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Best Environmental Management Practice in the Retail Trade Sector

Learning from frontrunners

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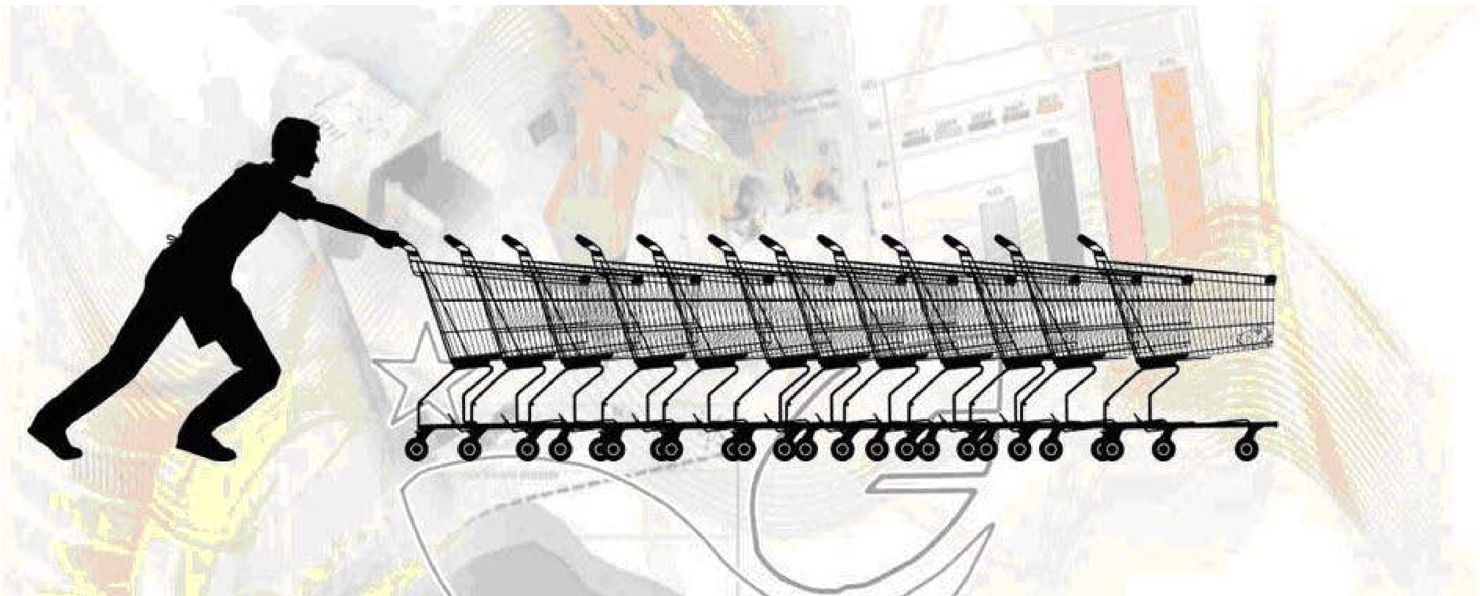

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JRC Scientific and Policy Report on
Best Environmental Management Practice
in the

Retail Trade Sector

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European Commission

In memoriam:

This report is dedicated to the memory of Don Litten (*21.02.1951 - †19.09.2009), who worked tirelessly to promote better environmental management practices, and who contributed to the development of this document.

Table of contents

List of figures

List of tables

EXECUTIVE SUMMARY

A.1. GENERAL ASPECTS, STRUCTURE AND CONTENT OF THE DOCUMENT

A.1.1 General aspects

Background
This report represents the scientific and technical basis of the Sectoral Reference Document (SRD) on Best Environmental Management Practice in the Retail Trade Sector which has been developed according to Article 46 of the Eco-Management and Audit Scheme (EMAS) regulation([1]).

Objective and intention of this document
This document is intended to support environmental improvement efforts of all actors in the retail trade sector. It can be used by all organisations and stakeholders of the sector who seek for reliable and proven information to improve their environmental performance. In case they have an environmental management system, such as EMAS, they can also use the document to develop it further, especially with respect to continuous environmental improvement measures and targets.
For this purpose, this document describes best environmental management practices (BEMPs), i.e. those techniques, measures or actions that allow organisations of a given sector to minimise their impact on the environment in all the aspects under their direct control (direct environmental aspects) or on which they have a considerable influence (indirect environmental aspects). Following this integrated approach, the scope of this document is broad and covers the most important direct and indirect environmental aspects. Thus, not only the direct operations of the retailers but also their supply chain were considered in detail. For the different BEMPs, the document also present appropriate environmental performance indicators which enable organisations to monitor their performance and compare it over time and with benchmarks. Indeed, the document also reports a list of benchmarks of excellence representing the exemplary environmental performance achieved by frontrunner organisations in the sector.

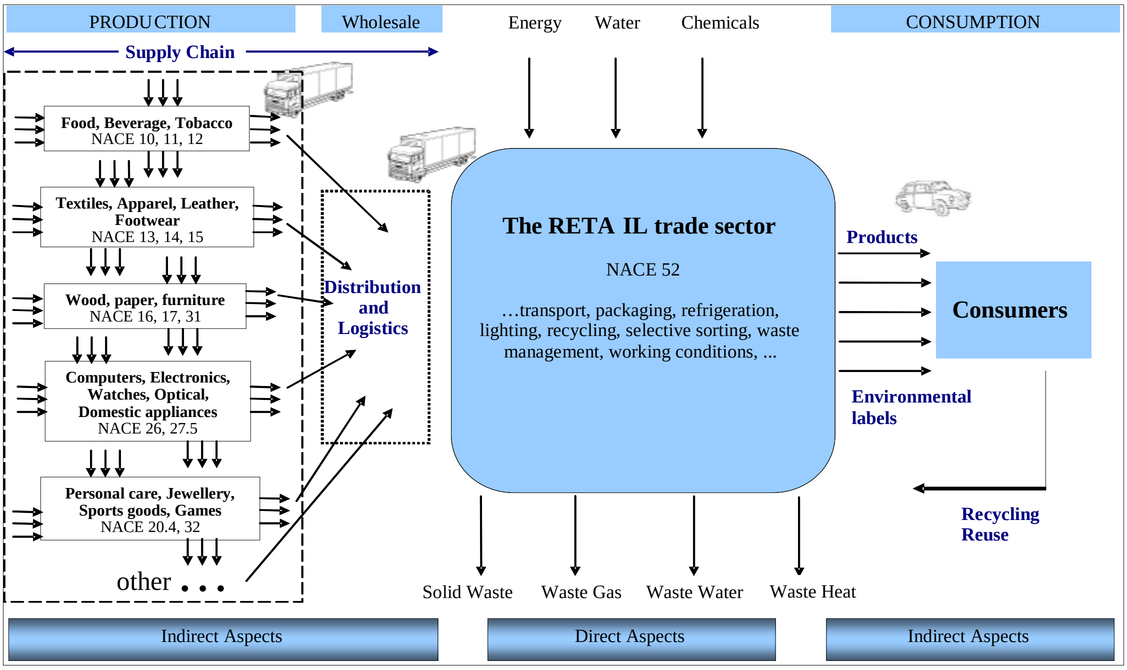
Approach used to develop this document
A Technical Working Group (TWG) was set up to get a broader access to the sector, to obtain more qualified information and to verify the techniques described as well as to draw the conclusions with respect to appropriate environmental performance indicators and benchmarks of excellence. There was one meeting at the beginning of the whole development process on 25 June 2009 (so-called kick-off meeting) as well as a final meeting at the end on 18-19 November 2010 (final meeting).
A lot of information needed to draft this document was already publicly available from various sources, including a number of comprehensive reports. That was supplemented with information collected directly from retailers and other stakeholders, including consultancy firms, non-governmental organisations, and technology providers.
The techniques described in the document were selected according to the frontrunner approach, i.e. by identifying frontrunner organisations and studying in-depth their performance and the frontrunner techniques implemented by them. This was required as the benchmarks of excellence are a major outcome of the whole process. For this purpose, frontrunner organisations and techniques were identified and evaluated in detail through desk research and expert consultation. If needed, site visits were carried out to obtain further required information and understanding, both for technical and economic considerations.

([1]) Regulation (EC) No 1221/2009 of the European Parliament and of the Council of 25 November 2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), OJ L 342, 22.12.2009

The techniques are presented according to a common structure. Amongst others, this includes their "applicability", to provide clear indications under which conditions or circumstances a certain technique can be implemented (technical feasibility) as well as economic information concerning investment and operation costs (economic viability).

A.1.2 Structure of the document

The document covers the whole value chain for the products sold in retail stores. On the basis of mass stream thinking, the following input/output scheme has been used to structure the document.



Overview of inputs and outputs of the Retail Trade sector

The heart of the document is Chapter 2 presenting the 'Best environmental management practices (BEMPs)'. The structure of the description of the different practices is similar to the Best Available Techniques Reference Documents (BREFs), developed according to Article 13 of the Industrial Emissions Directive: technical description, achieved environmental benefits, appropriate environmental indicator, cross-media effects, operational data, applicability, economics, driving force for implementation, reference retailers and reference literature.

Reflecting the overview above, the different techniques are grouped as follows:

- BEMPs to improve the energy performance (section 2.1)
- BEMPs to improve the sustainability of retail supply chains (section 2.2)
- BEMPs to improve transport and logistics operations (section 2.3)
- BEMPs concerning waste (section 2.4)
- other BEMPs (reduced consumption and use of more environmentally-friendly paper for commercial publications (section 2.5), rainwater collection and reuse (section 2.6), and influencing consumer environmental behaviour by means of the example of plastic bags (section 2.7).

The content of these chapters covers the most significant environmental aspects of the sector.

The first two groups of BEMPs (improving the energy performance and improving the sustainability of the supply chains) are the most important ones.

In addition to Chapter 2 on BEMPs, Chapter 1 contains general information about the retail trade sector such as data on turnover and employment as well as the direct and indirect environmental aspects. These are illustrated by means of the overview of the inputs and outputs of the retail trade sector (see figure above). Chapter 3 describes two new emerging techniques concerning the improvement of energy performance (building design and refrigeration). The aim of Chapter 4 is to facilitate the use of the document by SMEs within the Retail Trade sector. A set of tables on the applicability of the different BEMPs to SMEs are also included at the end of this executive summary.

Finally, Chapter 5 of the document contains concluding tables that compile the information from Chapter 2. Conclusions are drawn with respect to key environmental performance indicators (Section 5.4) and benchmarks of excellence (section 5.5). A final table (Section 5.6) presents a set of recommended sector-specific key environmental performance indicators. These are a subset of all the indicators listed in the document and in the previous section of the conclusions and are those indicators whose use is recommended for most organisations within the sector.

A.2. ENVIRONMENTAL INDICATORS AND BENCHMARKS OF EXCELLENCE

A.2.1 Approach to conclude on environmental indicators and benchmarks of excellence

This document was developed based on an information exchange with retailers, consultations with experts, a literature review and site visits. Some of the cooperating retailers were big players in the retail market.

The conclusions on the environmental indicators and benchmarks of excellence have been derived by expert judgement of the European Commission through the JRC-IPTS, and by the technical working group (TWG). This group included companies, umbrella associations, verification bodies, accreditation bodies and other stakeholders. The European Commission organised and chaired the meetings of the TWG. The conclusions on the environmental performance indicators and benchmarks of excellence were drawn at the second meeting of the working group in November 2010. There was consensus and no split views were recorded.

A.2.2 Presentation of the environmental indicators and the benchmarks of excellence

The conclusions on the environmental indicators and benchmarks of excellence associated with the application of BEMP are compiled in the following summarizing table which is structured according to the BEMPs described in Chapter 2. The table contains cross references to the background information on the BEMPs in Chapter 2 of the SRD. This executive summary can be used as a stand-alone document.

Benchmarks of excellence	BEMP is to	Recommended indicators	Remarks
ENERGY PERFORMANCE **Chapter 2.1 Best environmental management practices to improve energy performance of the retail sector**			
Specific energy consumption for heating, cooling and air conditioning **less than or equal to 0 kWh/m^{2}yr if waste heat from refrigeration can be integrated (see Section 2.1.6.4)**. Otherwise, less than or equal to **40 kWh/m^{2}yr for new buildings and 55 kWh/m^{2}yr for existing buildings.**	**improve the envelope of existing retailer buildings** to reduce energy losses to an acceptable and feasible level. **BEMP is to optimise the building envelope design** in order to fulfil demanding standards going beyond existing regulations – see Section 2.1.6.1. **retrofit existing HVAC (heating, ventilation and air conditioning) systems** in order to reduce energy consumption and improve indoor air quality**.** **optimise the design of HVAC systems in new buildings,** using innovative systems to reduce the primary energy demand and to increase efficiency – see Sections 2.1.6.2 and 2.1.6.3. **use integrative concepts** for the whole building or for parts of it to reduce the energy demand of the store – see Section 2.1.6.3.	**Store specific energy consumption** per m^2(sales area) and year. **Store primary energy consumption** per m^2 (sales area) and year.	**Applicability:** applicable to new and existing stores and to all sales concepts. Climatic dependence factors can be applied to the benchmark if backed by sound scientific justification. **Economics**: long payback times for envelope retrofitting are foreseen (see Table 2.7). A new optimised building should not cost more than 10 % of a similar building without improvement measures.
Heat consumption of **0 kWh/m^{2}yr** (absence of heating system).	**recover the waste heat from the refrigeration cycle and to maximise its use** – see Sections 2.1.6.4 and 2.1.6.2.	**Store energy consumption** per m^2(sales area) and year. **Energy savings** per m^2 sales area and year. **Produced or recovered heat** per m^2 sales area and year.	**Applicability:** can be applied to any food retailer. Benchmark of excellence derived for a load of refrigeration (low and medium temperature) higher than 40 m of refrigeration cabinets per 1000 m^2 sales area. Climatic dependence factors can be applied to the benchmark if backed with sound scientific justification. **Economics**: Integration with building envelope and HVAC retrofitting have long payback periods (> 3 years).
100 % of stores and processes are monitored. Implemented **benchmarking** mechanisms (y/n).	**monitor the energy use** of the processes inside a store (heating, refrigeration, lighting, etc.), also at store and/or organisation levels. **benchmark the energy consumption** (per process) and **to implement preventive and corrective measures** – see Section 2.1.6.5.	Implementation of a monitoring system **(y/n)** **Percentage** of stores controlled **Number** of controlled processes	**Applicability:** can be applied to any sales concept. This practice is very relevant for retailers managing a large number of stores. **Economics**: Low cost of implementation if it is integrated into business management structures for new stores. For existing stores, it can be complex but can result in higher savings due to the implementation of corrective measures.

Benchmarks of excellence	BEMP is to	Recommended indicators	Remarks
100 % covered low temperature cabinets. **100 % use of cooling zones** (e.g. in cash and carry) or **100 % covering of medium temperature** refrigeration where this can lead to an **energy savings of more than 10 %.** Specific (linear) consumption of refrigeration **3000 kWh/m yr.**	**implement energy-saving measures in the refrigeration system of a food store,** especially the covering of refrigeration display cases with glass lids, when the energy-saving potential produces relevant environmental benefits – see Section 2.1.6.6.	**Specific energy consumption** per m^2 sales area and year **Specific (linear) energy consumption per m** of display case and year. **Percentage** of stores with natural refrigerants.	**Applicability:** applicable to food retailers. Covering freezers and medium temperature cabinets have an impact on the HVAC system. **Economics:** Covering of cabinets can have short payback times (< 3 years) if the achieved savings are equal to or higher than 20 %.
General use of natural refrigerants (y/n).	**use natural refrigerants in food stores,** as the environmental impact would be reduced substantially and **to avoid leakages** by ensuring that installations are tightly sealed – see Section 2.1.6.6.	**Leakage control** (% of refrigerant). **Percentage** of stores with natural refrigerants.	**Applicability:** applicable to food retailers. The application of CO_2 for medium temperature cycles depends on ambient temperature. **Economics:** Shifting to natural refrigerants, such as CO_2, has the lowest emissions abatement costs.
Lighting: power consumption is less than **12 W/m²** for supermarkets and **30** W/m² for specialist stores.	**design smart lighting strategies** with enhanced efficiency and reduced consumption**, to use daylight** without affecting the sales concept and **to use the most efficient lighting devices** – see Section 2.1.6.7.	**Specific energy consumption** per m^2 sales area and year. Installed **lighting power** per m^2.	**Applicability:** applicable to any sales concept. An important influence on marketing aspects is observed for lighting. **Economics:** The definition of an optimal lighting strategy and using the most efficient devices can lead to a savings higher than 50 %.
100 % of **distribution centres who exclusively** service the retailer are **monitored.**	**implement energy saving measures in distribution centres**, **to audit** energy use periodically within the environmental management system, **to train staff** regarding energy savings and **to communicate** the energy saving efforts of the organisation internally and externally – see Section 2.1.6.8.	**Specific energy consumption** per m^2 sales area and year. Installed lighting and/or appliance **power** per m^2. Energy management system in place to drive continuous improvement **(y/n).**	**Applicability:** There is no limitation on the size, type or geographical location of the retailer to perform a comprehensive management system, taking into account appliances, distribution centres, specific energy uses or communication and training.
To have **net zero energy buildings** (store or distribution centre) where local conditions allow the production of renewable energy on site, or investment in equivalent renewable energy generation at other locations (y/n).	**integrate renewable energy sources** in stores where previously measures to reduce the energy demand and increase the efficiency have been applied – see Section 2.1.6.9.	**Specific energy generation** per m^2 of sales area. **Percentage** of energy from alternative generation**.** **Percentage** of alternative energy generation in excess of consumption.	**Applicability:** applicable to any sales concept. Important limitations are the availability of renewable sources, accessibility of land or roof installations and demand fixing for combined heat and power systems. **Economics:** Implemented techniques will produce benefits in the long term.

Benchmarks of excellence	BEMP is to:	Recommended indicators	Remarks
SUPPLY CHAIN IMPROVEMENT **Chapter 2.2 Best environmental management practices to improve sustainability of retail supply chains**			
Systematic implementation of supply chain improvement programmes across priority product groups	**(for top-level management) to integrate** supply chain sustainability into the **business strategy**, and for dedicated management personnel or units to **coordinate implementation** of necessary actions across retail operations – see Section 2.2.6.1.	**Public reporting** of quantitative corporate targets specifically related to improving the sustainability of priority product supply chains (y/n) Presence of a **high-level business unit** with responsibility for **driving and coordinating** supply chain sustainability actions (y/n) **Systematic implementation of supply chain improvement** programmes across priority product groups (y/n).	**Applicability:** all retailers can integrate supply chain sustainability into business strategy. For small retailers, this is limited to green procurement and encouraging ecological consumption. For larger retailers that sell private label products, a higher level of integration is possible. **Economics**: costs associated with systematic improvement of supply chains should be balanced against: (i) mitigation against supply chain cost volatility arising from anticipated resource supply constraints; (ii) higher profit margins associated with value-added product ranges; (iii) long-term economic advantage associated with reputational and marketing advantages.
Implementation of systematic assessment (independently or through consortia) of core product supply chains	**identify priority products, processes and suppliers** for improvement through environmental assessment of product supply chains, using **existing scientific information**, **consultation with experts** (e.g. NGOs), and **lifecycle assessment tools** – see Section 2.2.6.2. **identify effective supply chain improvement mechanisms** for **priority products,** specifically **chains of custody** and **control points** that could be used to effectively influence environmental performance – see Section 2.2.6.3.	Life cycle environmental loadings (CO_2 eq., kg SO_x eq., kg VOC eq., kg 1,4-DCB eq., kg Sb eq., m^3 water, kg PO_4 eq.), biodiversity pressures, location-specific water pressures, expressed per product mass or, where more accurate, per functional unit. **Number** of core product supply chains assessed. **Number o**f priority product supply chains that are environmentally improved through the application of best practice techniques. Implementation of a **systematic assessment** (independently or through consortia) of core product supply chains (y/n).	**Applicability:** basic environmental assessment methods are relevant to all retailers and all products, to select the most appropriate product groups for choice editing and green procurement and for promotion of front-runners. More data intensive assessment methods are applicable to private label products sold by larger retailers, to inform the implementation of supply chain improvement through environmental requirements and supplier environmental performance benchmarking. Core (high sales volume) products should be prioritised for assessment. **Economics:** basic assessment of hotspots based on existing literature is inexpensive, but full supplier-specific assessment is expensive. Costs may be compensated by the identification of new process efficiencies, and by revenue increases associated with value-added products, marketing and reputational benefits.

Benchmarks of excellence	BEMP is to:	Recommended indicators	Remarks
100 % certification according to third party environmental standards	**exclude worst performing products**, and **require widespread** certification according to third party environmental standards for **priority products** – see Section 2.2.6.4.	**Percentage of sales** within a product group certified to a specified third party environmental standard. The **environmental performance** represented by that standard. **Percentage certification targets**, for product groups where a programme for widespread certification is being implemented. **Number of product groups** where more than half of sales are certified	**Applicability:** choice editing and green procurement may be implemented by any retailer, to branded and private label products. This technique should be applied to priority product groups identified during supply chain assessment. **Economics:** Achieving widespread certification incurs significant supplier costs usually passed on to the retailer. These costs may be offset by small price premiums that can be asked for certified products. Certification may also increase retailer's overall private label sales through a positive 'halo effect' (improved customer perception).
100 % private label sales within a product group comply with particular retailer-defined environmental requirements.	**establish environmental criteria for priority products and their suppliers,** targeting identified **environmental hotspots,** and to **enforce** compliance these criteria through product and supplier **auditing** – see Section 2.2.6.5.	**Percentage of private label sales** within a product group compliant with specified environmental requirements. The **environmental performance** represented by those requirements. **Percentage compliance targets**, for product groups where a programme for widespread compliance is being implemented. **Number of product groups** where more than half of sales are compliant with specific environmental requirements.	**Applicability:** large retailers, private label priority products. **Economics:** auditing of supplier environmental performance can be integrated into social auditing and product quality control systems to minimise additional costs. For suppliers, compliance costs should be balanced against improved security of demand and enhanced marketability for their products, and any price premiums they may consequently realise. For retailers, costs should be balanced against reduced reputational and medium-term business supply chain risks associated with unsustainable practices, and against price and marketing premiums they may consequently realize.
100 % private label sales within a product group are sourced from suppliers participating in retail programmes to improve environmental performance.	**drive supplier improvement** by establishing **information exchange systems** that can be used to **benchmark suppliers**, and by **disseminating better management practices**. The latter aspect may assist supplier compliance with third party standards and retailer-defined criteria – see Section 2.2.6.6.	**Percentage of private label sales** that originate from suppliers participating in retail programmes to improve environmental performance. The level of **environmental performance** represented by those programmes. **Percentage participating suppliers targets**, for product groups where a supplier improvement programme is being implemented. **Number of product groups** where more than half of sales originate from suppliers participating in retail programmes to improve environmental performance.	**Applicability:** large retailers, private label priority products. **Economics:** Retailers may offer suppliers a small price premium to encourage participation in improvement schemes, and pay for data collation and dissemination of better management practice techniques. These costs should be balanced against reduced reputational and medium-term business supply chain risks associated with unsustainable practices, and against price premiums that retailers may consequently realise. The dividends of any identified efficiency improvements may be shared with retailers through contractual agreement.

Benchmarks of excellence	BEMP is to:	Recommended indicators	Remarks
10 % sales within food product groups certified as organic. 50 % cotton sales certified as organic. 10 % sales within non-food product groups certified according to official (ISO Type-I) environmental labels.	**promote front-runner certified ecological products. Awareness campaigns, sourcing, pricing, in-store positioning and advertising** are important components of this technique, which can be effectively implemented through development of **own-brand ecological ranges** – see Section 2.2.6.8.	**Percentage sales** within a product group certified according to front-runner exemplary standards. **Number of product groups** for which front-runner ecological products are offered. Existence of an extensive **own-brand ecological product range** (y/n).	**Applicability:** all retailers can stock and encourage consumption of front-runner ecological products. Large retailers can implement this technique more extensively, through the development of own-brand ecological ranges. **Economics:** Supplier costs associated with front-runner certification are passed on to retailers. Certified front-runner ecological products are associated with significant price premiums and higher profit margins. Own-brand ecological ranges are also likely to increase a retailer's overall private label sales through a positive 'halo effect'.

