric cookers. The unit cost of electricity is up to 3.4 times the cost of gas (Carbon Trust, 2011a). Lifetime cost comparisons between gas and electric ovens (including induction hobs) should account for the factors such as additional cooling and ventilation requirements (installation and operating costs) for gas heat sources. For example, Clarkes restaurant in Peterborough decided to fit an induction cooker because fitting a new canopy and interlock to bring the extraction system up to the current Corgi gas specification was going to cost the same as buying the new induction suite (Control Induction, 2011).

Cooking techniques

Efficient cooking techniques and use of appropriate equipment can result in savings equivalent to, or even greater than, savings achievable through the selection of efficient equipment. Although such techniques can be virtually free to implement, they are more likely to be implemented with regular, high-quality staff training.

Ventilation

Installation of a kitchen ventilation unit with processor control of a variable speed fan in the Hotel des Indes, The Hague, reduced ventilation energy consumption by 60 % and had a payback of 1.3 years (Green Hotelier, 2011). Savings of 62 %, equivalent to 76 285 kWh per year, and a payback period of less than one year, were also quoted for the installation of variable-speed processor-controlled fans in a large hotel kitchen by Fisher (2006).

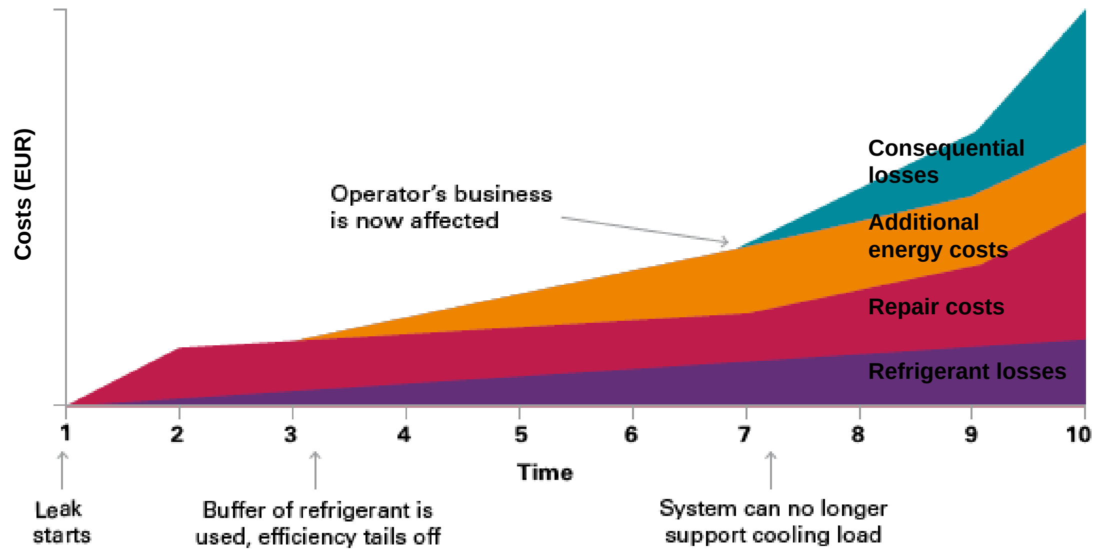
Refrigeration

As with cooking appliances, investing extra to purchase more efficient models always pays back over the equipment lifetime, and often within a few years.

Basic measures such as installation of strip curtains in cold room entrances and installation of electronically commutable evaporator fan motors pay back over a few months to a few years. For example, adjusting compressors to reduce temperature lift between evaporator and condensers will cost a few hours' labour for a technician (Carbon Trust, 2011b).

Installing a high performance heat recovery plant in the refrigeration system of a large restaurant or hotel costs in the region of EUR 2 200 to 4 400 and has a payback time of three to five years (Carbon Trust, 2011b).

Refrigerant leakage incurs significant costs over time through reduced system operating efficiency and effectiveness (Figure 8.32). Leak detection and repair costs (typically a few hundred up to a thousand euro depending on the size of the system) are paid back with a few years for small leaks, and within one year for large leaks (Carbon Trust, 2011b).



Source: Carbon Trust (2011b).

Figure 8.32: Costs incurred over time as a consequence of an unrepaired refrigerant leak

Driving force for implementation

Measures to reduce energy consumption in kitchens are driven by economic efficiency factors (see above), and uncertainty over future energy prices.

Investment in efficient new equipment may be encouraged or brought forward by various government-funded incentive schemes, such as the Enhanced Capital Allowance scheme in the UK.

Installation of refrigeration systems that use hydrocarbon or natural refrigerants is being driven by European regulation phasing out the use of fluorinated gases in refrigeration equipment.

Reference organisations

Two example organisations that implement best practice are:

- The Scarlet Hotel in Cornwall UK (induction hobs, efficient dishwasher)
- Le Premier Restaurant in Århus, Denmark.

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