Benchmarks of excellence	BEMP is to:	Recommended indicators	Remarks
TRANSPORT AND LOGISTICS PERFORMANCE **Chapter 2.3 Best environmental management practices to improve transport and logistics operations**			
100 % of transport and logistics (T&L) providers comply with either: (i) third-party-verified environment-related standards (ii) specific environmental requirements (iii) best environmental management techniques contained in this document.	**integrate environmental performance and reporting criteria into the procurement** of transport and logistic services provided by third parties, including requirements for implementation of BEMPs described in this document – see Section 2.3.4.1.	**Percentage of transport providers certified** to environment-related standards (includes registration to reporting programmes), such as: Clean Shipping Project, ERRT Way Ahead Programme, US Smartway Program. **Percentage of transport providers complying** with specific **environmental requirements** or BEMPs described in this document.	**Applicability:** all retailers purchase at least part of their transport and logistic operations from third party providers, and can make purchasing decisions according to efficiency or environmental criteria. Small retailers are completely dependent on third party providers. **Economics:** improving the efficiency of transport and logistic operations reduces operating costs, and requires effective monitoring and reporting. Efficient third party transport providers may be able to offer lower cost services to retailers.
For 100 % T&L operations between first-tier suppliers, retail stores and waste management facilities, including those performed by third party transport providers, the following indicators are reported: (i) percentage transport by different modes (ii) kg CO_2 eq. per m^3 or per pallet delivered. For all in-house T&L operations between first-tier suppliers, retail stores and waste management facilities the following indicators are reported: (i) truck load factor (% weight or volume capacity) (ii) kg CO_2 eq. per tkm	**report on the efficiency and environmental performance of all transport and logistic operations** between first-tier suppliers, distribution centres, retailers and waste management facilities, based on monitoring of in-house operations and data provided by third party operations – see Section 2.3.4.2.	**Tonnes CO_2 eq. per year** emitted by transport and logistic operations. **kg CO_2 eq. per m^3**, or pallet delivered. whether the following parameters are reported for **all** relevant transport and logistic operations: (i) percentage transport by **different modes** (ii) **kg CO_2 eq. per tonne, per m^3 or per pallet delivered (y/n).** whether the following indicators are reported for **all in-house** transport and logistics operations: (i) **truck load factor** (% weight or volume capacity) (ii) **kg CO_2 eq. per tkm**.	**Applicability:** all retailers. Reporting on in-house transport and logistics operations will only apply to larger retailers. Small retailers can use basic data on average emission factors for different modes of transport to estimate emissions. **Economics:** effective monitoring and reporting requires small investment in necessary information technology systems and management but can identify options to improve the efficiency of transport and logistic operations, and therefore reduce costs.

Benchmarks of excellence	BEMP is to:	Recommended indicators	Remarks
Systematic implementation of packaging improvements to maximise density and improve T&L efficiency.	**integrate transport efficiency into sourcing decisions and packaging design,** based on **life cycle assessment of products** sourced from different regions, and through **designing product packaging to maximise the density of transport units** – see Section 2.3.4.3.	**kg CO_2 eq./m^3** (or pallet) delivered. **Modal split** of transport. **Number of product groups** where sourcing or packaging has been modified specifically to **reduce T&L and life cycle environmental impact**. **Systematic implementation of packaging improvements** to maximise density and improve T&L efficiency (y/n).	**Applicability:** large retailers with private label ranges. **Economics:** for sourcing, highly dependent on product and source location, related to a multitude of sourcing factors. For packaging, increasing the density of packaged goods can considerably improve transport efficiency (by up to 30 % for the example of IKEA tea-light candles), and therefore reduce transport costs.
Over 50 % of overland transport between first-tier suppliers and retail distribution centres (tkm or sales value) is by water/rail (where infrastructure allows). Over 99 % of overseas transport, according to sales value, is by ship.	**shift towards more efficient transport modes**, especially rail, water-based transport and larger trucks, and to minimise air-freight. This overlaps with planning of product sourcing and distribution networks – see Section 2.3.4.4.	**Percentage of total product transport** (tkm or sales value), from first-tier suppliers to stores, accounted for by **specified more-efficient modes.**	**Applicability:** large retailers with in-house transport and logistic services, small retailers where they can select transport providers based on different modes, third party transport providers. Products sourced over longer distances. **Economics:** loading and unloading costs for efficient modes (train and ship) are more than compensated for by lower specific transport costs over longer distances.
Systematic optimisation of distribution networks through the implementation of strategic hub locations, consolidated platforms, and direct routing.	**optimise the distribution network** through the systematic implementation of the most efficient of the following options: (i) **strategic centralised hubs** to accommodate rail and water-based transport, (ii) **consolidated platforms, (iii)** and **direct routing** – see Section 2.3.4.5.	**kg CO_2 eq. per m^3 (**or pallet) delivered. Number of **consolidation platforms** in use. Number of **strategic central hubs** in use. Number of **direct transport routes** in use. **Percentage reduction in T&L GHG emissions** through implementation of specified distribution network improvement options. Outsourcing of T&L operations to a **third party provider with an optimised distribution network**. **Systematic optimisation of distribution networks** through the implementation of strategic hub locations, consolidated platforms, and direct routing. (y/n)	**Applicability:** large retailers with in-house transport and logistic services, third party transport providers. Products sourced over longer distances. **Economics:** distribution network optimisation to coordinate transport from multiple suppliers does not require significant investment. Building new central hubs integrated with rail and water-based transport networks does require significant investment. In both cases, increased loading efficiency and the use of more efficient modes for longer distance routes can significantly reduce operating costs. Payback periods vary from months to years. Efficiency dividends may be shared between cooperating parties.

Benchmarks of excellence	BEMP is to:	Recommended indicators	Remarks
100 % of drivers continuously trained in efficient driving, or implementation of an efficient driving incentive scheme for drivers. Systematic optimisation of routing through back-hauling waste and supplier deliveries on store-delivery return journeys, use of telematics, and extended delivery windows.	**optimise operational efficiency through efficient route planning, use of telematics, and driver training.** Efficient route planning includes **back-loading** store delivery vehicles with waste and with supplier deliveries to distribution centres, and making **night deliveries** to avoid traffic congestion – see Section 2.3.4.6.	**kg CO_2 eq. per m^3** (or pallet) delivered. Fleet average **percentage load efficiency** (volume or mass capacity). Fleet average percentage **empty running** (truck km). **Fleet average g CO_2 eq./tkm.** **Percentage of drivers** continuously trained in efficient driving. Implementation of an **efficient driving incentive scheme** for drivers (y/n). **Percentage reduction in T&L GHG emissions** through the implementation of specified options (i.e. back-hauling waste or supplier deliveries, telematics, driver training and incentive schemes, off-hour deliveries). **Systematic optimisation of routing** through back-hauling waste and supplier deliveries on store delivery return journeys, use of telematics, and extended delivery windows (y/n).	**Applicability:** large retailers with in-house transport and logistic services, third party transport providers. All products. **Economics:** driver training costs are low, and offer payback periods of weeks to months assuming a 5 % fuel saving. Route optimisation may require significant investment in information technology, but can reduce capital investment costs (fewer trucks required) and significantly reduce operating (fuel) costs. Payback periods are short. Efficiency dividends may be shared between cooperating parties.

Benchmarks of excellence	BEMP is to:	Recommended indicators	Remarks
100 % trucks EURO 5 compliant with HGV fuel consumption of less than 30 l/100 km. 100 % trucks, trailers and loading equipment compliant with PIEK noise standards, or equivalent standards that enable night deliveries. Operation of alternatively fuelled vehicles (natural gas, biogas, electric). 100 % vehicles fitted with low rolling resistant tyres. 100 % vehicles and trailers designed or modified to improve aerodynamic performance.	**minimise the environmental impact of road vehicles** through purchasing choices and retrofit modifications. This includes the purchase of **alternatively powered vehicles, efficient vehicles** and **low-noise** vehicles, **aerodynamic modifications**, and the application of **low rolling resistance tyres** – see Section 2.3.4.7.	**l/100 km** (vehicle fuel consumption). **kg CO_2 eq. per tkm.** **Percentage vehicles** within transport fleet compliant with different **EURO classes.** **Percentage of vehicles**, trailers and loading equipment compliant with PIEK **noise standards**, or equivalent standards that enable night deliveries. **Percentage of vehicles** in transport fleet powered by **alternative fuel sources**, including natural gas, biogas, or electricity**.** **Percentage of vehicles** within transport fleet fitted with **low rolling resistance tyres.** **Percentage of vehicles** and trailers within transport fleet designed or modified to improve **aerodynamic performance.**	**Applicability:** large retailers with in-house transport and logistic services, third party transport providers. **Economics:** for vehicles driven long distances at higher speeds (> 80 km/h), small investments in aerodynamic modifications and larger investments to upgrade to aerodynamic tractor and trailer units offer payback periods of months to years. Low rolling resistance tyres pay back over months to years. Alternatively-powered vehicles require considerably higher investment costs that may not be paid back, but this depends on national fuel and road taxation policies. For the example of Albert Heijn, investment in low-noise transport and loading equipment increased capital costs by 15 %, but reduced overall transport and logistic costs by more than 20 %.
WASTE MANAGEMENT **Chapter 2.4 Best environmental management practice concerning waste**			
Zero food waste sent to landfills or incineration plants.	**integrate environmental practices to avoid food waste generation,** as monitoring, auditing, prioritising, logistic issues, better preservation mechanisms, temperature and humidity control at store, distribution centres and delivery trucks, training staff, donation, etc. – see Section 2.4.6.1**, and to avoid landfilling or incineration of food waste through fermentation processes** – see Section 2.4.6.4.	kg or tonne of food waste, absolute value, per m^2 or per EUR million of turnover. **Percentage of food waste generation** referring to total food purchases. **kg or tonne of food exceeding the sell-by date** but not the use-by date, **donated to charitable institutions.** **kg of food waste** sent to **recovery operations**, such as fermentation. **kg of food waste** sent to **landfill or incineration** plans.	**Applicability:** food retailers of any size and in any European country. **Economics:** treatment costs of less than EUR 100 per tonne. Achieved savings are higher if prevention measures are implemented or food exceeding sell-by date is donated.

Benchmarks of excellence	BEMP is to:	Recommended indicators	Remarks
A waste management system is integrated in the store and its objective is to recycle or reuse 100% of secondary packaging materials.	**integrate waste management practices where prevention is prioritised** – See section 2.4.6.2.	**Percentage of recycling and reuse rates.**	**Applicability:** any food retailer could implement this practice. **Economics:** prevention measures and joint initiatives among stores can produce costs savings
Consumer return of 80% without deposit. Consumer return of 95% with deposit.	**implement take-back systems and to integrate them in the company logistics**, as, for example, for PET or PE bottles – see Section 2.4.6.3.	**Percentage recycling rate** defined per sales of returnable bottle.	**Applicability:** any food retailer could implement this practice **Economics:** expensive equipment and maintenance and staff resources needed. In some countries it is mandatory, such as Germany. For example, Switzerland is implementing EUR 0.013 fee per bottle to give an incentive for the system.

MATERIALS CONSUMPTION **Chapter 2.5 Reduced consumption and use of more environmentally friendly paper**			
100 % certified/recycled paper. Grammage less than 49 gr/m^2. Less than 10 % coated paper. 100 % print shops EMAS/ISO 14001 certified.	**reduce the impact through less consumption of materials, such** as paper optimisation for commercial publications – see Section 2.5**.**	**Percentage of paper** used that is **certified** **Grammage** of paper used **Percentage** of **coated paper** **Percentage of printing shops** certified **EMAS** or **ISO 14001**	**Applicability:** any food retailer could implement this practice. **Economics:** expected costs reduction, if compared to normal practices.
WATER MANAGEMENT **Chapter 2.6 Rainwater collection and reuse**			
Rainwater collection and/or infiltration on site are integrated in the water management system.	**collect and reuse and/or infiltrate on site r**ainwater from roofs and parking areas – see Section 2.6	**Y/N**	**Applicability:** any retailer could implement this practice, although climate can be an important factor when implementing this measure. **Economics:** cost intensive measure.
CONSUMER BEHAVIOR **Chapter 2.7 Influencing consumer environmental behaviour**			
Zero one-use bag available at checkouts.	**influence consumers to reduce their environmental impact,** through campaigns, such as the removal of plastic bags, responsible advertising and providing best guidance information to consumers – see Section 2.7.	**Number** of available one-use bags at check-outs	**Applicability:** any food retailer could implement this practice. **Economics:** expected costs reduction, if compared to normal practices.

A.3. Use of the SRD by SMEs

Small and Medium Enterprises wishing to improve their environmental performance may consider the different options mentioned in the tables below. A user-friendly analysis of costs, applicability and environmental benefit, is performed below with three colour symbols representing the level of each aspect. For more detailed information, the sections concerned in chapter 2 are indicated.

Colour code for the assessment of best environmental management practices for SMEs

Symbol	● (orange)	● (yellow)	● (green)
Cost (initial investment)	High	Medium	Low
Applicability to SME	Not applicable	Applicable with restrictions	Fully applicable
Environmental Benefit	Low	Significant	High

Best Environmental Management Practices for SMEs: energy performance– including refrigerants consumption

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Energy performance – including refrigerants consumption	Improvement of Building Envelope	2.1.6.1.				Usually, SMEs do not own the building or the building unit where they operate. Nevertheless, they have direct control of glazing, shading, entrances, space heating and cooling (in some cases not), management and control of air flow and general maintenance of building-related aspect. Costs to retrofit existing systems are high, although some measures have very low payback times.
	Optimized design of HVAC systems	2.1.6.2.				
	Integrative concepts for buildings	2.1.6.3.				
	Heat recovery from refrigeration	2.1.6.4.				Only suitable for central refrigeration systems. The engineering of the system can be contracted to third parties.
	Monitoring	2.1.6.5.				Metering system needed for each process. The environmental benefit depends on the implementation of corrective measures.
	Efficient refrigeration: single measures	2.1.6.6.				Cost-efficient solutions through good management and operation are feasible. Other measures, as glass lids on cabinets, are less accessible to SMEs.
	Efficient refrigeration: shift to natural refrigerants	2.1.6.6.				For small stores with plug-in devices, it would be only possible for new equipment.
	Efficient lighting	2.1.6.7.				Use of smart lighting systems and efficient devices is feasible for SMEs
	Secondary measures	2.1.6.8.				Efficient appliances, staff training and communication are feasible measures
	Alternative Energy sources	2.1.6.9.				Green purchasing can be a good solution for micro enterprises. For SMEs, the use of renewable energy or other alternative sources can be achievable, although the payback times are usually high.

Best Environmental Management Practices for SMEs: supply chain

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Supply chain	Integrate supply chain sustainability into business strategy and operations	2.2.6.1				The managing director of an SME may decide to stock and sell products certified to environmental standards, based on identification of priority product groups and a plan of action.
	Assess core product supply chains to identify priority products, suppliers and improvement options	2.2.6.2				For SMEs, this involves identification of priority products to which third party environmental certification should be applied, based on sales volume and environmental impact intensity (identified through reference to scientific literature).
	Identify effective product supply chain improvement mechanisms	2.2.6.3.				For SMEs, this involves identification of appropriate third party environmental standards for either universal application (for use in green procurement) or to identify front-runner products (to encourage sustainable consumption).
	Choice editing and green procurement of priority product groups based on third party certification	2.2.6.4.				Certified products may be more expensive, thought this is highly dependent on the specific standard and product. By marketing the value-added of certified products, retailers can charge consumers a small price premium.
	Enforce environmental requirements for suppliers of priority product groups	2.2.6.5.				This BEMP is applicable only to private label products, and may involve significant costs. It is not applicable to SMEs.
	Drive supplier performance improvement through benchmarking and best practice dissemination	2.2.6.6.				This BEMP is applicable only to private label products, and may involve significant costs. It is not applicable to SMEs.
	Collaborative research and development to drive widespread supply chain improvement and innovation	2.2.6.7.				This BEMP is applicable only to private label products, and therefore not to SMEs.
	Promote front-runner ecological products	2.2.6.8.				Front-runner environmental products are usually associated with a significant price premium which consumers must be convinced to pay through effective marketing.

Best Environmental Management Practices for SMEs: transport and logistics

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Transport and Logistics	Green procurement and environmental requirements for transport providers	2.3.4.1				Applicable to all retailers, and the main improvement option for SMEs who rely on third party providers for most of their transport requirements.
	Efficiency monitoring and reporting for all transport and logistic operations	2.3.4.2				Applicable to all retailers. For small retailers, BEMP requires collation of basic information on the transport mode and distance.
	Integrate transport efficiency into sourcing decisions and packaging design	2.3.4.3				Only applicable to large retailers with private label products. Not applicable to SMEs.
	Shift towards more efficient transport modes	2.3.4.4				Primarily applicable to retailers with extensive in-house transport and logistic operations. Not applicable to SMEs, except where available procurement choices enable selection of more efficient transport modes for particular products.
	Optimise the distribution network	2.3.4.5				Only applicable to retailers with extensive in-house transport and logistic operations. Consolidated platforms may be implemented with little investment, but development of strategic central hubs is expensive. Not applicable to SMEs.
	Optimised route planning, use of telematics and driver training	2.3.4.6				Applicable to SMEs if they have their own transport vehicles (e.g. delivery vans).
	Minimise the environmental impact of road vehicles through purchasing decisions and retrofit modifications	2.2.3.7				Applicable to SMEs if they have their own transport vehicles (e.g. delivery vans). There is a wide variation in investment costs for different procurement options and vehicle modifications.

Best Environmental Management Practices for SMEs: Materials consumption – excluding refrigerants consumption

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Materials consumption	Reduce consumption and use of more environmentally friendly paper for commercial publications	2.5				This technique can be applied to any company generating commercial publications.

Best Environmental Management Practices for SMEs: Waste Management

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Waste management	Food waste prevention and minimization	2.4.6.1				Any SMEs can apply preventing measures to avoid food waste generation. Management costs would be compensated by cost savings derived from less product losses and less generated waste
	Integration of waste management activities	2.4.6.2				SMEs producing a huge amount of wastes should allocate resources and train staff for waste management.
	Return systems for PET and PE bottles and for used products	2.4.6.3				These systems are increasing reuse and recycling rates in the countries where it is mandatory. Extra resources would be needed for management of the return system.
	Fermentation of food waste	2.4.6.4				Applicable to food retailers with direct control on the treatment of their wastes.

Best Environmental Management Practices for SMEs: Water Management

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Water management	Rainwater collection and reuse to the ground at retail supermarket from roofs and parking areas	2.6				Applicable for large surfaces, in case of new stores.

Best Environmental Management Practices for SMEs: Consumer Behaviour

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Consumer behaviour	Influencing the consumer behaviour: the example of plastic bags	2.7.2				Small and medium enterprises can be benefitted from the removal of free disposable plastic bags, as they can save a significant amount of money by avoiding its purchase and/or adding a fee to each disposable bag

PREFACE

1. Background

This JRC Scientific and Technical Report has been drafted to establish the basis for the development of the Sectoral Reference Document (SRD) on Best Environmental Management Practice in the Retail Trade Sector, elaborated according to Article 46 of the Eco-Management and Audit Scheme (EMAS) regulation([2]). EMAS was introduced in 1993 for voluntary participation by organisations, by Council Regulation (EEC) No 1836/93 of 29 June 1993 (EC, 1993). Subsequently, EMAS has undergone two revisions in 2001 and 2009. One of the new elements introduced with the latest revision is the development of sectoral reference documents on best environmental management practice as a tool to help organisations better focus on the most important environmental aspects in a given sector and to promote best environmental practice and performance.

This is the first of a series of reports to be published in the next few years covering a number of sectors for which the Commission is developing SRDs on Best Environmental Management Practice. The Institute for Prospective Technological Studies (IPTS) of the European Commission's Joint Research Centre leads the scientific and technical work.

More information on the overall work carried out in this area are available on the IPTS website at: http://susproc.jrc.ec.europa.eu/activities/emas/

2. Objective and intention of this document

This document is intended to support the environmental improvement efforts of all actors in the retail trade sector. It can be used by all organisations and stakeholders of the sector who seek for reliable and proven information to improve their environmental performance as well as for appropriate environmental performance indicators and benchmarks of excellence. In case they have an environmental management system, such as EMAS, they can also use the document to develop it further, especially with respect to continuous environmental improvement measures and targets.

As indicated above, this document is the scientific and technical basis for the SRD on Best Environmental Management Practice in the Retail Trade Sector.

3. Content

Three key elements constitute the heart of this document: best environmental management practices, environmental performance indicators and benchmarks of excellence.

<u>Best environmental management practices</u> (BEMPs) are those techniques, measures or actions that allow organisations of a given sector to minimise their impact on the environment in all the aspects under their direct control or on which they have a considerable influence.

BEMPs can be of a technical or technological nature, such as improving the energy efficiency of a certain process, or of a more management or organisational type, such as providing training to employees or engaging in environmental improvement with suppliers.

BEMPs are identified not only within the physical site boundaries of the organisations of the sector concerned but across the whole value chain of their products and services, and considering environmental impacts over the whole life cycle.

The concept of BEMP, similarly to the concept of Best Available Technique (BAT) according to the Industrial Emissions Directive (IED)([3]), is linked to two key criteria: the best practice is already implemented at full scale by a number of organisations in the sector or at least by one

([2]) Regulation (EC) No 1221/2009 of the European Parliament and of the Council of 25 November 2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), OJ L 342, 22.12.2009 organisation if replicable/applicable by others; and the best practice is technically feasible and economically viable.

In order to make the document more structured and the information easier to find, all the BEMPs are described according to a common structure: technical description, achieved environmental benefits, appropriate environmental indicator, cross-media effects, operational data, applicability, economics, driving force for implementation, reference retailers and reference literature. This is similar to the structure used in the Best Available Techniques Reference Documents (BREFs), developed according to Article 13 of the IED([3]).

An environmental performance indicator is a "specific expression that allows measurement of an organisation's environmental performance" (EMAS Regulation([2]), Art.2) and "shall: give an accurate appraisal of the organisation's environmental performance; be understandable and unambiguous; allow for a year on year comparison to assess the development of the environmental performance of the organisation; allow for comparison with sector, national or regional benchmarks as appropriate; allow for comparison with regulatory requirements as appropriate" (EMAS Regulation([2]), Annex IV). Indicators can be absolute or relative (or normalised), specific or aggregated (or weighted).
This report focuses on sector-specific environmental performance indicators, i.e. indicators that go beyond the general core indicators which can apply to all kind of organisations. They deal with the following key environmental areas (defined for the core indicators in the EMAS regulation): energy efficiency; material efficiency; water; waste; biodiversity and emissions.

Sector-specific environmental performance indicators can be defined at different level: at the level of the whole organisation or company, at the level of a certain site or at the level of a specific process or activity (Figure i).

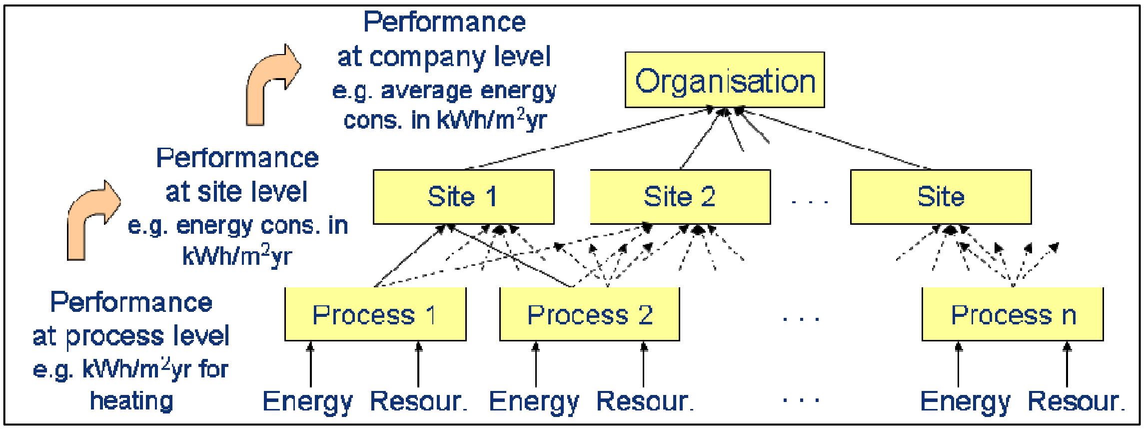


Figure i: Bottom-up approach for environmental performance indicators and benchmarks of excellence

Indicators can be relevant and useful at all these levels, but focus was given to the process level as this is the level which allows for better and more meaningful comparability across organisations and against benchmarks. This is also the level where indicators can provide useful guidance on which areas/activities/processes within a certain organisation show the lowest performance or offer the highest potential for improvement. As shown in Figure i, this corresponds to taking a bottom-up approach to environmental performance indicators, where the environmental performance at higher levels is a result or, to some extent, a weighted average of the environmental performance at process level.

([3]) The Industrial Emission Directive (IED) replaces the Integrated Pollution Prevention Control (IPPC) Directive with effect from January 2014. More information on the IED directive and on the development of BREFs can be found on the web-site of the European IPPC Bureau (http://eippcb.jrc.ec.europa.eu) and on DG Environment web-site at: http://ec.europa.eu/environment/air/pollutants/stationary.

In this report, environmental performance indicators are always given in relation with a specific BEMP. On the one hand, this makes clear which indicators can be used to monitor progress in the implementation of that technique. On the other hand, if an organisation can use a certain indicator and would like to improve its performance in that area, it can implement the related BEMPs.
It should also be noted that an environmental performance indicator may be appropriate for a certain company, enterprise or administration but may not be for others. If an indicator can be applied to many companies, enterprises or administrations of a certain sector, a benchmark of excellence may be derived from it.

As no official definition of benchmark of excellence existed when the work on this series of reports was started, an appropriate understanding and interpretation of the meaning of this term was developed. The understanding is that this term reflects exemplary environmental performance. The term has to be seen in connection with best environmental management practice which takes also economic considerations into account. As a consequence, benchmarks of excellence cannot simply mean the best of the best but, as rule of thumb, the 10 or the 10 to 20 percent best performing installations within the sector overall, or within a good or best performing organisation within the sector. Where there are sufficient data (which is often not the case), frequency distributions of a quantified environmental performance indicator can be used to illustrate the approach.

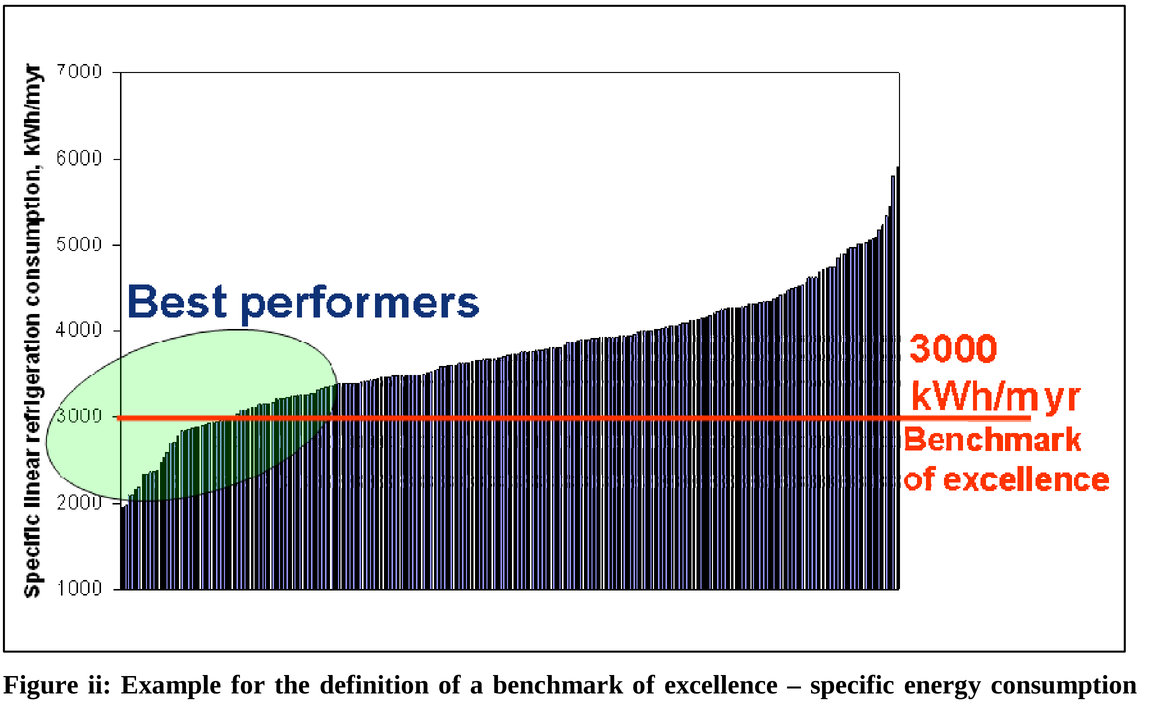


Figure ii: Example for the definition of a benchmark of excellence – specific energy consumption for commercial refrigeration of food in retail stores

Figure ii shows an example for commercial refrigeration of food by a remote system. In this case, the most appropriate environmental performance indicator is the annual energy consumption per metre of display case and year and the benchmark of excellence was concluded by the Technical Working Group (see section 4 below) to be 3000 kWh/myr. The data shown in the graph stem from one frontrunner retailer. However, the benchmark was also checked against other data sets and experts' judgement.
The benchmark of excellence can also just be a yes or no criterion, such as for the use of natural refrigerants or for the systematic implementation of supply chain improvement programmes across priority product groups (see table of benchmark of excellence contained in the executive summary). It can also be a percentage of stores applying a certain technique, such as the percentage of stores of a retailer where energy is monitored across specific processes, or the

percentage of sales within a product group certified to a specified third party environmental standard.
Benchmarks of excellence represent thus a high and ambitious environmental performance level, far better than good or average performance. In principle, it is also possible that a benchmark of excellence is derived from a few cases, if the technical feasibility and the economic viability are given.
As discussed for the environmental performance indicators, benchmarks of excellence are usually derived for processes where the comparability is best.

Benchmarks of excellence are reference points against which an organisation can compare its environmental performance in order to identify improvement potentials.

4. Approach used to develop this document

The following strategy was developed and implemented in the elaboration of this report:

- A technical working group (TWG) was established to get a broad access to the expertise present in the sector, to obtain support with respect to the identification and description of techniques as well as to draw conclusions on the appropriate sectoral environmental performance indicators and benchmarks of excellence. The TWG comprises a range of experts with in-depth knowledge of the sector from different perspectives (see the set-up in the Figure iii).

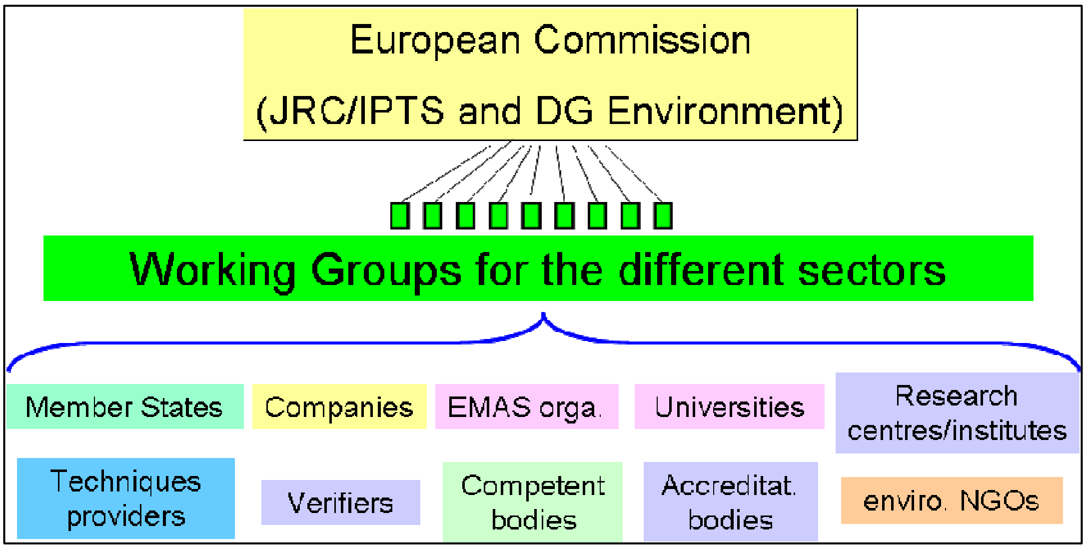


Figure iii: Structure of the Technical Working Group (TWG)

The elaboration process of this report started with the identification of experts to form the TWG. Then, two meetings were held: a kick-off meeting on 25 June 2009 and a final meeting on 18-19 November 2010 (Figure iv).

Besides the meetings, the technical working group interacted constantly with the IPTS providing information and comments on the two drafts of the document that were shared with them. For the collection of feedback, it was chosen to take an informal approach. Comments could be provided by e-mail without using a specific format or template. This reduced substantially the work load for the members of the TWG and this is considered crucial to ensure the participation of very competent experts in the drafting of a document of non-binding character.
The draft versions of the document as well as information on the advancement of the work were published on the IPTS website and thus available for consultation by all interested stakeholders.

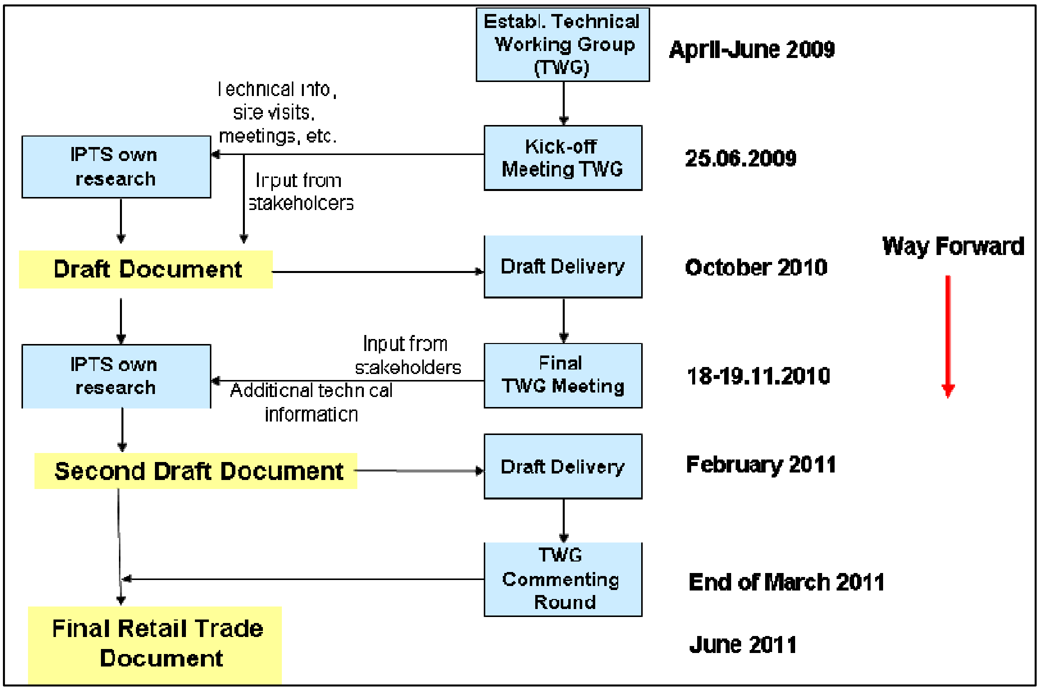


Figure iv: Timing for the elaboration of the Retail Trade document

- Given the focus of this document on best practices and benchmarks of excellence, a so-called frontrunner approach was developed. Often it is sufficient and appropriate to describe average or good performance, but in this case best environmental performance is required. For this purpose, the research carried out focused on studying frontrunner retailers. Frontrunners were indentified by desk research (looking at available sustainability reports of retailers, environmental statements, case studies, literature review, information on environmental indicators, correspondence with sector experts, consultancy firms, non-governmental organisations, technology providers, etc.). The frontrunners identified (certain retailers but also technology providers, consultancy firms, etc.) were contacted and in many cases they were open and prepared to provide all requested information. Thus, relevant techniques were identified and described along with defining suitable environmental performance indicators. In addition, preliminary ideas concerning possible benchmarks of excellence were derived. Where required, visits of sites operated by frontrunners were carried out to complete the understanding of frontrunner techniques and to obtain specific information for their description according to the common structure.
  In two cases, the detailed data provided was declared confidential. Consequently, upon explicit agreement of the provider, the data were used in an anonymous form (graphs) but were still useful. At any rate, confidential was respected.

- As mentioned earlier, a very important outcome of this document is the definition of a set of benchmarks of excellence for the environmental performance in the retail trade sector. These are directly built on the technical descriptions of the best practice techniques, which also include one or a number of environmental performance indicators. Based on these descriptions, the technical working group for the retail trade sector concluded, thanks to his expert judgement, on appropriate benchmarks of excellence. These benchmarks are presented as an essential part of the conclusions chapter of the document. The same chapter also include a table with all environmental performance indicators and a summary indicators table containing a set of recommended sector-specific key environmental performance indicators. These are a subset of all the indicators listed in the document and are those indicators whose use is recommended for the organisations within the sector.

5. How to use this document

This document is not conceived to be read from its beginning to the end, but as a working tool for professionals willing to improve the environmental performance of their organisation and who seek for reliable and proven information to do so.
Different parts of the document will be interesting and will apply to different professionals and at different stages.

The best way to start using this document is reading the short section about its structure to understand the content of the different chapters and, in particular, which are the areas for which BEMPs have been described and how these BEMPs have been grouped.
Then, chapter 1 would be a good starting point for the readers looking for a first general understanding of the sector and its environmental aspects.
Those looking for an overview of the BEMPs described in the document could start from chapter 5 (Conclusions) and in particular with subchapter 5.5 which present a summary table of the benchmarks of excellence, i.e. the exemplary performance level that can be reached in each area, together with links to the relevant BEMPs to be implemented to achieve those environmental performance levels.
For the readers looking for information on how to improve their environmental performance in a specific area, it is recommended to start directly at the concrete description of the BEMPs on that topic, which can be easily found through the table of contents (at the very beginning of the document).
Finally, those readers mostly interested in environmental performance indicators for organisations of the retail trade sector would find useful to begin with the table in subchapter 5.6 containing a list of recommended sector-specific key environmental performance indicators, as well as information on the related benchmarks of excellence and links to the relevant BEMPs.

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SCOPE

This document addresses the activities specified in Section G 47 of Annex I of Regulation 1893/2006/EC (NACE Rev.2([4])), namely: ‘Retail trade, except of motor vehicles and motorcycles’. Retailing of services, e.g. restaurants, hairdressers, travel agents are excluded.

Retailing covers the resale without transformation of new and used goods to the general public for personal or household use and consumption([5]). A retail store may be specialised in a specific product category or non-specialised and cover the entire range of product categories included in retail. The product categories define the various 'sectors' of retail trade. The major retail trade sectors are the following:

- food
- beverage
- tobacco
- fruit and vegetables
- meat and meat products
- fish, crustaceans and molluscs
- bread, cakes, flour and sugar confectionery
- automotive fuel
- information and communication equipment
    - computers, peripheral units and software
    - telecommunications equipment
    - audio and video equipment
- textiles
- hardware, paints and glass
- carpets, rugs, wall and floor coverings
- electrical household appliances
- furniture, lighting equipment
- cultural and recreation goods
    - books
    - newspapers and stationery
    - music and video recordings
    - sporting equipment
    - games and toys
- clothing
- footwear and leather goods
- dispensing chemist
- medical and orthopaedic goods
- cosmetic and toilet articles
- flowers, plants, seeds, fertilisers, pet animals and pet food
- watches and jewellery.

([4]) http://ec.europa.eu/environment/emas/documents/nace_en.htm
([5]) http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-NP-06-008/EN/KS-NP-06-008-EN.PDF

STRUCTURE

Following a brief description of the context and scope of this document (current section), Part 1 ('GENERAL INFORMATION') provides some background information on the retail trade sector in short chapters:

- Chapter 1.1 regarding turnover and employment
- Chapter 1.2 regarding environmental aspects
- Chapter 1.3 regarding social responsibility and sustainability.

More comprehensive background information on relevant retail operations and environmental aspects are provided in Part 2 of the document ('BEST ENVIRONMENTAL MANAGEMENT PRACTICES'), in Chapter 2.1 to Chapter 2.7.

Part 2 represents the main body of document, and is divided into five main chapters, each dealing with a particular group of operations and activities over which retailers have, or could reasonably be expected to have, a significant degree of control and that have important consequences for environmental performance or impact:

- Chapter 2.1 deals with the energy efficiency of retail buildings, including all energy-consuming processes within buildings (e.g. insulating properties of building envelopes, refrigeration, lighting, ventilation), and is divided into 9 techniques.
- Chapter 2.2 addresses how retailers can improve the sustainability of their product supply chains (e.g. assessing supply chain impacts, sourcing certified products, encouraging ecological consumption), and is divided into 8 techniques.
- Chapter 2.3 deals with transport and logistic operations association with supply and delivery of retails goods, including distribution network design, collaboration with suppliers and third party transport providers, etc., and is composed of seven techniques.
- Chapter 2.4 deals with waste management and recycling, including retailers' provision of take-back systems for recyclable materials, and is composed of four techniques.
- Chapter 2.5 is comprised of a single technique to reduce paper consumption and use certified paper in marketing material
- Chapter 2.6 is comprised of a single chapter to reduce water consumption and run-off
- Chapter 2.7 is comprised of a single practice as an example on how consumer behaviour can be influenced.

Part 3 of the document shows the description of several emerging techniques, focused on the energy performance of retailers.

Part 4 of the document summarises how to apply the document to SMEs and what techniques can be applied to SMEs following three main criteria: costs, applicability and environmental benefit.

Part 5 of the document summarises the main conclusions on retail best practice, relevant indicators, and proposed performance benchmarks.

1 GENERAL INFORMATION

1.1 Turnover and employment

Retail belongs to the non-financial part of the service sector and constitutes, together with wholesale trade and motor trade, the branch of distributive trades. The retail sector is characterised within Eurostat's structural business statistics according to NACE code G.52 (NACE Rev. 3): 'retail trade, except of motor vehicles and motorcycles; repair of personal and household goods'). In 2007, about 3.8 million enterprises were active in retail trade in the EU-27 (Table 1.1). In 2008, retail enterprises employed almost 18 million people, generated a turnover of EUR 2 537 billion, and generated a value added of EUR 418 billion (Table 1.1). The high turnover share of the sector (second only to wholesale trade), reflects the buying and (re-)selling nature of this activity.

The retail trade sector is a significant component of the European economy that has grown strongly since 2000, with an average growth rate of 3.4 % between 2000 and 2008 (Eurostat, 2009b). In 2006, it represented 7.4 % of the EU-27 non-financial business economy, 8.1 % of the UK economy, 8.3 % of the French and Portuguese economies, and 12 % of the Greek economy (Eurostat, 2009a). In terms of total value added to the EU-27 economy, the UK retail sector contributed the most (EUR 87.1 billion), followed by Germany (EUR 76.1 billion). Approximately 75 % of total value added by the sector is concentrated in Germany, Spain, France, Italy and the United Kingdom. The retail trade is a relatively labour-intensive sector, and accounts for 13.4 % of employment across the non-financial business economy within the EU-27 (Eurostat, 2009c).

Table 1.1: Main indicators for wholesale and retail trade in the EU-27 for 2007 and 2008

	Enterprises	Employees	Turnover
	number (2007)	number (2008)	million EUR (2008)
Austria	42478	342564	52752
Belgium	73668	292428	80161
Bulgaria	91632	288249	10936
Cyprus	11550	37946	5737
Czech Republic	124672	356515	37497
Denmark	24525	239214	42755
Estonia	4058	50515	5311
Finland	23300	162255	34976
France	461114	1594127	395058
Germany	295047	2885907	411648
Greece	194164	546418	65880
Hungary	98865	337166	28303
Ireland	16777		
Italy	685698	1971918	322837
Latvia	12927	104187	6936
Lithuania	43555	167455	9434
Luxembourg	2905	22458	13669
Malta	:		
Netherlands	78795	777182	99978
Poland	372639	1376904	103449
Portugal	182339	463386	47962
Romania	134649	566694	32136
Slovakia	9097	104726	10657
Slovenia	7126	56145	11812
Spain	526772	1836869	242749
Sweden	59250	307760	60805
United Kingdom	198707	3098245	403132
EU-27	**3784470**	**17987233**	**2536570**
Source: Eurostat, 2010			

1.1.1 Composition of the retail trade sector in the EU-27

Figure 1.1 and Figure 1.2 provide some key statistics on the composition of the retail sector within the EU-27. Repair of personal and household goods is a minor component of NACE code G.52. The largest source of economic activity within the retail sector is the sale of non-food products in specialist stores (e.g. electronic, hardware, clothes stores) (Figure 1.1). The second largest source of sectoral economic activity is the sale of general products in non-specialised stores (e.g. super markets). Specialised food retailing accounts for just 6 % of economic activity in the sector on average across the EU-27, although it is considerably higher in some smaller Member States. Just 5 % of economic activity in the sector arises from sales outside of stores, although this is rising. Eurostat (2009a) reported that 12 % of distributive trade (that includes retail) was conducted via e-commerce in 2008.

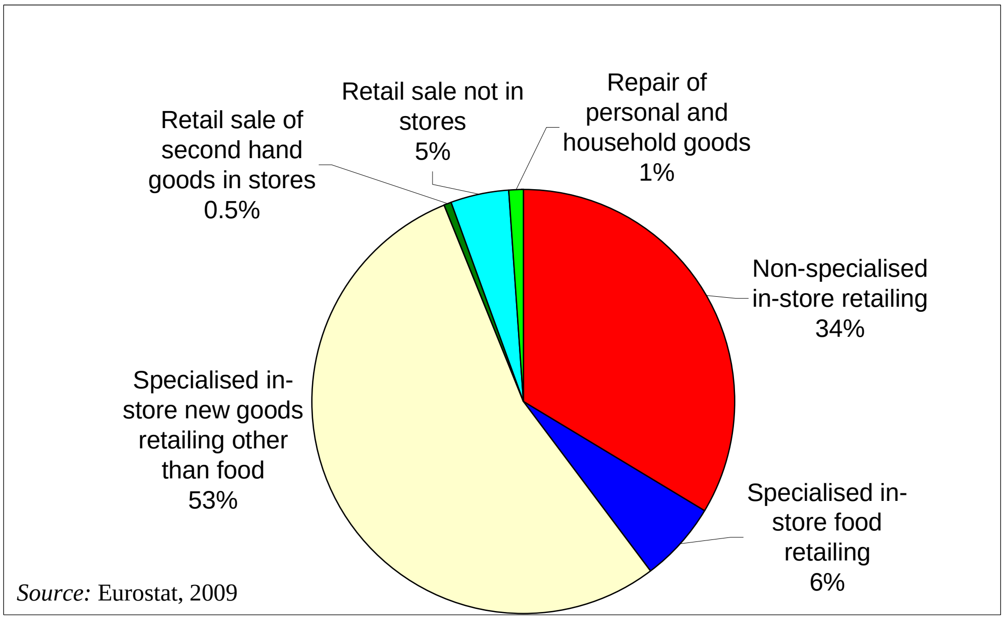

Figure 1.1: Breakdown of retail and repair sector (NACE code G.52) by type of sale, according to share of gross value added in 2006

The largest portion of economic activity within the retail trade sector (43 %) is generated by large enterprises employing 250 or more persons (Figure 1.2). However, there is a bimodal distribution of economic activity within this sector, with 32 % of economic activity generated by small enterprises employing 1 to 9 persons. Medium sized enterprises employing between 10 and 249 persons accounted for 25 % of economic activity.

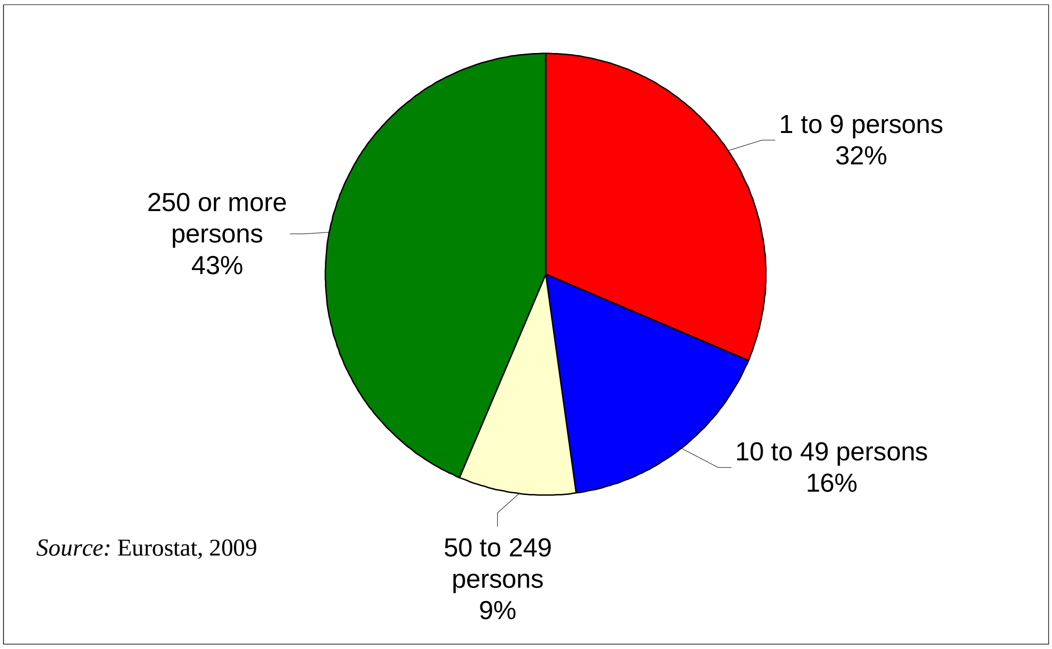

Figure 1.2: Breakdown of retail and repair sector (NACE code G.52) by size of enterprise, according to share of gross value added in 2006

1.2 Environmental issues of the retail trade sector

1.2.1 Direct aspects

The retail sector is strategically positioned after the production supply chain and in direct contact with consumers**.** As such, the retail sector has the ability to strongly influence both the production and consumption aspects of environmental damage. Figure 1.3 provides a schematic overview of the sector and its links with suppliers and customers. Every stage of the production and consumption chain, from growing crops or raising livestock, through manufacturing, storage, distribution and consumption, to dealing with wastes, has environmental impacts. The choices of all the actors along these value chains influence the environmental footprints of these chains, and of each other. Retailers are uniquely positioned to coordinate actions across suppliers and consumers, and drive substantial environmental improvements throughout their products' value chains.

In the bottom of the figure reference is made to the environmental aspects of the whole chain from production to consumption according to their origin. Direct aspects are the ones related to the retail sector only, whereas indirect aspects originate from all the other actors except retailers i.e. producers**,** wholesalers**,** transporters and consumers. Maintenance of product flows within the retail sector requires significant inputs of energy, water and chemicals, and generates significant outputs of solid waste, waste gas, waste water and waste heat (Table 1.2). Heating, lighting, refrigeration, transport and packaging are some of the key activities that give rise to direct environmental impacts associated with the retail sector. Table 1.2 refers to some of the environmentally important inputs and outputs most relevant to the retail trade sector. Some aspects, such as electricity consumption, are general aspects that are of high relevance for most sectors. Other aspects, such as carrier bag waste, are specific to the retail sector.

Table 1.2: Some examples of direct environmental aspects of retail activities

INPUTS	Examples
Energy	Electricity is the main energy source of energy for refrigeration, lighting, air conditioning, escalators, lifts, computers and other accessories in most sectors. It may also be used for heating Fuel consumption for transportation fleet Natural gas or light oil for building heating
Water	For domestic use and for cleaning operations.
Chemicals	Refrigerants, cleaning and disinfection agents, vehicle oils and additives, etc.
OUTPUTS	
Waste gas	Acidifying gases, ozone forming gases, toxic gases and GHGs arising from goods transport, heating boilers, etc.
Solid waste	Paper, cardboard, glass, wood, plastic and other packaging materials, organic materials, food waste and carrier bags Hazardous waste: batteries, fluorescents, mineral oils For household waste (indirect aspect) around half originates from supermarket purchases. 25 % of household waste is packaging(*)
Waste water	Domestic sewage, waste water from cleaning operations, condensates from air conditioning
Noise	From refrigeration systems, deliveries, customer traffic
Odour	From refrigeration and waste systems
(*) http://www.wrap.org.uk/retail/index.html	

1.2.2 Indirect aspects

Major indirect impacts are associated with aspects of production and consumption. The supply chain of the retail sector begins with the manufacturers of consumer products and their raw material suppliers. Most products require substantial inputs of natural resources such as minerals, water and energy. The supply chain of many consumer products is complex, and it may be challenging to attribute quantifiable environmental impacts to specific actors upstream of retailers. Other products have a clear chain of custody and well quantified environmental impacts. In some cases, the environmental performance of supply sectors may be regulated by external agencies. For example, the IPPC Directive applies to large industrial installations in the following sectors in Europe:

- Glass Manufacturing (EC, 2006)
- Food Drink and Milk (EC, 2001)
- Rearing of poultry and pigs (EC, 2003a)
- Slaughterhouses and animal by-products (EC, 2005)
- Tanning of Hides and Skins (EC, 2003b)
- Textiles (EC, 2003c).

For such sectors, there may be little scope for retailers to exert further influence on environmental performance. However, many suppliers are from sectors or countries where environmental regulation is weak. There is considerable potential for retailers to play a leading role in improving the environmental performance of such suppliers, and in the process shift towards more sustainable business.

Retailers may be in direct contact with the producers of the products they sell, particularly own brand products, or they may obtain products through intermediary wholesalers. Where chains of custody are long and complex, retailers may be somewhat removed from the actors responsible for the primary environmental impacts within the supply chain. Nonetheless, the concept of environmentally preferable purchasing is expanding across companies and government organisations based on verifiable environmental criteria that can be used to identify ‘products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose’ (PPRC, 2004; US EPA, 2010). There is considerable scope for retailers to take greater responsibility in product sourcing to drive considerable environmental improvement across product value chains.

For some products, a large share of their environmental burden may arise during the consumption phase of their lifecycle. Main sources of consumption impacts include the transportation of goods from the retail outlet to households, actual consumption (e.g. the washing of textiles, the use of energy for cooking), and the generation of post-consumer waste. Figure 1.1 highlights the importance of environmental labels as a tool that can influence the environmentally responsible behaviour of consumers (and ultimately producers), and the return of used products to the retailer for recycling/reuse as a tool that can significantly reduce post-consumer waste and diminish the use of natural resources. Consumer choices influence the use of resources and can have environmental effects in the whole length of the supply chain (EEA, 2005).

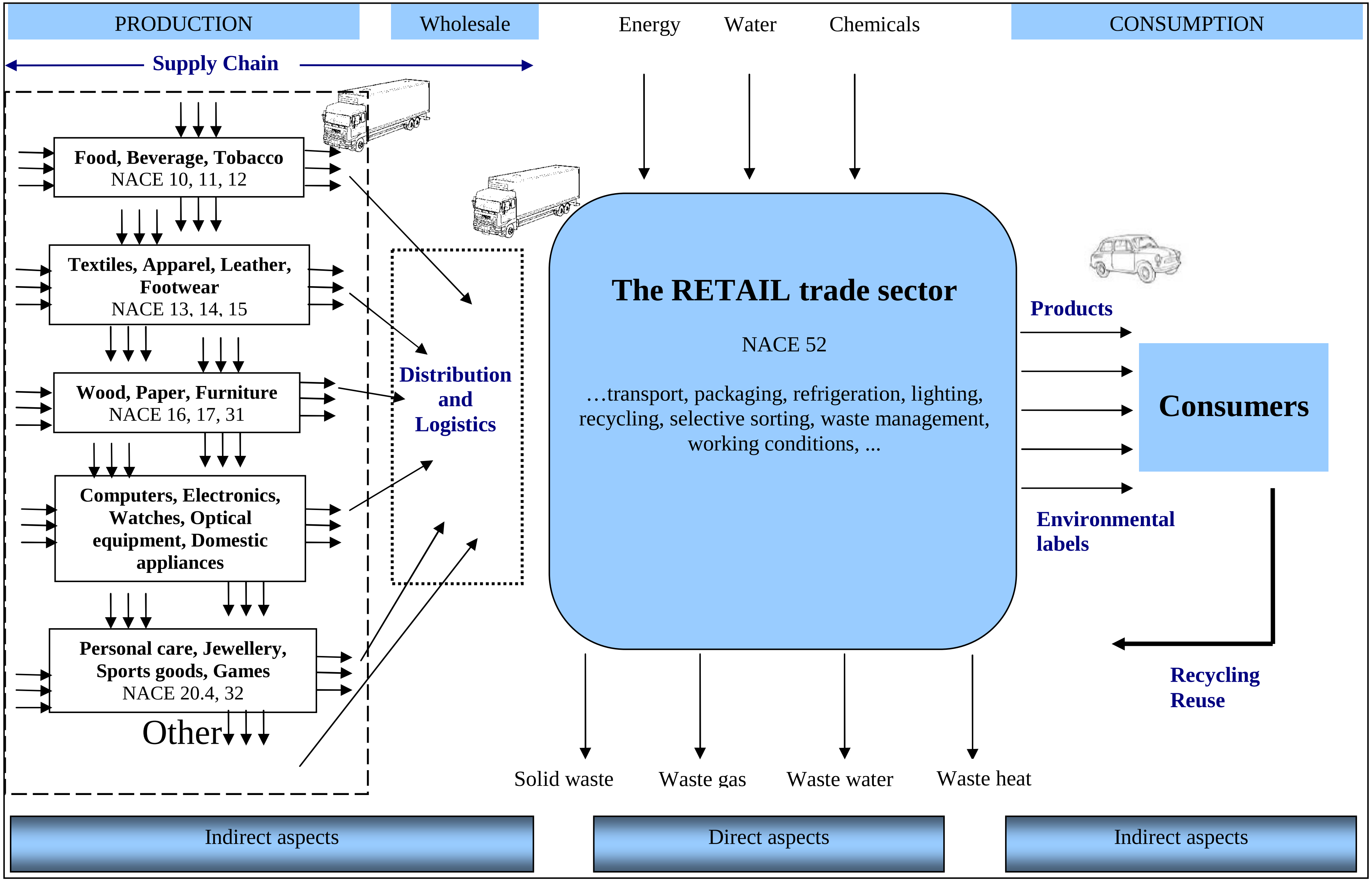

Figure 1.3: Overview of Inputs and Outputs of the Retail Trade sector

1.3 Social responsibility and sustainability in the retail sector

1.3.1 Social responsibility

There are many web-based publications on sustainability policy and practices within the retail sector, and most large retailers publish annual sustainability reports. Brand image and company reputation are particularly important to retailers, and appear to be increasingly important drivers of environmental responsibility as a consequence of increasing consumer awareness of environmental problems. Consumers are ever more willing to support companies that address environmental and social issues. The purpose of annual 'triple bottom line' or sustainability reports is to meet society's demand for greater accountability and to demonstrate that the company is aware of, and actively manages, its risks (KPMG, 2002).

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2 BEST ENVIRONMENTAL MANAGEMENT PRACTICES

2.1 Best environmental management practices to improve the energy performance of the retail trade sector

2.1.1 Chapter structure

This chapter provides practice-oriented information to retailers to improve the energy performance of their activities. Only direct aspects of energy, i.e. those controlled by the company, are being covered and the focus is mainly made on the operation of stores. An introduction about energy management systems and energy commitments of known retailers is provided in Section 2.1.2. The scope of this part of the document is further explained in Section 2.1.3 and the most important drivers, also explained for each described technique, are shown in Section 2.1.4.

A comprehensive list of the most outstanding practices for energy performance improvement is provided in Section 2.1.5. Section 2.1.6 gathers all the described techniques. The building aspects are first explained: building envelope in Section 2.1.6.1, HVAC in Section 2.1.6.2 and Passive House concepts in Section 2.1.6.3. The integration of heat recovery from refrigeration within a store is explained in Section 2.1.6.4. Monitoring of energy consumption, in Section 2.1.6.5, is also considered as a best practice regarding to direct aspects. Best practices in refrigeration are described in Section 2.1.6.6. The shift to more efficient lighting systems is shown in Section 2.1.6.7. Other aspects, as the single measures or integration of alternative energy sources are shown in sections Section 2.1.6.8 and Section 2.1.6.9.

2.1.2 Chapter introduction

The energy management of a company is usually integrated in the environmental management system. With the implementation of an energy management system, energy would be integrated into organisational business structures, not only because of the public image and reputation but also improved business performance through better energy performance and cost-savings.

The European standard EN16001:2009 and the international standard ISO 50001 (draft published in 2010) on Energy Management Systems integrate energy in the typical business structures. These standards are quite similar to ISO 9001 and ISO 14001 and they are based on a Plan, Do, Check, Act (PDCA) approach, which is a continuous improvement scheme. Figure 2.1 shows a simplified diagram of how the different management systems are complementing each other. The standard for the energy management was developed to be a complement of the environmental management system with enhanced focus on the economic aspects of energy performance.

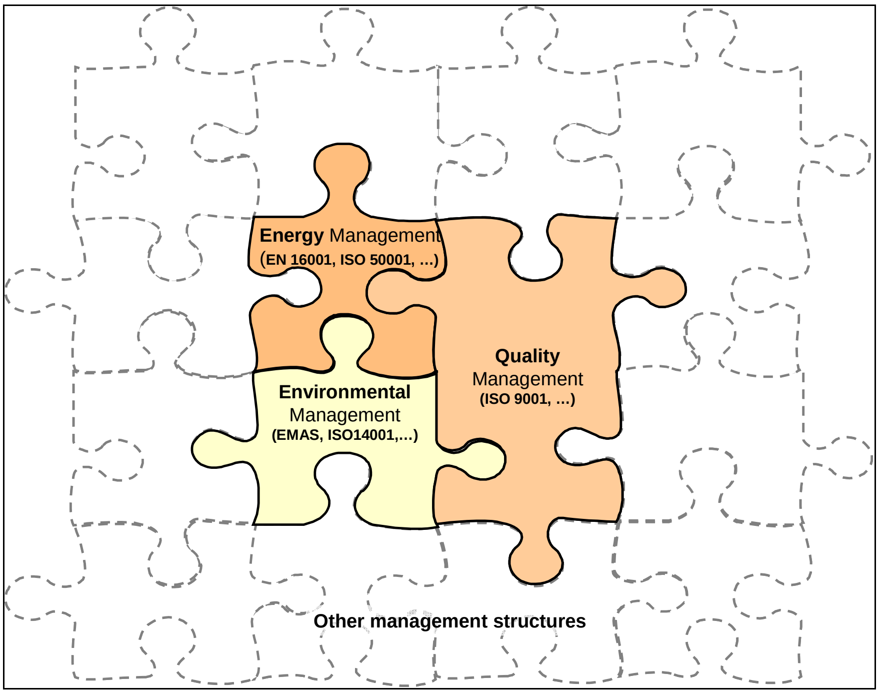


Figure 2.1: Illustrative scheme of the integration of the energy management system with other management structures in a company

As well as for other standards, the PDCA approach (Figure 2.2) is initiated with an initial review of the energy related aspects, where an evaluation of the energy aspects of the company has to be completed. Targets, objectives, the programme for the implementation, etc. of the energy management system have to be defined in the first steps. Then the implementation and operation are performed and checked. A good monitoring and measurement system is required. This is quite significant for retailers, which usually have hundreds or thousands of stores to manage. The cycle finishes (and start again) with the 'act' aspect, in which the reporting, audits and top management review of the system are performed and new or reviewed targets have to be proposed.

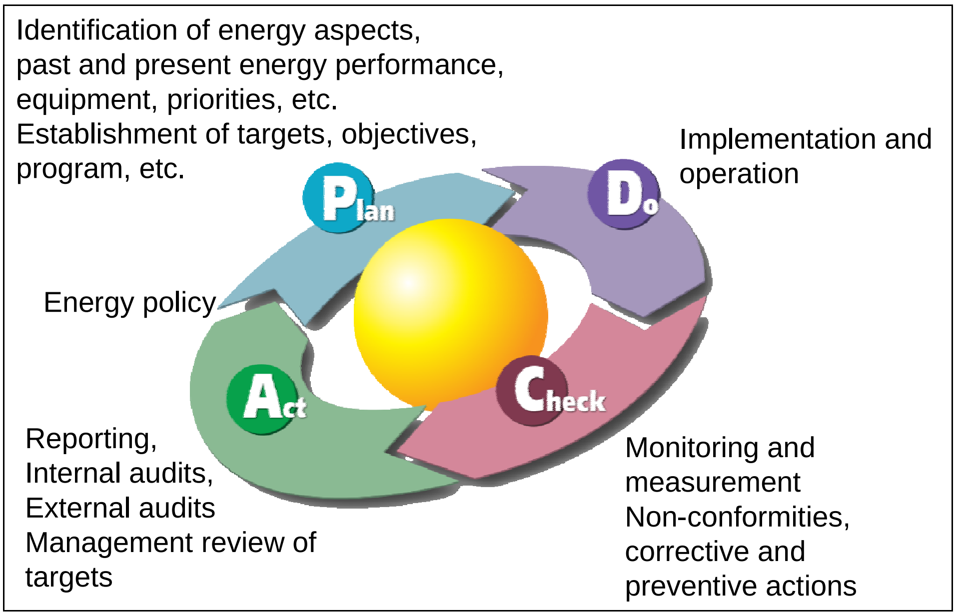


Figure 2.2: Scheme of the Plan Do Check Act approach in an Energy Management System

Management systems, both for environment or energy, help the organisation to establish coherent policies, to set procedures for improving, to gain knowledge and understanding of their operations and to establish continuous improvement mechanisms. However, there are not any absolute requirements or mandatory threshold values for the energy performance. The establishment of such limit or threshold values for the energy performance would depend on the commitment of the company top management to establish objectives and targets.

The commitment to improve the environmental performance (an thus energy performance) of the retail trade sector in Europe is reflected in the creation of the Retail Forum, which is intended to contribute to the implementation of the EU Action Plan on Sustainable Consumption and Production and Sustainable Industrial Policy, presented by the Commission in July 2008.

The Retail Forum is a multi-stakeholder platform. It was developed with the aim of exchanging best practices on sustainability and identifying opportunities and barriers of the achievement of sustainable consumption and production. The first Retail Forum meeting focused on energy efficiency of stores and an issue paper was produced ([6]), with a list of already applied techniques in the retail trade sector. Most of them are explained in this document in a very comprehensive way. Details about the performance, the environmental benefit, economic performance and other aspects are provided. There is no overlapping between the two documents, as they are complementing each other.

In the framework of the Retail Forum, the Retailers' Environmental Action Programme (REAP) was launched and some mechanisms were provided to enhance the dialogue with the European Commission and other relevant stakeholders. It also makes available the commitments and actions of retailers in Europe. The REAP commitments database is located at the Commission webpage ([7]) and the list of commitments for energy efficiency (shown in Table 2.1) represents 25 % of the total list.

Table 2.1: Examples from REAP commitments to improve the energy efficiency of stores

Retailer	Target description
'What we sell' category	
Asda Walmart	End the sale of filament light bulbs by end 2010 versus 2008
	Consumer electronics will use 25 % less energy by end 2010 versus 2007
Auchan	Stop of selling incandescent light bulbs > 75 watt to consumers
Delhaize Group	For Belgium, end of incandescent light bulb sales by the end of 2010
FCD	Decrease market share of incandescent light bulbs
	Decrease energy consumption of light bulbs sold
	Increase market share of CFLs (A+B)
	Phase out of incandescent light bulbs.
	Increase the share of CFLs (number) from 10.7 % in 2007 to 25 % in 2009 and 35 % in 2011
Kooperativa Förbundet	Introduction of a new method to assess the carbon footprint of products when sourcing PLBs
Leroy Merlin, Spain	Increase "A" categories for domestic appliances
The Co-operative Group	Stock white goods A or above and phase out the sale of tungsten incandescent light bulbs
'How we sell' category	
ANCC/Coop Italia	Reduction of energy consumption in 184 members' company stores with 'Green Light' certification by promoting energy efficiency applied to lighting

([6]) More information available at http://ec.europa.eu/environment/industry/retail/about.htm
([7]) http://ec.europa.eu/environment/industry/retail/reap/index_en.html

Retailer	Target description
	Increase energy efficiency by using district heating
	Promoting energy efficiency in dimmered plants
	Promoting energy efficiency by use of LED technology
	New 'green' logistic centre for non-food products
	Reduce energy consumption
APED	Promoting the replacement of halogen lamps by LED in member companies' stores
	Promoting the replacement of CFL by LED lamps in refrigerating appliances
Asda Walmart	New stores will consume 30 % less energy by end 2009 over 2005 base levels
	Existing stores will consume 20 % less energy by end 2009 over 2005 base levels
C&A	Installation of an environmentally-friendly lighting system
Carrefour	Reduce energy consumption per m^2 of sales area by 30 % by 2020 (based on 2004 baseline consumption)
Colruyt	Continue the design of more ecoefficient buildings and shops
	Systematically monitor energy use in our buildings in order to save energy by 2015
Coop Norway	To increase eco – efficiency in buildings
Delhaize Group	Decrease 35 % of overall energy consumption by energy efficiency measures on store level by 2020
	Explore innovative refrigeration system designs and operating practices.
El Corte Inglés	Promote energy efficiency as a principle favouring a relevant electric consumption reduction per year and m^2
FCD	Improve the energy efficiency of stores by determining end of 2009 indicators and standard values.
IKEA	Reduce energy consumption for the whole of IKEA with 25 % in relative terms e.g. kWh/m^3 sold (base FY 05)
Inditex	Reduction by 20 % of electrical power consumption per garment in all stores built as of 2009
Kaufland	Identify the most economic and ecological measures to reduce energy consumption and GHG emissions by using energy-efficient technologies or renewable energy sources
Kingfisher	Achieve a 10 % reduction in store energy consumption per m^2 of total sales area by 2011/12 against the 2006/07 baseline
Kooperativa Förbundet	Reduce the environmental impact of its business, in particular its carbon footprint
	Reduce direct emissions of GHG in relation to turnover
	Reduce energy consumption per m^2 and diesel consumption in transport
	Introduction of energy-efficient pilot stores, reducing energy consumption, exploiting daylight for lighting, and putting doors and locks on all refrigerators and freezers
Lidl	Use environmentally friendly freezing cabinets in new shops
	Use of heat recovery system from our refrigeration plants
Marks & Spencers	Source or generate 100 % 'green' electricity of M&S stores, offices and distribution centres in the UK and Ireland by 2012
	Reduce the amount of energy used in the stores by 25 % per square foot of floor space
Mercadona	All the new and the refurbished stores shall be Eco-efficient stores (more than 20 measures to reduce electrical consumption in stores (efficient lighting system, improvement of insulation, more efficient heating/cooling systems)
	Re-use the heat produced by the air conditioning to acclimatise the stores in 45 % of the new and the refurbished stores in 2009
Mercator	Implementation of ISO 14001 in all shops in Slovenia by the end of 2009
	Implementation of environmental Balanced ScoreCard and IT support for the group of parameters written down in ISO 14001
Metro Group	Reduction of the specific energy consumption per m^2 of selling space
REWE Group	Develop and implement a technical energy management system
Royal Ahold – (Albert Heijn)	20 % reduction of CO_2/m^2 in 2015 compared to 2008
	20 % renewable energy use in 2020

Retailer	Target description
	Measures: reengineering Refrigeration and HVAC systems, low temperature condensation, heating with heat pumps, no gas, low GWP and natural refrigerants, EC ventilators
S Group	Promoting energy efficiency applied to lighting and heating in order to reduce energy consumption in its members' company stores
Tesco	Become a zero-carbon business
	Reduce emissions from existing stores and distribution centres
	Reduce emissions of new stores and other buildings
The Co-operative Group	Reduce greenhouse gas emissions from refrigeration
	Reduce energy consumption of buildings
	Reduce the use of ozone-depleting refrigerants
Communication category	
C&A	Change of garment labelling, encourage customers to reduce reliance on tumble drying wherever possible and suggestion to wash one-click-down.
Carrefour	Raise awareness and promote energy efficient actions, products and renewable electricity
ConfCommercio	Increase the awareness of members on energy efficiency
IKEA	Promote energy saving light bulbs through different national campaigns and initiatives
Marks & Spencers	Encourage people to wash clothes at 30 degrees to cut energy use and CO_2 emissions. 70 % of clothing products now carry a 'wash at 30' label

The environmental impact of energy consumption should be taken into account when retailers implement new energy efficiency measures. In this document, there is not only one proposed route of what best practices should be applied. In a first step, it is recommended to reduce the energy demand (e.g. reduce heat demand by increasing building insulation). Then, shift to a better energy use through improved efficiency (e.g. an efficient boiler) should be performed. The use of cleaner energy sources (e.g. biomass) should be performed after the aforementioned consumption minimisation. The priority actions and their connection with energy aspects in order to set energy objectives and targets are shown in Figure 2.3.

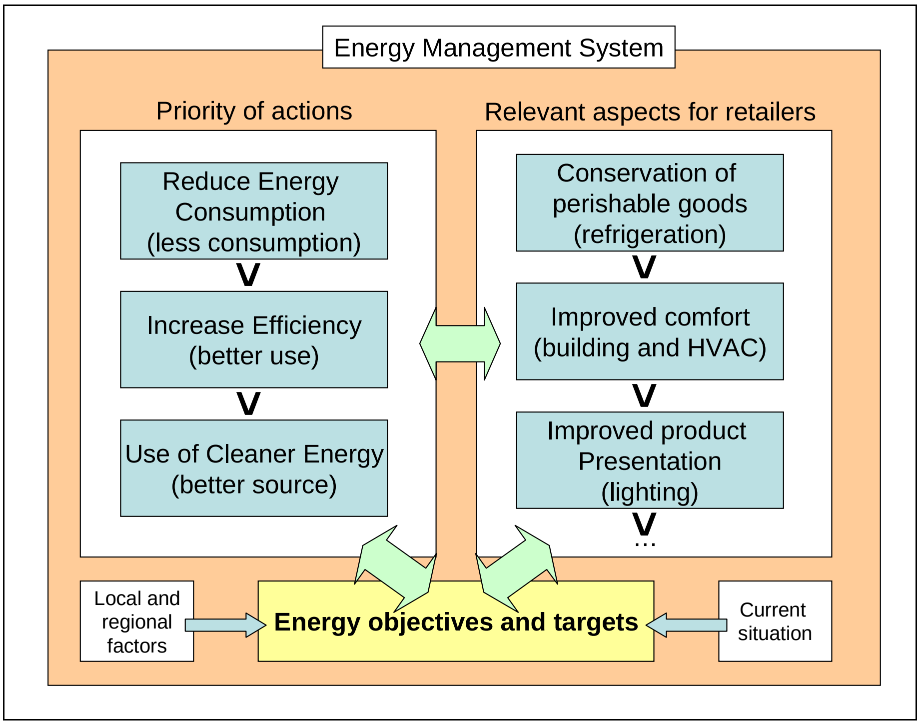


Figure 2.3: Priority of actions for the energy management system and their connection with the most relevant aspects of retailers

Some retailers only apply the most innovative techniques to one or a few 'model' stores. Public image and reputation make these retailers go for highly visible 'lighthouse' projects. The environmental relevance of this kind of single model stores is negligible if compared to the overall performance, i.e. the sum of the results of each store of the group. However, these projects can contribute to knowledge and deriving new measures to be systematised. Therefore, a learning process from the lighthouse store results is required.

2.1.3 Scope of this Chapter

In this chapter only those energy elements under the control of the company, i.e. direct aspects are covered. The focus will be on stores which have the highest energy consumption and emissions. The described best practices for stores are mainly applicable to distribution centres (e.g. buildings and refrigeration). The energy consumption of retailers' transport and logistics is also high and it is covered in another chapter.

In Europe, the specific energy use of a food store varies from 500 to 1000 kWh per year and square metre of sales area. This value is very high if compared to conventional residential buildings (150–250 kWh) or office buildings (100– 200 kWh)([8]). The differentiated elements of retail operations in a store involve different aspects of food conservation, marketing of products and improved comfort. Usually, 75 % of the carbon footprint of a retail-trade company, without considering the supply chain, comes from the operation of stores, while 20 % comes from the logistics aspect and only 5 % comes from the operation of distribution centres. This document mainly covers the energy aspects of stores operation. Figure 2.4 shows a simplified scheme of the most important elements of the energy management system of stores.

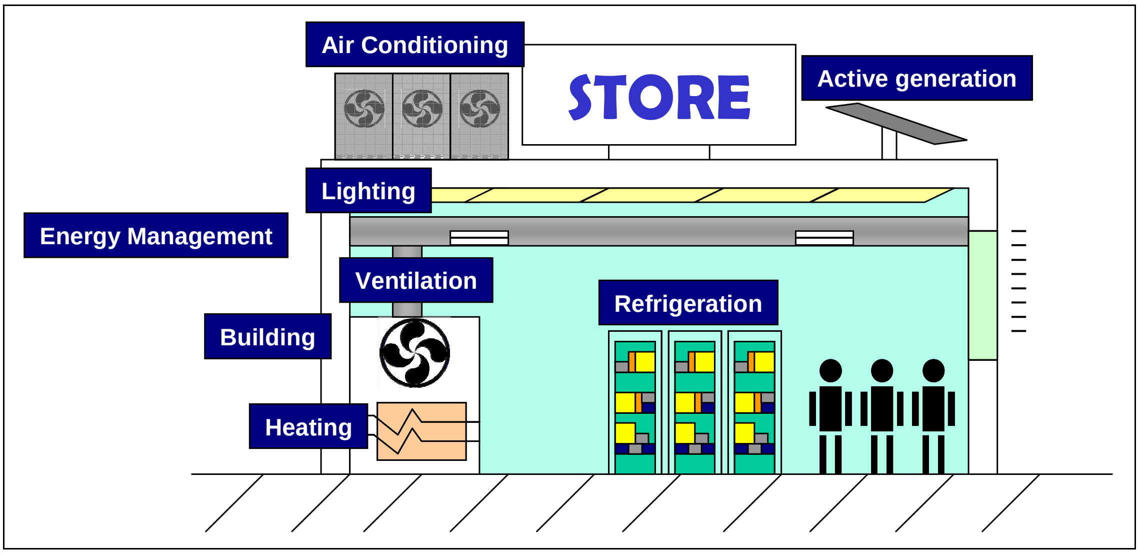


Figure 2.4: Main energy aspects of store operations

The average share for energy consumption of each element([9]), for a food retailer, is:

- 50 % for food conservation by refrigeration
- 25 % for lighting

([8]) The figures for retailers are collected from various sustainability reports. The value for office buildings is collected from Schlenger, J. *Climatic Influences on the Energy Demand of European Office Buildings*. Thesis dissertation. University of Dortmund, Dortmund, 2009. The figures for residential buildings were collected from Nemry, F., Uihlein, A. et al., 2008. Environmental *Improvement Potentials of Residential Buildings (IMPRO-Buildings).* JRC Scientific and Technical Reports. EUR 23493.

([9]) Values collected from several retailers sustainability reports and from the Energy Efficiency issue paper of the Retail Forum.

- 20 % for heating, ventilation and air conditioning, HVAC
- 5 % for electric appliances and others internal processes. This element can vary significantly from one retailer to another.

For non-food retailers, the map for the energy consumption of a store is not so clear, as many types of business should be covered. For example, the consumption of appliances in electronics stores is higher than for other kinds of business, which can be more dependent on lighting, such as furniture or Do-It-Yourself stores.

Energy consumption is responsible for a considerable environmental impact. This can be easily corroborated through published carbon footprint reports of retailers. Carrefour, in their 2009 sustainability report, calculated the carbon footprint of their operations and the results are shown in Figure 2.5. Also, the emissions of GHG associated with Metro Group (Germany) and Migros (Switzerland) are shown in Figure 2.6. For Carrefour, leakage of refrigerants has a higher influence than for other retailers, as the load is higher than for the other retailers. As shown, the carbon footprint of retail companies is highly dependent on electricity use. This effect is more important for companies with fewer food stores, such as Metro Group. The influence from heating systems and the used fuel is also quite important.

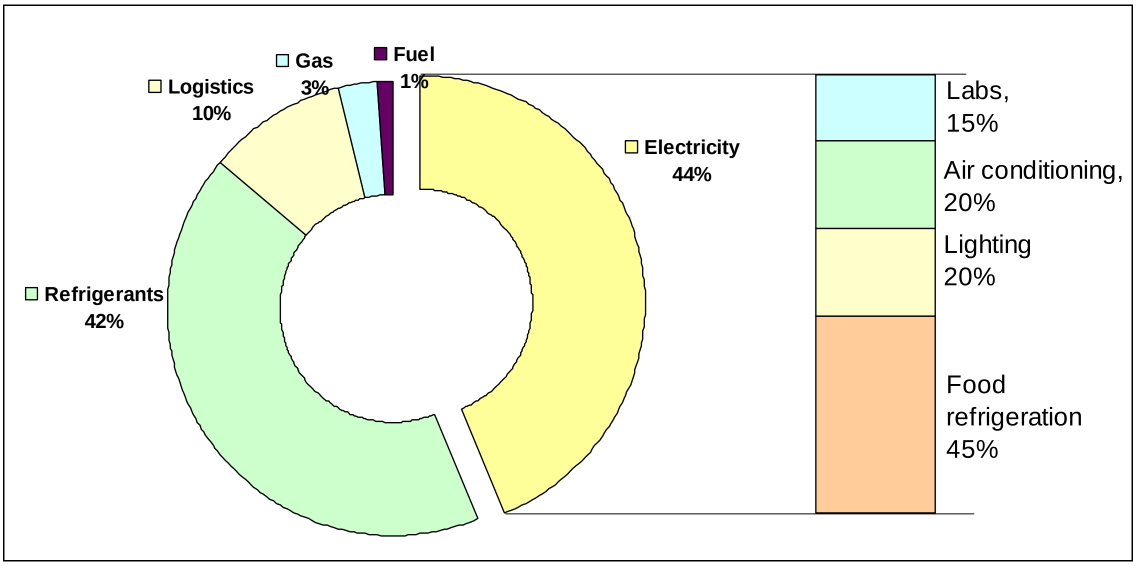


Figure 2.5: Carbon footprint breakdown of Carrefour activities and disclosure for the emissions associated with electricity

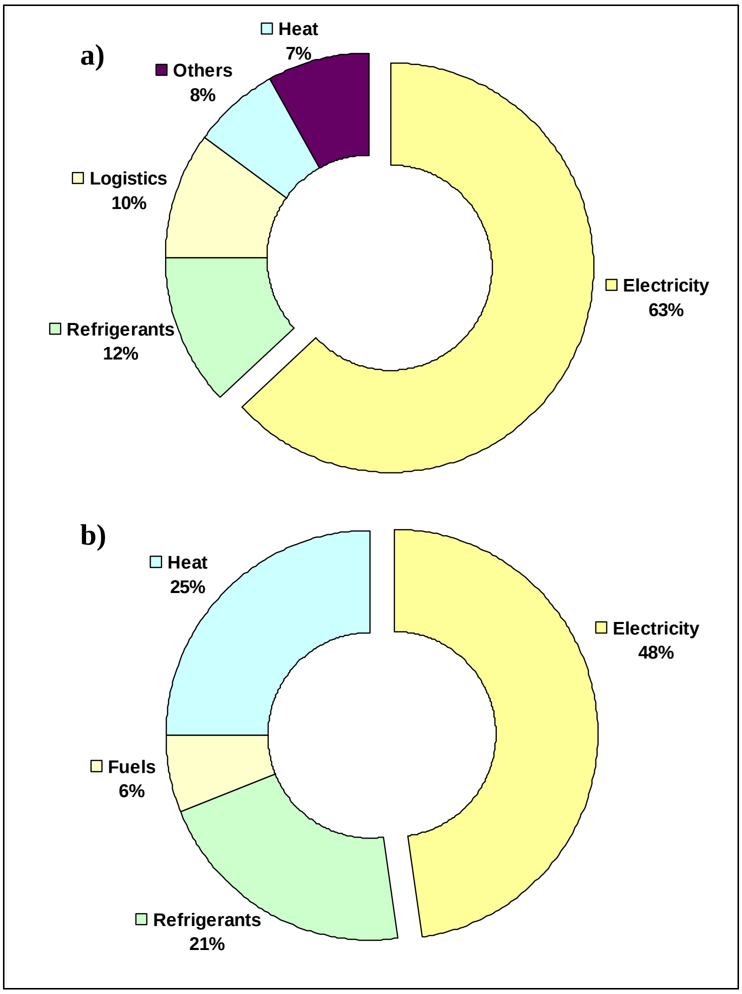
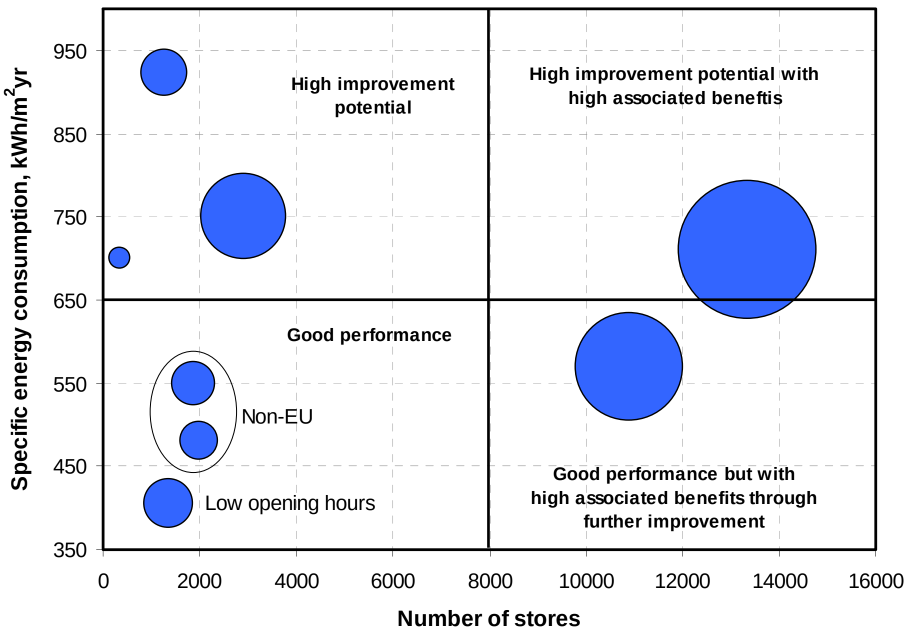


Figure 2.6: **Carbon footprint breakdown of Metro group (a) and Migros (b)**

2.1.4 Drivers of retailer energy performance improvement

The improvement of energy performance needs a comprehensive view. Retailers in Europe operate many thousands of stores. Certain measures having a short payback time applied in each store can produce huge savings. Figure 2.7 illustrates the huge improvement potential of some European food retailers. In this figure, the specific energy consumption per square metre of sales area for several retailers is shown. The data were taken from the last sustainability, corporate or financial reports of these sampled retailers. The chart does not aim to compare the performance of different retailers, but gives an idea of what the improvement potential is. Large European retailers, with a large number of stores and high sales area (represented by the size of bubbles in Figure 2.7) have the highest improvement potential through applying energy-saving measures. For them, energy savings, even with the simplest solutions, are huge.



NB: - Specific energy consumption in kWh per m^2 sales area and year.
- Each bubble is placed at the average value of the retailer and the size of the bubble represents the total sales area.

Figure 2.7: Specific energy consumption vs. number of stores for a sample of food retailers

For medium-size retailers, there is also a huge potential both for the reduction of the energy consumption and costs savings. A specific energy consumption of about 500–550 kWh/m^2yr can be considered good performance, although the absolute consumption value for some retailers is even lower due to fewer opening hours (less building use) than for typical retailers.

A similar analysis can be performed with specialized non-food retailers. Figure 2.8 shows the specific energy consumption per square meter of sales area for different sales concepts. The green and red lines show the average energy consumption, depending on the sales area, derived from the study for German buildings([10]). As shown, specific data for sampled retailers (electronics and Do-It-Yourself concepts) fit perfectly to the German values. The energy consumption is much lower than for food-retailers, where refrigeration plays a key role. Nevertheless, there is a huge potential for improvement, as the variability of the data is really high. From the study of German buildings, average heat consumption is 195 kWh/m^2 for non-food retailers with less than 300 m^2, and 105 for those over 300 m^2. The potential improvement of these non-food stores is represented by best performance: for example, all IKEA stores in Switzerland consume less than 40–55 kWh/m^2 for heating, as they are certified with the Minergie standard (the value of required heat demand varies depending on if they are new or retrofitted stores).

([10]) Arge Benchmark. 'Benchmarks für die Energieeffizienz von Nichtwohngebäuden - Referenzwerte für Energieausweise', Report, 2009. Available at www.arge-benchmark.de

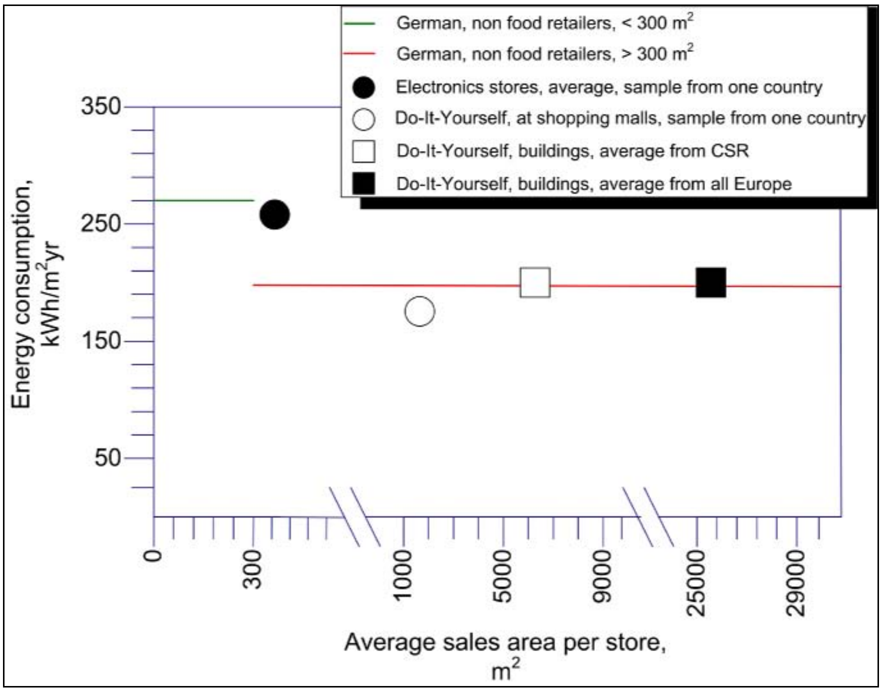


Figure 2.8: **Specific energy consumption vs. average sales area for several non-food retailers**

Small and medium-sized companies have similar energy consumption profiles to large retailers in terms of specific values (per square metre of sales area). Figure 2.9 shows the disclosure for electricity and heating consumption for stores of less than 300 m^2 from the benchmarking study aforementioned for German retailers.

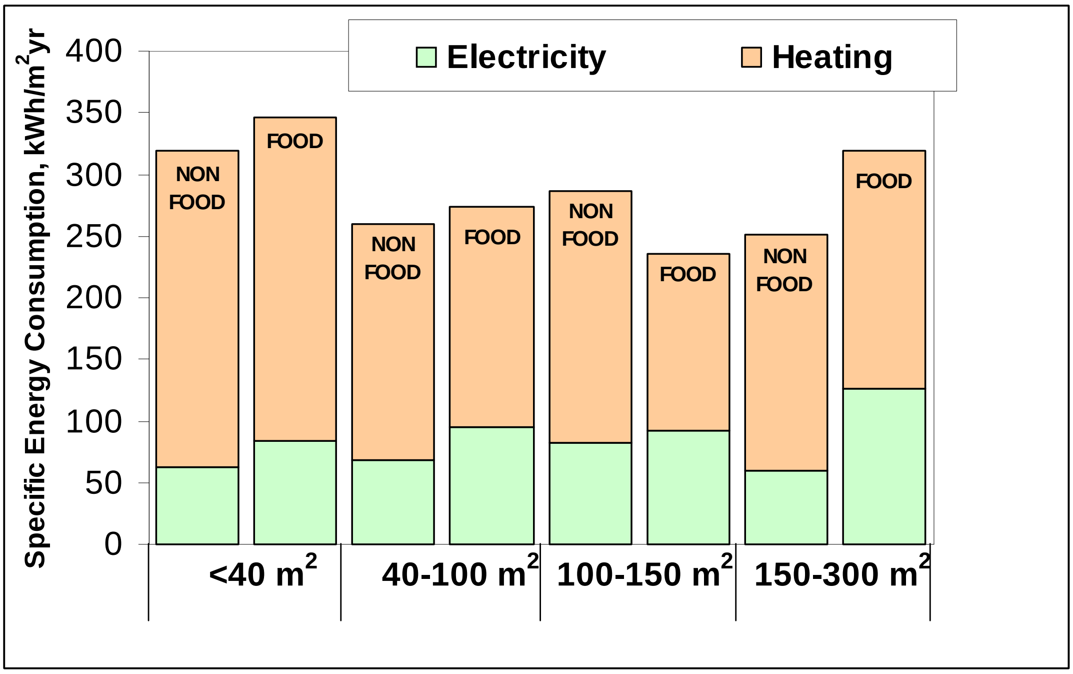


Figure 2.9: **Specific energy consumption for heating and electricity of small stores (<300 m^2)**

Results show very high energy consumption for heating, while the relative impact of electricity consumption is relatively low. The energy consumption for non-food is similar to the energy consumption of larger retailers, while the energy demand of food retailers is significantly low if compared to larger companies (see Figure 2.7). This behaviour can be due to less refrigeration and lighting load in small stores. Nevertheless, the improvement potential is really high and the environmental and economic benefits of energy performance improvement are also high for small companies.

An ambitious energy policy to achieve the best energy performance would lead to the implementation of the best management practices. These practices would improve the environmental profile of the company but also other important driving forces have to be considered:

- improved business performance because of less costs and more competitiveness (relevant for SME)
- generated knowledge and expertise to improve insight into energy aspects
- synergies with other management systems would be established
- decision-making process would be improved
- better response to future regulations through anticipated actions
- better preparation for foreseen energy prices increases and better response to energy market turbulences (relevant for SME)
- better public image and reputation (relevant for SME).

2.1.5 Techniques portfolio

Best practices are proposed in a 'techniques portfolio' and described in subsequent sections. Some of them are not single techniques, but they summarise the best available practices for the improvement of one or more relevant aspects of retailers. The covered areas are buildings, electricity, warm water and active generation of energy. The information provided in this document has been gathered by different means.

- Information provided directly by retailers. Relevant European retailers have provided an important amount of information to develop this document. Some of the provided data were confidential and the information is presented in an anonymous manner. The exchange of information has been very significant for this part of the document.
- Publicly available information about retailers' initiatives. For example, joint initiatives such as the Retail Forum or companies' sustainability and financial reports were used.
- Existing literature. Relevant existing or ongoing studies in each knowledge topic and publicly available literature.
- Own research. Important conclusions were derived from EC own research activities.

The selection of aspects to be covered in this chapter was made attending to the environmental relevance of retailers' activities. In addition, current environmental performance of the sector was taken into account in relation to other sectors. This is the case for building aspects: the contribution of these aspects to the overall performance is not as significant as for other sectors, but the detected situation of retailers' buildings requires special attention when making comparisons with other sectors. There is significance in the order of described practices. The application of a technique should be considered in accordance with the prioritisation of actions and aspects (see Figure 2.3). This should be considered in the decision-making process of retailers, where local and regional circumstances, the starting point and other issues should be considered.

The energy efficiency techniques presented in the document for best environmental management practices are listed below and presented in Table 2.2.

- Technology area: four main areas were identified:
  - buildings: the elements associated to retailers' buildings are influencing the performance of retailers;
  - electricity, mainly for refrigeration and lighting;
  - warm water: is not as important as other aspects, but good practices relevant for retailer and other sectors were identified;
  - active generation: the generation of electricity from renewable sources or combined heat and power systems is comprised here.
- Aspect: the energy aspect affected by the technique.
- Technique: the formal heading for subsections of section 2.1.6.
- Content: a small summary of the contents.
- Scope: The applicability to new or existing stores.
- Target groups: relevant retailer stakeholders or third parties to whom the chapter is directed.

Table 2.2: Energy efficiency techniques portfolio

Technology Area	Aspect	Techniques	Content	Scope	Target groups
Building	Envelope	Retrofitting the building envelope for optimal energy performance	Wall, roof, ground, windows, shading systems, orientation	New and existing stores	Planners, designers, architects, building owners, environmental (energy) managers, consultants, investors, construction companies
	Heating, Ventilation and Air Conditioning (HVAC)	Design premises for new and existing Heating, Ventilation and Air Conditioning systems	Size, zoning, upgrading, diagnosis, screening, maintenance of HVAC systems	New and existing stores	Designers, architects, building owners, environmental (energy) managers, consultants, investors, HVAC suppliers
		Use of integrated design concept	The use of passive house models or concepts in the design and management of HVAC systems.	New stores	Planners, designers, architects, building owners, environmental (energy) managers, consultants, investors, construction companies, HVAC suppliers
	Integrated approaches	Integration of refrigeration and HVAC	Waste heat recovery from refrigeration. Energy recovery. Use of sustainable heating systems	New and existing stores	Planners, designers, architects, environmental (energy) managers, consultants, investors, construction companies, HVAC suppliers
	Monitoring	Monitoring of stores in the energy management system	Comprehensive monitoring of energy consumption of stores for an appropriated energy management of retailers	Existing stores	Regional managers, store managers, environmental (energy) managers, consultants, investors
Electricity	Refrigeration	Efficient refrigeration	Energy saving measures for the refrigeration system of stores. Simple saving measures, refrigeration system retrofitting, refrigerant shifts	New and existing stores	Designers, environmental (energy) managers, store managers, consultants, investors, suppliers
	Lighting	Efficient lighting	Use of natural lighting. Use of efficient lighting devices	New and existing stores	Designers, environmental (energy) managers, store managers, consultants, investors
	Other aspects	Simple secondary measures for reducing energy consumption	The reduction of the energy consumption through single measures are explained: use of high-rated appliances, setting up energy objectives, training, communication, etc.	New and existing stores	Designers, environmental (energy) managers, store managers, consultants, investors, staff representatives
Warm water	Solar / Biomass	Use of alternative energy sources	Efficient integration and optimisation of the input from RES and other sources.	New and existing stores	Designers, environmental (energy) managers, store managers, consultants, investors, suppliers
Active systems	Renewable energy				
	Cogeneration				

2.1.6 Best environmental management practices

2.1.6.1 Retrofitting the building envelope for optimal energy performance

Description

Nowadays, there is a high awareness about the energy performance of buildings, as they are responsible for the consumption of 40 % of primary energy in Europe. However, one area of poor understanding is how building elements affect energy consumption, and associated cost implications (WBCSD, 2008). An integrated approach is always needed when a building is being retrofitted to increase its energy performance, i.e. to reduce its energy consumption. Individual actions for building elements will not be effective and will have higher costs than comprehensive and integrated actions.

The envelope is particularly important for increasing the energy efficiency of a building, as a good envelope minimises the need for heating and cooling power. In Europe, Directive 2010/31/EU on the energy performance of buildings, EPBD, gives a framework for the Member States to set minimum requirements for new buildings and those undergoing major renovations. This regulation was adopted on 19 of May of 2010 and is more restrictive than the last one. The Directive sets the minimum requirements for the energy efficiency aspects in national codes, where the building envelope plays a very important role.

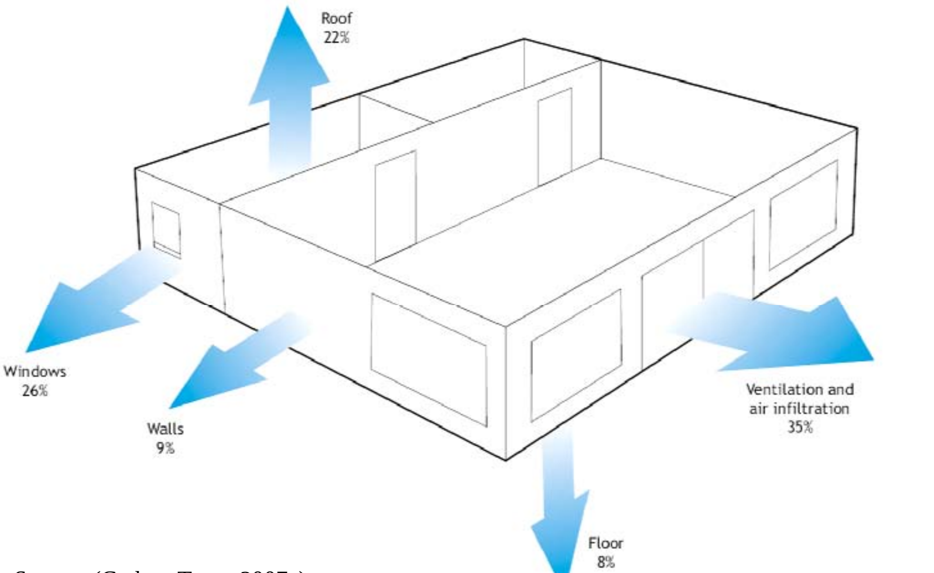
The building envelope is defined as those integrated elements which separate the building interior from the outdoor environment. These elements are classified in this document as:

- insulation system (e.g. walls, façade, roof, floor)
- windows/glazing system (e.g. windows with single, double and triple pane)
- shading devices (e.g. external or internal blinds)
- air tightness (e.g. sealing, doors).

The distribution of energy losses throughout the building envelope depends on many different factors such as climate, quality of construction materials, socio-cultural issues, etc. For illustrating the energy losses, as an example, Figure 2.10 shows the average heat loss from a typical commercial building in the United Kingdom (Carbon Trust, 2007a).

The energy performance of a building envelope is usually measured by means of the U-value ([11]). All the building codes in Europe and all over the world have set requirements for U-values that are legally binding for new and renovated buildings (Laustsen, 2008). In Europe, the required value usually varies from one climate to another, being more restrictive for northern countries than for the southern ones. The renovation of a building according to (or going beyond) certain available standards and requirements allows for the minimisation of energy consumption. In addition, this approach can be combined with further measures based on an integrated energy approach looking at a site as a whole, e.g. a supermarket, taking into account all energy consuming processes and operations as well as all energy producing processes (e.g. waste heat from refrigeration).

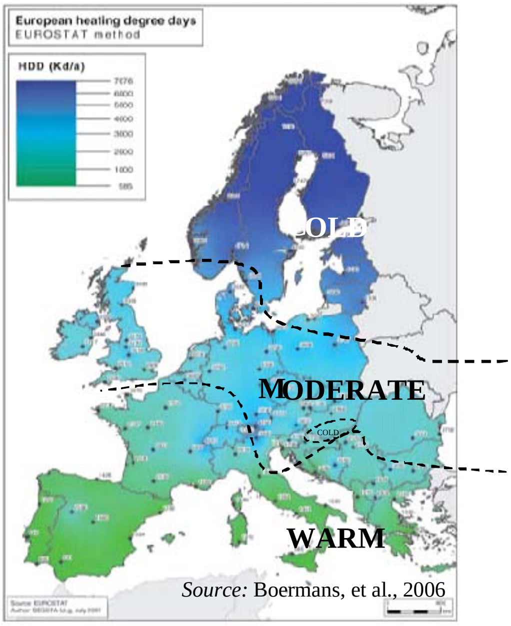
([11]) U-value is measured as W/m^2K and represents the amount of energy per second that is lost per square meter of element (wall, roof, floor, etc.) and per one degree of temperature difference between the building interior and the outdoor environment.



Source: (Carbon Trust, 2007a)

Figure 2.10: Energy losses from a typical UK commercial building through the envelope elements

As already indicated, an important factor influencing the techniques involved in the refurbishment of the building envelope is the climate. In Europe, three climatic zones are considered, depending on the outdoor temperature (Figure 2.11). The division was made according to the number of heating degree days (HDD) ([12]): Warm zone, up to 2000; Moderate zone, from 2000 to 4000; Cold zone more than 4000.



Source: Boermans, et al., 2006

Figure 2.11: European climatic zones based on the number of heating degree days

([12]) Heating degree days (HDD): number of days when the outdoor temperature is 1 °C lower than 18 °C. If the difference is, e.g. 2 °C during one day, the value of HDD would be 2 for that day. So, the general expression for its calculation is HDD = (18–T) × Δt, where Δt is the time in days. EUROSTAT method for HDD calculates this parameter with the following conditions:

- T is the average temperature between maximum and minimum temperature of a day;
- The term (18 – T) is considered to be null when the value of T is 15 °C (heating threshold) or more.

For the building envelope, a number of techniques can be implemented for retrofitting. A summary is shown in Table 2.3.

Table 2.3: Techniques for improving the energy efficiency of the building envelope

Envelope element	Technique	Description	References
Wall/façade/roof/floor – cellar ceiling	Change insulation materials	When an existing building is retrofitted, new materials have to be considered to increase or change the insulation, and in turn save energy. For example, an increase of 15 cm of mineral wool insulation can save up to 200 kWh/m^2 per year in cold climates ([13]).	Petersdorff, 2006. Carbon Trust 2007a, 2007c, 2007d. DOE, 2010.
	Techniques to increase the insulation thickness	The material thickness is the most important aspect of insulation. Examples of techniques are: external thermal composite system , cladding with air circulation, cavity insulation, fixation to inner surface of walls, flat roof exterior insulation, waterproofing layer, insulation of cellar ceiling, crawl spaces for ground insulation, etc.	Petersdorff, 2006. Carbon Trust 2007a, 2007c, 2007d. DOE, 2010.
Windows / glazing	Change to more efficient glazing	Glazing is the use of glass panes assembled into units of two, three, even four in order to increase its thermal and acoustic insulation properties. A gas (air) or vacuum fills the gap between two units. Multiple panes can give good insulation without sacrificing transparency. Examples of the most common retrofitting actions are: increase in the number of panes (up to four) low-e coatings CO2, vacuum or argon filling	Petersdorff, 2006. Carbon Trust 2007a. DOE, 2010. Krigger, 2004.
	Change to more efficient sashes and frames	Change to materials for frame, sash and other window components: wood (high thermal performance, high cost for maintenance), aluminium and other metals (bad thermal performance, zero cost for maintenance). Vinyl frames (high thermal performance and zero cost maintenance, but low resistance to heat). The replacement of metal parts of the frame and the sash is also a good practice, as it produces thermal breaks that improve insulation.	Petersdorff, 2006. DOE, 2010. Krigger, 2004.
Shading	External and internal devices	Solar shading devices should allow the control of direct, diffuse and reflected solar radiation and glare. They contribute to the energy performance of buildings by allowing interior exposure to low-angled sun in winter but not in the summer sun. Sometimes they perform other roles: some blinds can act as thermal barriers to prevent thermal losses. So, they have a direct influence on the energy requirements for the heating, cooling and lighting of a building. Some of the most common external devices are: overhangs, awnings, trees and vegetation, roller shutter, venetian blind, roller blind, etc. Examples of internal devices are: venetian blind, roller blind, and curtains	European Commission, 2005. ESSO, 2006.

([13]) Calculated for a model 1000 m^2 building with the same U-values as the average requirements in cold countries.

Envelope element	Technique	Description	References
Air tightness	Improvement of doors	From the energy efficiency point of view, doors are important and generally have the same problems as portals. The most important measure for the energy efficiency of doors is to avoid air leakage, which can account for up to 20 % of building heat loss. Therefore, weather stripping and sealing must be implemented following examination. For the best performance, doors should be replaced for doors with more effective insulation (low U-value doors). Storm doors should also be used	DOE, 2010. Krigger, 2004
	Fast acting doors	When a door has to be used frequently, such as in warehouses, it is usually left open by the operator. This results in huge losses of energy for heating and cooling. The use of automated fast-acting doors for customer entrances or rapid rolling doors can produce great energy savings, especially for SMEs	DOE, 2010. Krigger, 2004
	Sealing	Air leakages usually originate from window and door frames, lighting fixtures, ducts penetration, dryer ventilation, plumbing penetration and electrical outlets. These leakages can account for between 25 % and 40 % of the heating and cooling needs of a building. Two techniques can be used to reduce the air leakages from building envelope elements: weather stripping (installation of tension seal, felt, reinforced foams, tape, reinforce vinyl, door sweeps, magnets, tubular rubber, reinforced silicone, door shoe, etc.) and caulking (silicone, expandable polyurethane, butyl rubber, etc.)	DOE, 2010
	Buffer sections	The use of buffer sections, like a draught lobby for the entrances, reduces the heating and cooling needs of a building, as the rate of exchanging air with the outdoor environment is minimised. The same can be done for vehicular accesses, e.g. in warehouse entrances	Carbon Trust 2007a, 2005b.
Overall envelope	Orientation	For optimising the energy performance of a building, the area of glazing and shading has to be maximised for the north and the south façades of the building, while they have to be minimised for the west and east orientations. For the north and south façades, the solar heat gain and the visual transmittance has to be high, while for the west and east façades it has to be low in retailers buildings, as it can be a source of discomfort for customers due to glare and air conditioning problems	ASHRAE, 2008.
	Maintenance	The management techniques related to maintenances are the simplest solutions to saving energy. Some examples include: keeping main entrances and windows closed keeping the blinds opened for using natural light as much as possible making regular inspections to the construction elements in order to detect signs of damage: rips, cracks, gaps, damps, condensation making regular inspections to the construction elements in order to detect signs of damage: rips, cracks, gaps, damps, condensation	ASHRAE, 2008. Carbon Trust 2007a, 2005b.

The techniques explained in Table 2.3 can be controlled easily for owned buildings. However, many buildings from retailers are not owned by the retailer. Some companies operate in rented buildings or building units and do not consider the building aspect as an important part of their energy management, as it is not under their direct control. Nevertheless, the description of this technique is intended to provide the background of what can be done with the retailers' building envelope, so property owners are also a target group of the document. For retailers, the contractual relationship with the building owner requires a consideration for the thermal behaviour of the building, as it affects the user performance (the retailing company). Some key requirements in the contract are essential, not only to improve energy performance, but also to assure some minimum standards for the indoor environment. Then, it can be considered best practice to set up mechanisms within the company to influence owners to achieve demanding standards, going beyond national regulations, and integrating retrofitting action plans for both existing and new buildings. For this purpose, indications given in Table 2.3 puts in the hands of owners (retailer or not) a number of tools to improve their performance, independently of direct or indirect, sole or shared building control.

The concept of building unit was introduced in the recast of the Energy Performance of Buildings Directive and means 'a section, floor or apartment within a building which is designed or altered to be used separately'. With this concept, the directive affects also the application of minimum requirements for building units, new or those subject to major renovation. Also, the Directive states that any new building or building unit should have an energy performance certificate if it is sold or rented out to new tenants. This rule will also be applicable to buildings with a total useful area over 500 m^2 (threshold to be lowered to 250 m^2 in 2015) when a building is frequently visited by the public. This aspect of the Directive will be very relevant to retailing activity, which consists of an important number of sales concepts and where many buildings and building units are rented and, therefore, the influence on the building envelope can be really low. Some large retailers, with stronger influence, are key actors, as their requirements on building energy performance can help owners to achieve a good building energy performance and to implement a really high building standard. A very basic classification of retailers' buildings, attending to their energy consumption profile, is shown below:

Food retailers: The energy consumption profile of food retailers is characterised by a high demand of electricity for refrigeration. Three sales concepts are differentiated.

- Hypermarkets: with high sales area, low relative refrigeration load compared to food supermarkets and in stand-alone buildings, usually owned.
- Supermarket: with high refrigeration load, surface from 1000 to 3000 m2, can be in stand-alone buildings (usually owned) or building units (usually rented).
- Discounters: with average surface less than 1000 m2, in stand-alone buildings (usually owned) or building units (usually rented).
- Convenience stores and others: small stores with refrigeration of food. Building units are usually rented.

Non-food retailers: more heterogeneity is observed for this type of retailers. Attending to energy management, they can be divided into categories given below.

- Large stores: furniture, Do-it-yourself stores, electronics, etc. with more than 5000 m2. The building is usually owned, although many of them are rented. Influence of these retailers on the building is usually high.
- Commercial centres: integrated by many small specialty stores (in the same building) and with some large stores for food and other businesses.
- Small stores, usually integrated into building units.

The influence of retailers on rented buildings or building units varies a lot and usually depends on a large number of factors. This would finally benefit the smaller stores in the same commercial centre or in the same building.

Achieved environmental benefit

The energy consumption of stores and thus associated CO_2 emissions can be significantly reduced if the building envelope is retrofitted**.** Table 2.4 gives examples for heating savings obtained from the retrofitting of a model market building of 1000 m^2.

Table 2.4: Environmental benefits from some retrofitting packages

Retrofit packages	Applied techniques	Energy savings([1]), (kWh/m^2yr)
Wall/roof/ground/façade	Increase insulation thickness to 15 cm of mineral wool	Cold: 50 (h, mb) Moderate: 65 (h, mb) Warm: 50 (h, mb)
Wall/roof/ground/façade	Changes in the insulation material (for 15 cm)	Cold: 40 (w) – 50 (mw) (h, mb) Moderate: 50 (w)– 65 (mw) (h, mb) Warm: 44 (w) – 50 (mw) (h, mb)
Windows	Changes in glazing	Cold: 50 (dp) – 90 (tp) (h, mb) Moderate:30 (dp) – 60 (tp) (h, mb) Warm: 20 (dp) – 35 (tp) (h, mb)
Overall envelope	Changes in wall, roof and windows of existing buildings, see (Boermans et al., 2006)]	Cold: 60-100 (o, mb) ([2]) Moderate: 50–130 (o, mb) ([2]) Warm: 45-75 (o, mb) ([2])
Shading devices	Addition of shading blinds	Cold: 30(le) – 40(li) (hc, mb) Moderate:15(li) – 20(le) (hc, mb) Warm: 10(hi) – 35(le) (hc, mb)
Air tightness	Weather-stripping, caulking, door improvement	Reduction of energy consumption by up to 40 %

([1]) Initial situation: U-values for each climate are the average code requirements for each climate.
([2]) Initial situation: U-values for each climate are real averages from existing buildings.

NB: **h**: heating, **mb**: model building, **w**: wood, **mw**: mineral wool, **dp**: double pane, **tp**: triple pane, **le**: external blind with low air permeability, **li**: internal blind with low permeability, **hc**: heating and cooling, **hi**: internal blind with high air permeability, **o**: overall energy consumption

The use of retrofitting actions of the building envelope, combined with the best practices in the heating, ventilation and air conditioning (HVAC) system can produce great savings, leading to low values of primary energy consumption for HVAC: <55 kWh/m^2yr. For example, several existing stores of the Swiss retailers Migros and Coop (see reference retailers) have been refurbished to this value which is laid down in the Swiss Minergie Standard (Swiss Energie, 2007). In the case of new buildings, energy consumption is <40 kWh/m^2yr. Ikea has 10 stores in Switzerland, all of them certified with the Minergie standard.

In Switzerland, the Minergie Standard is widely accepted by builders, planners, architects or engineers as it can be met with a high degree of freedom in the design of building structures and the choice of materials. Economics are also considered within the standard: the budget for a certified new building (or for the renovation) should not exceed more than the 10 % of the typical cost of a similar uncertified building.

Appropriate environmental indicator

The easiest way to control the environmental impact of the building energy performance is to use, as an indicator, the specific energy consumption for space heating and/or cooling, defined per unit of sales area and year. This indicator would gather all the techniques involving building envelope and the HVAC aspects. The indicator should not exclude the renewable energy consumption. In order to compare different buildings, correction factors with a scientific basis can be used to calculate the sales area (e.g. height, factors for corridors, stairs). The time of use of the building can differ for different regions across Europe, but it is not recommended to correct it unless comparison between buildings is being performed.

Some retailers control energy consumption in terms of specific consumption of primary energy. This method allows for controlling the amount of depleted energy resources due to the store activity and means a much lower consumption if alternative energy sources (such as renewable, resource heating, etc.) are used.

Technically, the energy performance of the building envelope can be measured in terms of the specific energy demand for heating, i.e. the amount of energy that the building really needs and may be corrected as a function of the climate in order to make comparisons among different buildings. This would be a clear indication of the thermal behaviour of the building, although the methodology requires modelling work that has to be done by specialised staff. The performance can also be measured with the U-value (W/m^2K) in terms of heat losses or gains per envelope area and temperature difference of 1K. Also, the indoor air exchange rate, defined as outdoor air uptake (m^3/h) per building volume (m^3) is also pointed by technicians as a really good indicator for the thermal behaviour of the building as it affects the heating or cooling needs of the building.

Cross-media effects
For the building construction and the production of the insulation material, a significant amount of energy is required, but this is usually small compared with the HVAC savings. Environmental-friendliness of the insulation material has to be considered, although the environmental benefit from the achieved energy savings is much higher than the impacts from the insulation materials life cycle, as these materials are supposed to have a long lifetime (Nemry, 2008).

Operational data
The techniques addressed in Table 2.3 and others not mentioned in the table, have to be directed towards reducing the heat transmission losses through walls, roof, cellar, ground floor, windows and other elements of the building envelope. A warm climate does not negate the energy and economic benefits of good insulation. Buildings in Mediterranean countries have higher heating-energy consumption than similar buildings in Scandinavian countries (Schengler, 2009). As an example, Table 2.5 shows the typical values for office buildings in different European locations. The calculation procedure of energy consumption of the building in Table 2.5 excludes the internal processes (refrigeration and others) and only includes the relevant aspects of the envelope: heating, cooling, lighting and ventilation.

Table 2.5: Estimated average energy consumption of typical office buildings

City	Energy consumption (kWh/m^2yr)
Oslo	144 (48 % heating)
London	122 (30 % heating)
Brussels	130 (43 % heating)
Milan	215 (64 % heating)
Madrid	180 (53 % heating)
Source: Schlenger, 2009	

The values shown in Table 2.5 can be reduced if the proposed refurbishments are performed in the building. The initial situation is quite different for the three European climatic zones: the current codes in Nordic countries are more restrictive and require lower U-values than in moderate or warm zones, as their awareness about energy efficiency of buildings is higher. The low levels of insulation in some Mediterranean countries must be corrected under the new codes: Table 2.5 shows the example of typical office buildings in Madrid and Milan, where the heating demand is higher than the demand in Oslo.

The current U-values of buildings and the existing code requirements are significantly influenced by climatic conditions, as shown in Table 2.6.

Table 2.6: Average U-values of existing buildings and code requirements

Element	Cold Zone		Moderate Zone		Warm Zone	
	Existing	Code	Existing	Code	Existing	Code
Wall, W/m²K	0.5	0.17	1.5	0.4	2.6	0.5
Roof, W/m²K	0.5	0.13	1.5	0.25	3.4	0.4
Ground floor, W/m²K	0.5	0.17	1.2	0.4	3.4	0.5
Source: Boermans, 2006.						

Optimisation of the building envelope goes beyond code requirements. This is quite important for the warm zone of Europe, where the codes have made good progress in relation to existing building practices. Nevertheless, they have not yet progressed to achieve the optimum value for the minimum energy consumption and minimum life cycle costs (Laustsen, 2008) to achieve the best energy performance of the building.

Applicability

Although this section is dedicated to the retrofitting of existing buildings, all the covered measures can be applied to all new buildings or building units. All the measures explained in the description of this best practice are applicable to any building, new or retrofitted. Tenants should implement mechanisms to influence owners and should be aware of the importance of the building envelope in their environmental performance.

Economics

When a building is going to be retrofitted, it is not only done to improve energy efficiency. Other elements also have to be changed in order to renovate the installation or fulfil some standards, like the upgrading of electrical installations and safety devices. The European Insulation Manufacturers Association has made a very comprehensive study of the insulation opportunities and has made an economic analysis of the impact of the insulation. The most relevant results of the retrofitting economy are shown in Table 2.7.

Table 2.7: Economics of building retrofitting for meeting the codes

Retrofit packages	Applied techniques	Cost (EUR/m²)	Payback time (yr)
External wall insulation	Increase in insulation thickness	C: 77 M: 42 W: 32	C: 25 M: 8 W: 6
Roof insulation	Increase in roof insulation	C: 46 M: 25 W: 16	C: 14 M: 4 W: 2
Windows	Change to more efficient glazing	C: 133 M: 116 W: 60	C: 8 M: 14 W: 16
Retrofitting	Improvement to meet code requirements	C: 145 M: 86 W: 63	C: 10 M: 7 W: 4
Overall savings		C: 62 kWh/m²yr (EUR 0.12 / saved kWh) M: 136 kWh/m²yr (EUR 0.03 / saved kWh) W: 150 kWh/m²yr (EUR 0.02 / saved kWh)	
NB: All the results presented are for coupled refurbishment. C: cold zone. M: moderate zone. W: warm zone. Costs per saved kWh are calculated only for retrofitting for a depreciation time of 20 years. *Source:* Petersdorff, 2006			

The costs shown in Table 2.7 are calculated for retrofitting an existing building to meet the current code requirement (shown in Table 2.6). The costs are always lower for warm zones, as the requirements are not as high as for colder zones. The increase of thickness of insulation is lower for achieving similar savings, and the materials for the warm zones can be cheaper. Shown values are estimations, while real values are very dependent on individual circumstances. For example, the low payback times and cost per saved kWh for the warm zone are due to the assumption of a worse initial energy performance of the building.

Driving force for implementation

The main driving forces are energy savings, cost savings, reduction of CO_2 emissions and, in cases for major renovations, fulfilment of legal requirements. Environmental credentials, e.g. in the sustainability report, communicated to retail stakeholders, such as customers and shareholders, can also be an important driving force for the retrofitting of buildings.

Reference retailers

The two Swiss retailers **Migros** and **Coop** already retrofitted existing stores according to the MINERGIE standard (Swiss Energie, 2007). All **IKEA** stores in Switzerland are also certified with the Minergie standard. For retailers, this standard sets maximum energy consumption values of **55 kWh/m^{2}yr** (for existing buildings) and **40 kWh/m^{2}yr** (for new buildings) for the sum of primary energy consumption of heating, cooling, warm water and basic electricity uses. This standard gives freedom to architects and engineers for the design of the building, but the envelope is always a key element. Examples of retrofitted stores are shown in the Minergie database at www.minergie.ch.

Colruyt, Belgium. This company has established an energy efficiency policy for its stores. This policy includes the orientation and insulation issues of Colruyt Group buildings. In the case of orientation, they have built a new distribution centre, with south orientation to take advantage of solar heat in winter. The freezer section has no contact with external walls and is next to the chilled food section. This policy includes a reference to the insulation materials for the envelope and shows the importance of this element in the energy performance of stores.

BioPlanet, Belgium. This company belongs to the Colruyt Group. They have established a new standard for their new supermarkets: the passive supermarket. The requirements for the new buildings are very similar to those proposed in the German standard (Passivhaus Institute, 2007): increase insulation in cellar ceiling, wall and roof obtaining a U-value of 0.15 W/m^{2}K, increased air tightness, limited ventilation losses and highly insulated windows (U 0.75 W/m^{2}K).

C&A Mainz, Germany. A textiles store was retrofitted to improve the energy efficiency in Mainz. The first element to retrofit was the building envelope. There was no insulation in the walls and the roof. The ground floor was already insulated with 5 cm and was not changed. The new insulation is 14 cm for walls and roof. The windows were changed from single glazing (U-value 5.8 W/m^{2}K) to double glazing with 1.4 W/m^{2}K of U-value. The main entrance was changed from a single air curtain to a draught lobby entrance. There were other important measures in the HVAC system, such as exhaust air heat recovery. Achieved energy savings, only for heating, are 80 kWh/m^{2}yr: they reduced the consumption from 97 to 17 kWh/m^{2}yr. The envelope is responsible for approximately 42 % of these savings. Ventilation improvement saves approximately 45 %. The draught lobby implementation at the main entrances is responsible for 13 % of savings, so its contribution is remarkably significant. Figure 2.12 shows this entrance.

Figure 2.12: Draught lobby at C&A Mainz entrance

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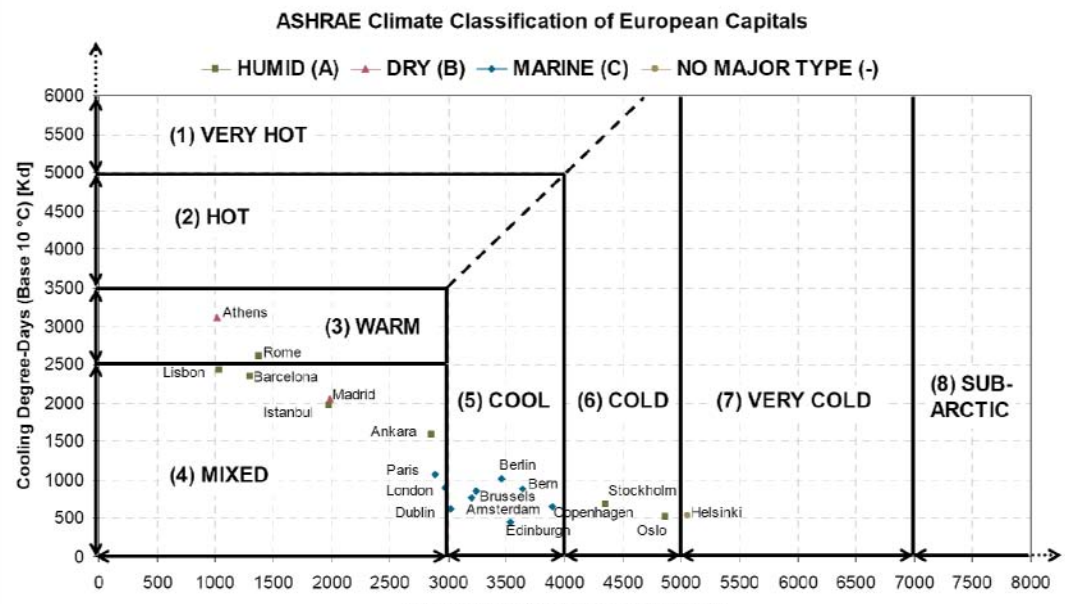
2.1.6.2 Design premises for new and existing Heating, Ventilation and Air Conditioning systems

Description

The purpose of the heating, ventilation and air conditioning (HVAC) system of a building is to achieve comfortable conditions for the occupants. The main occupants of a retailer building are the customers. The designer should avoid any source of nuisance for the clients, as it will negatively impact business. The design substantially changes across Europe, as the heating load is low in the south of Europe, or the cooling demand is neglected in Nordic countries. Figure 2.13 illustrates the segregation of climates in Europe, where some cities are differentiated with the cooling degree days ([14]) and the heating degree days ([15]) (Schlenger, 2009; Boermans et al., 2006).



Source: (Schlenger, 2009)

Figure 2.13: Climate classification of European capitals

Each climatic zone would have differentiated HVAC design premises, due to the different heating or cooling needs and the solar gain achievable in each location. The indoor air quality requirements also influence the design because of the integration of filters, humidifiers and other devices. The optimisation of thermal behaviour aspects of the building (see Section 2.1.6.1.) should be taken into account in the design. This optimal situation would lead to the lowest energy demand of the building. Nevertheless, it could be really difficult to predict an accurate value for the energy demand of the building. Also, optimal values would depend on energy prices and, therefore, solutions for different locations may differ. So, work on efficient energy modelling should be common practice during design steps. Also, modelling of existing buildings would allow the manager to set reasonable targets for the energy performance.

([14])Cooling Degree Days (CDD): number of days when the outdoor temperature is 1 °C higher than 10 °C (for the 10 °C basis). If the difference is, for example, 2 °C during one day, the value of CDD would be 2 for that day. So, the general expression for its calculation is CDD = (10–T) × Δt, where Δt is the time in days.

([15]) Heating Degree Days (HDD): number of days when the outdoor temperature is 1 °C lower than 18 °C (for the 18 °C basis). If the difference is 2 °C during one day, the value of HDD would be 2 for that day. So, the general expression for its calculation is HDD = (18–T) × Δt, where Δt is the time in days.

The HVAC consumes up to 50 % of the overall energy needs of average commercial buildings (Retail Forum, 2009; EPA, 2009). When the focus is on retailers, two specific aspects should be considered.

- The high energy demand for the refrigeration systems at food retailers. Here, the reuse of waste heat from cooling and refrigeration systems contributes to reduce the heating load of the building or even to remove it through integration (see Section 2.1.6.4). Furthermore, 'cool' zones, like corridors where cooling furniture is placed can provoke HVAC oversizing or uncomfortable areas for customers.
- The high energy demand for artificial lighting. It is common practice for improving the presentation of products. It considerably increases the energy consumption of a store without natural light sources.

In non-food stores, most of the consumed energy is used to maintain acceptable comfort levels. Lighting in some stores (garment stores) makes an important contribution to internal heat gain and can increase the demand for space cooling. This can lead to unusual HVAC designs for some buildings integrating this kind of stores: in winter, some garment stores need to be cooled, while the rest of the building needs to be heated.

Then, another consequence of bad design is oversizing. An Ashrae ([16]) calculation for US stores stated that almost 60 % of the energy demand for HVAC is wasted due to oversizing (Ashrae, 2008). The main reasons for that are:

- bad insulation and significant air leakages
- inefficient monitoring and control system
- for warmer climates, heating systems designs are oversized due to higher cooling demands.

The system oversizing leads to less efficiency. Moreover, poor humidity control, condensation problems, and poor mixing (stratification of air) are related problems and indoor air quality is reduced. Thus, since the system is less efficient, costs considerably increase, as the lifetime of compressors is reduced and the maintenance needs are higher.

The optimization of the HVAC system comprises a huge amount of individual techniques. To make a clear description of the main techniques, this chapter has been divided in several subsections:

- concepts and available techniques to retrofit existing systems
- design premises for new buildings
- energy management strategies for HVAC systems.

<u>Concepts and available techniques to retrofit existing systems</u>
When designing a new building or renovating an existing one, the optimisation of the HVAC system has to be considered in an integral approach (LBNL, 2001). The designer should cover, apart from the HVAC elements, the following aspects:

- envelope aspects for the best performance of the building
- potential solar gain: glazing and shading
- air leakages avoidance, air entrances (doors, gaps, etc.), air change rate fixing, heat recovery from exhaust air
- lighting system design (using natural sources as much as possible) and avoiding heat gains from lighting

([16]) ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers

- potential internal gains (from foreseen occupants, from internal appliances, waste heat from internal processes, etc.)
- monitoring and optimal control (which reduces maintenance and repair), flexible range of indoor air temperatures (19–26 °C)
- purchase and use of efficient HVAC elements.

When an HVAC system is retrofitted, the four aspects given below also have to be covered (LBNL, 2001).

- System upgrading: to change to modern and efficient equipment, to include zoning concepts, to improve or change ducts, etc.
- Sizing: the oversized HVAC systems have to be optimised; if improvements in the building envelope are introduced, the HVAC system could use considerably less energy, but it will become oversized.
- Integrating systems: the waste heat produced at refrigeration systems can be reused as a source of heat. The waste heat is so significant that stores recovering it are able to work without any other heating source (Migros, 2006) (here, the insulating role of the building envelope is quite relevant).
- Avoiding mould and odour: it has to be urgently corrected because it is an unhealthy situation for customers.

Several aspects have to be measured when the HVAC is retrofitted. For example:

- duct leakages
- air flows at registers
- air handler flow
- exhaust and supply fan flow
- refrigerant charge of the air conditioning system
- envelope leakage
- moisture-related aspects (mould and odour):
    - visualisation/odour
    - electrical inspection for moisture.

In Table 2.8, a checklist of aspects to be measured and controlled in the HVAC system is proposed. The diagnosis of the building would help designers and architects to decide what main aspects should be retrofitted in order to improve the energy efficiency of the HVAC system.

Table 2.8: Checklist for aspects and the potential retrofit actions([17])

Observation	Potential retrofit action
Duct leakage	Add seal ducts: aeroseal/tape/mastic
Bad duct insulation	Add insulation to ducts
Air flows at registers	Replace registers, open/close dampers, reduce system flow resistance by straightening existing ducts or replacing them with straight runs of new ducts
Low air handler flow	Replace filters, fix duct restrictions, change fan speed, replace fan with a high-efficiency unit, add extra returns in return-restricted systems
Bad filter condition	Replace filter
Incorrect thermostat setting	Raise thermostat in summer and lower it in winter to account for better distribution, mixing and envelope improvements
Spot ventilation	Replace fans if necessary. If possible, remove spot ventilation and use ducts and central ventilation
Spot ventilation: high power consumption	Replace with a higher efficiency unit, remove/reduce duct flow restrictions, clean fan and ducting
Equipment capacity	Replace with correct size
Refrigerant charge	Add/subtract refrigerant
Age and condition of HVAC system	Clean the system and repair damage or replace the system if >15 years old
Location of HVAC system equipment and ducts	Seal and insulate duct locations. If applicable, move system location
Window A/C units	Replace with central unit or improved distribution
Multiple systems/zoning	Ensure correct damper operation, check capacity of each system/zone load calculation
Moisture testing	Improve source control — better venting in sensitive zones, fix flashing/detailing, seal crawlspaces in high humidity climates, replace windows, add insulation to walls, floors and ceiling
Occupant survey - asking customers to report problems	Create moisture removal strategies; install new windows, change register type, airflow and location to improve mixing/remove drafts, add envelope insulation, etc.

Design premises for new buildings

All of the described techniques are always applicable to existing buildings. However, the cost of retrofitting would be prohibitive for some of them. Therefore the techniques would have to be considered from the very beginning of the design process. Several examples for these techniques are (Maisey, 2007):

- heating subsystem
  - installation of high-efficiency boilers (gas or oil fired 90 % efficient)
  - demand response programmes using smart control, monitoring and automatization
  - use of ductwork distribution, as it consumes less energy and increases the comfort and the air quality
  - recovery of heat from warm water
- ventilation system
  - monitoring pressure drops across the filters for replacement and maintenance
  - recovery of heat from exhaust air
- availability of alternative energy sources:
  - engine, turbine or fuel cell to produce electricity

([17]) The techniques involving the building envelope have been discussed in Section 2.1.6.1.

- absorption chillers
- renewable energy sources, CHP, geothermal heat pumps, etc.

- use of integrative concepts (see Section 2.1.6.3).

Zoning concepts should also be incorporated into the design. The building should be divided into differentiated thermal zones. The energy use or demand of the different zones can be very different. These zones have to be distributed in accordance with the building size, load requirements, the space layout, function, number of occupants and special needs. The use of zoning increases energy efficiency, achieving savings of 20–30 % from the HVAC energy consumption.

Energy management strategies for HVAC systems
The foreseen occupancy of a building is a determinant factor for the optimal design of the HVAC system. In the case of retailers, where the use of energy is usually governed by the refrigeration and lighting needs, great savings can still be achieved if the demand is controlled by the occupancy. If only the heating and ventilation devices of the store respond on demand, 10–20 % of the energy use of the store can be saved (Mathews, 2001; EPA, 2009). For example: a theoretical store will have a daily power consumption similar to that shown in Figure 2.14.

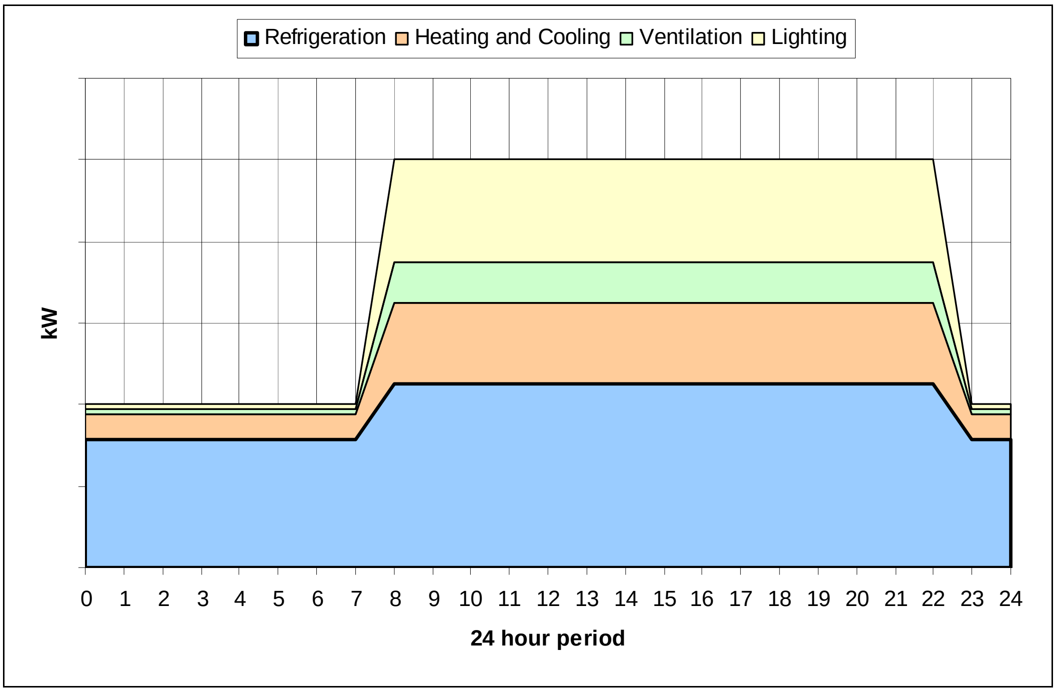


Figure 2.14: Hypothetical daily consumption of a representative European food retailer store

This figure shows a very basic consumption profile for the most important energy uses: refrigeration, ventilation, lighting and heating. Refrigeration is always working because of the need for preserving food products. Night curtains in refrigeration cabinets would allow for reducing the energy consumption of the refrigeration installation. The heating or cooling demand is maintained at minimum during the closed hours and some lighting and a minimum air flow for ventilation is also maintained. No fluctuation is plotted in the Figure, as it is kept simple to facilitate further explanations. The area under the overall consumption curve is the total energy consumption in kWh per day.

Figure 2.15 shows a hypothetical occupancy curve of a store. The occupancy curve can be very different from one retailer to another, as it depends on many factors: socio-cultural aspects, regional and local regulations, location of the store, climatic conditions, rural/urban surroundings, special opening hours, etc. Figure 2.15 is an example of an occupancy profile of a store.

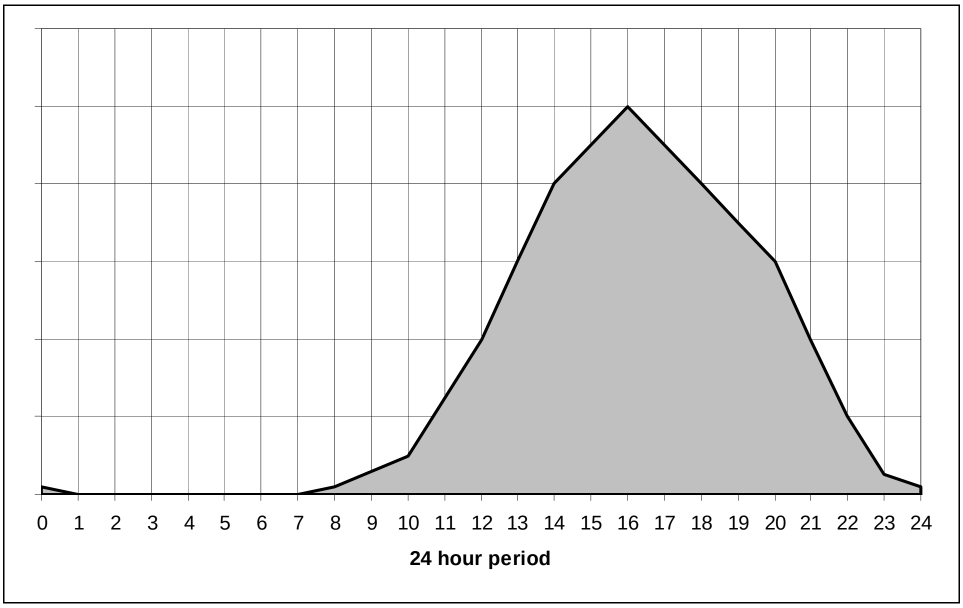


Figure 2.15: Hypothetical occupancy profile of a representative European retailer store

If the heating/air conditioning and ventilation demands are controlled as a function of the occupancy, the energy profile would probably change from Figure 2.14 to that shown in Figure 2.16.

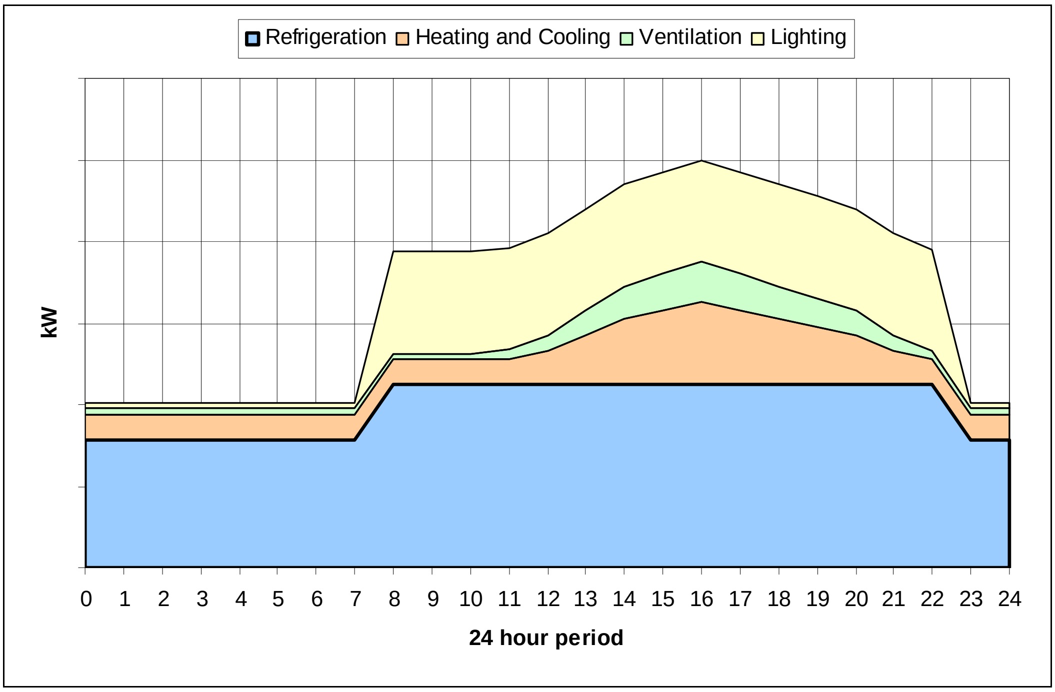


Figure 2.16: Power consumption profile of a representative store where heating and ventilation are controlled as a function of the occupancy

Finally, we can subtract the areas from Figure 2.14 and Figure 2.16. The energy savings correspond to the grey area of Figure 2.17, which is 10 % of the total energy demand. This reduction is obtained only by introducing an on-demand control. No change on the envelope or heating devices was performed and no leakage was avoided. This result suggests the great potential of some smart and inexpensive solutions to be applied for energy efficiency.

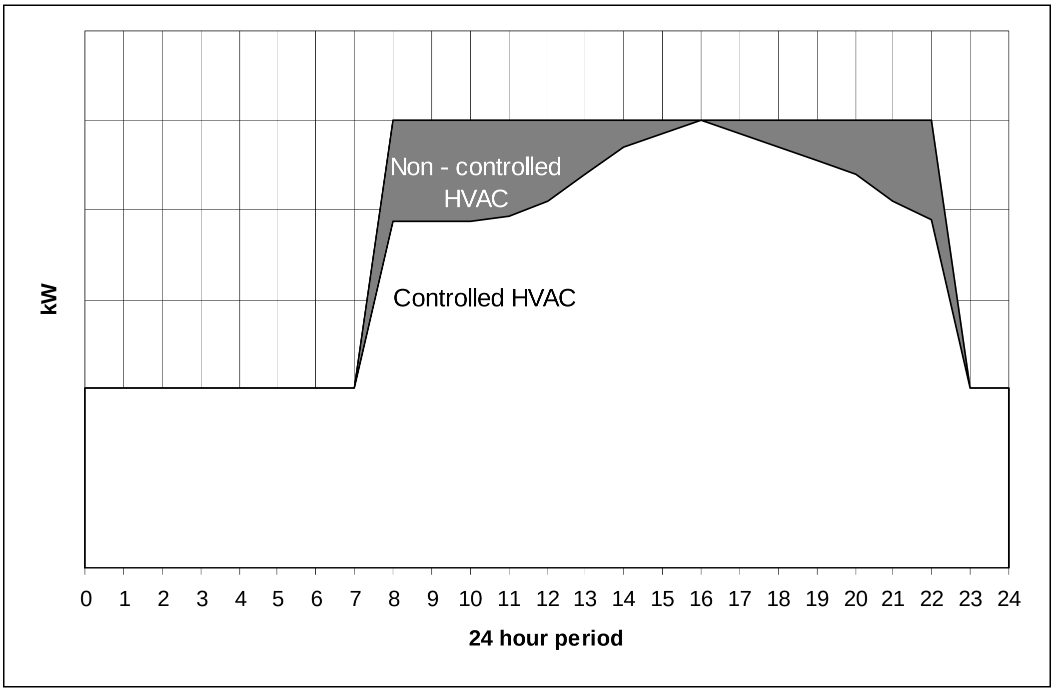


Figure 2.17: Examples of power profiles of a store for non-controlled and controlled HVAC systems as a function of demand

The use of on-demand control on the ventilation (using, for example, CO_2 sensors) would allow for minimising the energy loss in exhaust air. Some regulations of Member States have high threshold values and the required air flow is very high and does not allow for achieving an efficient heat recovery. It is also far from the optimal air exchange for occupancy levels. During the development of this work, some retailers showed their concern about the strong connection of the air change rate and the space heating or cooling demand.

Achieved environmental benefit

There are some examples of retrofitting existing buildings and new concepts in the design of new stores integrating all the energy aspects (building, refrigeration, electricity and renewable energy). Table 2.9 shows several examples for new and retrofitted examples.

Table 2.9: Examples of HVAC integrated approaches for new and existing buildings

Retailer	Location	HVAC actions	Other measures	Overall savings (kWh/m²yr)
Migros Centre Brügg, food + non-food, retrofitted	Brügg, CH	**Integration** of waste heat from refrigeration, **monitoring** and control, **zoning** concepts, **recovery of heat** from exhaust air	Retrofitting of the building envelope, recovery of heat for warm water production and space heating	**24** (79 % of heating demand; it was performing at 40 kWh/m²yr for HVAC before retrofitting)
Rewe Model Market, food store, new	Berlin, DE	**Geothermal heat pump**	Daylight architecture, improved envelope (wood materials), photovoltaics	**150** (42 % of primary energy demand, excluding refrigeration)
Tengelmann Kimamart, food store, retrofitted	Mülheim an der Ruhr, DE	**Geothermal heat pump**	Photovoltaics, efficient lighting, daylight use	**97** (30 % of total energy demand)
Kik Freestand, Textiles Market, retrofitted	Gnoien, DE	Central ventilation with **heat recovery**	Building envelope improvement	**138** (52 % of total energy demand)
BioPlanet Leuven design concepts from Colruyt Group, new food stores	Leuven, BE	**Heat recovery** from exhaust air, **waste heat recovery** from refrigeration	Daylight use, improved envelope, optimised cooling units, renewable energy integration	**350** (estimated 50 % less than other Colruyt stores)

Several conclusions for Europe arising from the described techniques and design premises for HVAC are given below.

- A good insulation means great energy savings for the HVAC system.
- The HVAC system tends to be oversized. The design of this element has to be performed after other thermal elements.
- New best solutions for stores integrate all of the elements: envelope, positioning of the building, use of glazing, waste heat from refrigeration, renewable energy, heat pumps, etc.
- Good monitoring, control and energy management is needed. The best management will avoid oversizing and high maintenance and repair costs and will provide an optimum indoor air quality.

The energy consumption of several existing stores of the Swiss retailers Migros and Coop and Ikea stores in Switzerland has been reduced to values lower than 55 kWh/m^{2}yr .This threshold value is laid down in the Swiss Minergie Standard (Swiss Energy, 2007), which is based on the use of retrofitting actions of the building envelope, combined with the best practices in the HVAC system. These measures produce great savings, leading to low values of primary energy consumption for HVAC. In the case of new buildings, the energy consumption has to be <40 kWh/m^{2}yr.

In Switzerland, the Minergie Standard is widely accepted by builders, planners, architects or engineers as it can be met with a high degree of freedom in the design of buildings and the materials selection. Economics are also considered within the standard: the budget for a certified new building (or for a renovation) should not exceed more than the 10 % of the typical cost of a similar uncertified building.

Furthermore, the concept of Passive House applied to retail buildings can considerably reduce the energy consumption of a retailer. Bio-Planet, from Colruyt Group, has started to use this concept for the design of new supermarkets. The concept of Passive House is to provide an acceptable and even improved indoor environment in terms of indoor air quality at minimum energy demand and cost (PassiveHaus Institute, 2007). The objective is to improve the thermal performance of the envelope and keep the heating system very simple. For this purpose, the heating needs of the building should be lower than 15 kWh/m^2yr. Moreover, the heating needs of a retailer can be null if the waste heat from the refrigeration cycle is recovered.

Ikea Sweden is also implementing a number of techniques to reduce the energy consumption of HVAC systems. For example, the use of floors and ceilings for heat transfer in new buildings or the retrofit of all spotlighting to reduce internal gains.

Appropriate environmental indicator

The easiest way to control the environmental impact of the HVAC system performance is to use, as an indicator, the specific energy consumption for space heating and/or cooling, defined per unit of sales area and year. This indicator would gather all the techniques involving building envelope and the HVAC aspects. The indicator should not exclude the renewable energy consumption. In order to compare different buildings, correction factors with a scientific basis can be used to calculate the sales area (e.g. height, factors for corridors, stairs, etc.). The time of use of the building can differ for different regions across Europe, but it is not recommended to correct it unless a comparison between buildings is being performed.

Technically, the energy performance of the HVAC system depends on many factors. One of them is the thermal behaviour of the envelope (see Sections 2.1.6.1 and 2.1.6.3). The air tightness and the ventilation air flow are also very relevant. Therefore, recommended technical parameters to control are the air exchange rate, air leakages (e.g. as percentage of air uptake) and envelope U-value, among others.

Cross-media effects

The heating needs will be reduced if good insulation is achieved and they can be negligible if the waste heat from the refrigeration system is recovered (see Section 2.1.6.4). Nevertheless, the cooling needs may increase because of internal gains. In this case, they may not be important as the overall consumption is usually reduced. This cross-media effect should be carefully studied for specific cases. If the initial U-value of the envelope is already very low, the energy consumption reduction may not be as significant as expected. For food retailers, the cool air from the refrigeration zone can be mixed with the incoming air to reduce the cooling load.

An important cross-media effect to face will be the indoor air quality of the building environment. The ventilation and air flow systems have to be carefully designed, as the reduction of air leakages can provoke more humidity and unwanted odours inside the building.

Operational data

Heating and cooling demand

The calculation of the heating and cooling demand of a building depends on a number of factors which include:

- status of the envelope and its insulating properties
- climatic conditions (latitude, humidity, proximity to the sea, etc.)
- building use (food store, non-food store, offices, warehouses, etc.)
- building occupancy profile (opening hours, use of building during closing hours, etc.)
- internal gains and heat recovery systems
- temperature control.

Schlenger (2009) calculated the heating and cooling demand for a model office in several locations across Europe. Taking into account the typical building of each location, the heating and cooling needs for the office was estimated. The optimisation of the building envelope (wall, roof, shading systems and glazing) led to remarkable results, shown in Figure 2.18. The heating and cooling demand for three different locations were calculated: Oslo as the cold zone, Brussels as a moderate zone and Madrid as a warm zone. The heating needs can be drastically reduced but the air cooling energy demand can increase. The improved air tightness and insulating properties of the envelope would lead to a higher influence of the internal and solar gains. The fact that there would be less heat loss through the building envelope compensates for the gains and, after the calculation, the cooling needs are very similar to a conventional situation. The worst initial scenario of warmer climates leads to great savings (more than 50 % in the case of Madrid). Although the cooling demand can increase, the heating demand of the optimised building is significantly minimised. For retailers, the use of waste heat from internal processes, like refrigeration, would lead to zero consumption in these climates.

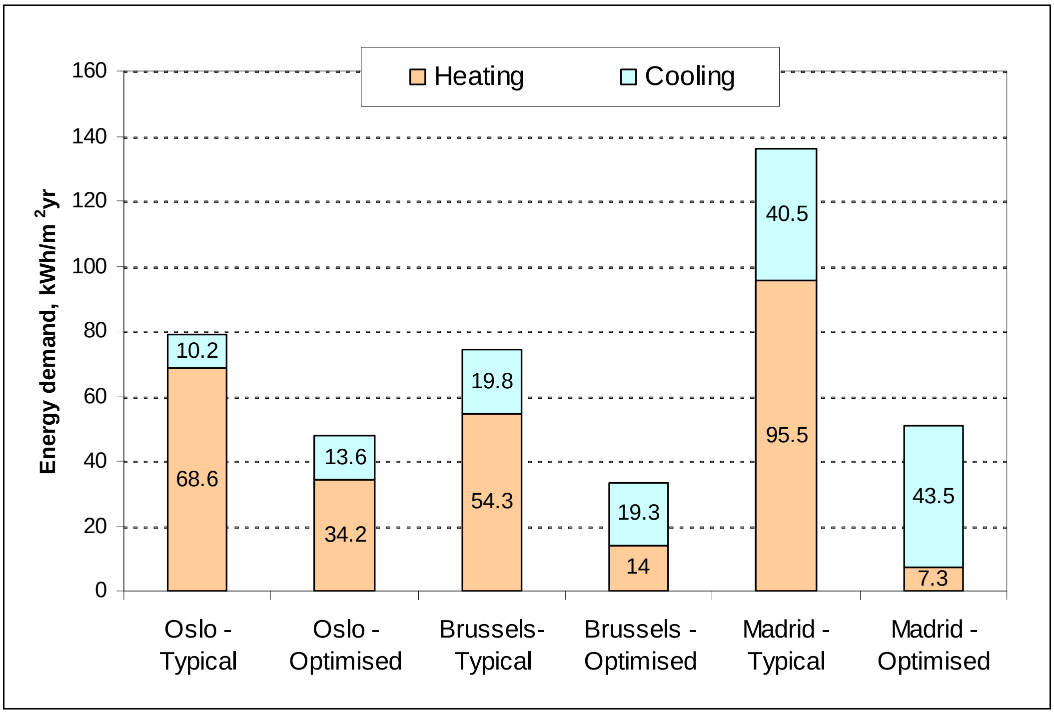
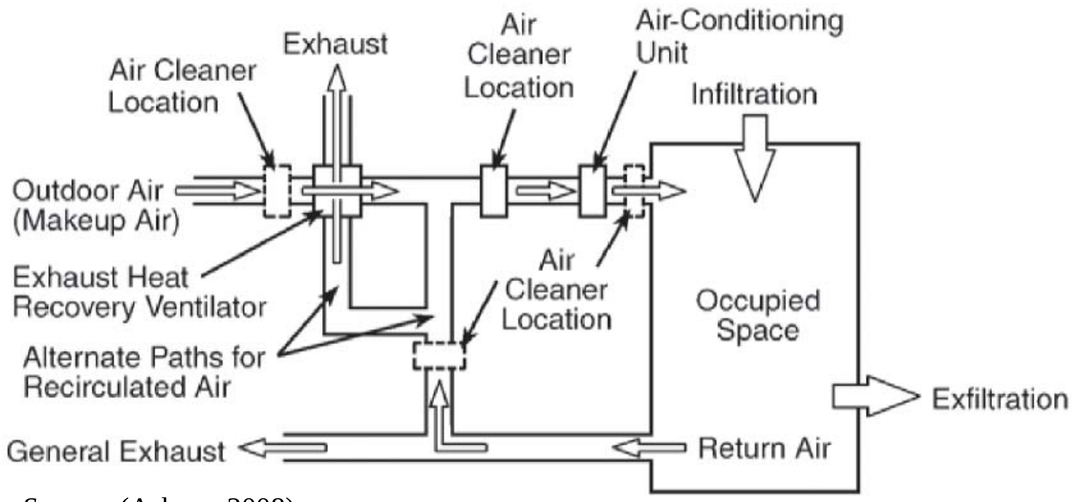


Figure 2.18: Energy use in EU locations

Ventilation needs

There are suggestions from some US and European standards (Ashrae, 2008) for retailers recommending a ventilation air flow of 20–30 m^3/h per person. The occupancy profile of the building is a determining factor and it has to be well calculated, as the air flow also has much influence on the heating and cooling systems design. The preferred solution for minimising the energy consumption and the ventilation costs is the demand control unit, as the profile for occupancy is highly variable.

Ashrae (2008) gives a general design concept for the ventilation system, as shown in Figure 2.19. The design for new stores has to include the possibility of recirculating air (for lower occupancy) and for heat recovery.



Source: (Ashrae, 2008)

Figure 2.19: Design example of a ventilation system for retailers

Applicability

The applicability of the techniques for the HVAC system depends on the following factors:

- The status of the building envelope: if there are important heat gains or losses through the envelope, the retrofitting of the HVAC system will be less effective.
- The climate and the outdoor environment; for instance, in cold climates the need for cooling is usually negligible but for the southern countries it is the most important issue. The orientation of the building and the surroundings are also a key element.

These measures are oriented to existing and new buildings. Some of the concepts for new buildings, such as the installation of cogeneration plants to replace boilers, heat recovery and Passive House concepts, are usually not applied to existing buildings because of the high installation costs. However, there are cases where these systems (or part of them) have been applied with good environmental results and short payback times.

The differences between different types of retailers may be important for some techniques. For food retailers, integration with heat recovery from refrigeration is essential to achieve good performance (see Section 2.1.6.4). Small stores usually depend on external systems (e.g. at commercial centres), but they should implement mechanisms to detect problems and potential corrective actions.

Air change rate is also a regulated parameter. The required value can be, in some cases, higher than the optimal value for the occupancy level.

Economics

Any implemented measures for increasing energy efficiency will always produce cost savings because of reduced energy consumption. Nevertheless, the achieved results will also depend on the building envelope. See Section 2.1.6.1 for more information.

A simple estimation has been made for the renovation of HVAC systems: one saved kWh per m^2 in a retailer building would produce, for a model 2000 m^2 store, EUR 150/yr savings in a warm climate, EUR 120/yr savings in a moderate climate and EUR 70/yr savings in a cold climate. Combined with other refurbishments options, this would lead to the savings shown in Table 2.10 (Petersdorff, 2006).

Table 2.10: Potential economic savings (estimated) from HVAC system renovation

Savings from retrofitting HVAC in a warm climate (kWh/m^2)	Total savings in a 2000 m^2 model store, retrofitting HVAC in a warm climate (EUR/yr)	Savings, retrofitting HVAC and envelope in a warm climate (kWh/m^2)	Total savings in a 2000 m^2 model store, retrofitting HVAC and envelope in a warm climate (EUR/yr)
95	11 200	140	1 6520

Driving force for implementation

The better environmental performance and the reduced energy consumption would be sufficient grounds for the implementation of the described measures. Other motivations will also push retailers to implement energy efficiency measures in the HVAC system: fulfilment of existing and future regulations, achievement better conditions for clients inside the building, reduction in the greenhouse gas emissions, etc.

Reference retailers

A number of retailers currently apply techniques to reduce the energy consumption of HVAC systems. Some of them are:

- Rewe, Germany
- Ikea, whole Europe
- Colruyt, Belgium
- Bio-Planet Leuven, Belgium
- Tenglemann, Germany
- Lidl, Germany
- Migros, Switzerland
- Coop, Switzerland

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2.1.6.3 Use of integrated design concepts for buildings

Description

Integrative concepts minimise the energy costs of a building, while achieving good thermal and comfort conditions for the occupants. A good example for this is the Passive House concept. For this standard, the maximum value of energy consumption for space heating or cooling is 15 kWh/m^{2}yr. So, the heating system is very simple and the approach saves costs if the building life cycle costs are analysed. Figure 2.20 shows the construction costs (initial investment), the energy costs during the lifetime and the total costs. In the chart of Figure 2.20, a drop at 15 kWh/m^{2}yr is observed: this point represents the minimum energy cost. Below this value, the construction costs would increase due to significant insulation and tightness. If heating demand is higher than 15 kWh/m^{2}yr, the life cycle costs would increase sharply due to the need of higher power for the heating system (PassivHaus Institute, 2007).

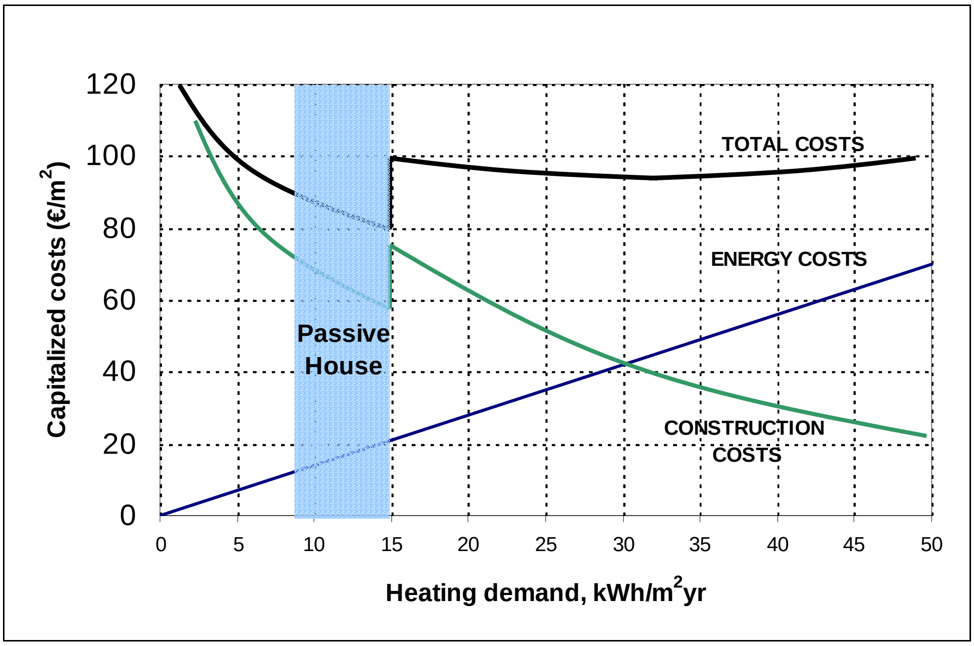

Figure 2.20: Total costs, energy costs and construction costs vs. building heat demand.

NB: This value should be less than 15 kWh/m2yr for a Passive House (indicated)

The aim of the standard is to provide an improved indoor environment (air quality and thermal comfort) with the minimum energy demand and cost. The basic idea of a Passive House is to improve the envelope to a point in which the heating demand becomes very low (Feist et al., 2005). This would lead to the minimum cost reflected in Figure 2.20. Table 2.11 gives an overview of what other requirements define the Passive House concept and how they can be achieved (Laustsen, 2008).

Table 2.11: Examples of requirements for integrated design concepts

Requirements	**Measure to achieve them**
The building heating + cooling demand must be lower than **15 kWh/m^{2}yr** The specific heat load should be less than **10 W/m^2** The building must not leak more air **than 0.6 times** the house volume Total primary energy demand can not be more than **120 kWh/m^{2}yr**	Improved insulation. Recommended U-values less than **0.15 W/m^{2}K** Design without **thermal bridges** Windows U-values lower than **0.85 W/m^{2}K** Air tight. **Mechanical ventilation** with heating recovery from exhaust air **Innovative heating technology** (renewable sources would account for 0 kWh/m^{2}yr of consumption)

The Passive House concept and other integrative approaches can be employed in the design of any new building for a supermarket or commercial centre. For non-food retailers, it would be easily applicable, although the internal gains from lighting should be controlled for warmer periods. When retailers offer refrigerated or frozen goods (meat, dairy products, fish, etc.), the influence of in-store processes can be very important. Refrigeration is the main energy-consuming process inside a store and it is responsible for the majority of the environmental impact of store operations.

For food retailers, the refrigeration process has to be integrated into the whole building concept and would facilitate the achievement of the main energy objectives. Two approaches are currently being applied.

- Bio-Planet, belonging to the Colruyt Group, has planned the first Passive House supermarket in Belgium. The refrigeration needs are minimised by closing freezers and creating isolated cold zones. These zones would offer refrigerated products and the access to the room is made through vertical synthetic strips. The orientation of the cold zones is also considered in the design: they are in the ground floor at the north side of the building (Colruyt Group, 2009).
- Migros, Coop and Ikea are currently applying the Minergie standard in their stores in Switzerland. They are applying it for new and existing stores. The concept is quite similar to the Passive House (air tightness, highly insulated buildings, controlled ventilation, etc.), although the requirement is of 40 kWh/m2yr for the HVAC system (55 kWh/m2yr for retrofitted buildings). The refrigeration is integrated into the energy system of the store by the measures given below.
    - Heat recovery from condensing refrigerant (only for food retailers). If the refrigeration load is enough, a store would be able to operate with no extra heating system.
    - Closing freezing cabinets and some refrigeration display cases.
    - Pumping air from the refrigeration section of the store to other warmer zones to achieve a lower temperature in summer. Therefore, no space cooling would be needed for some climates.
    - Heat recovery from exhaust air.

The integration of lighting is also important for retailers. The use of natural light, to avoid high electricity consumption, and optimised product illumination would reduce the energy demand. Less use of artificial lighting would reduce the heat gain of the store, but it can be compensated for by the solar gain if natural light is used (see Section 2.1.6.7).

Achieved environmental benefits
The application of restrictive and demanding standards for buildings would allow for the following:

- Reduction in the energy demand and to improve the energy performance.
- Help to achieve the targets of the energy policy of the company.

A continuous improvement would be assured if the company includes demanding standards in the general concept for new stores and the retrofitting of existing stores.

The energy use of a Passive House supermarket is much lower than a similar building constructed in the conventional way. Bio-Planet, from the Colruyt Group, states that a reduction of 80 % of the primary energy consumption can be reached if it is compared to the European average. So, the environmental benefit would depend on the basis for comparison.

Appropriate environmental indicator
As already explained for other management practices, the specific energy consumption per square metre and year seems to be a very relevant indicator for the sector, as many retailers are reporting it. Then, the easiest way to control the environmental impact of the HVAC system

performance is to disclose the energy consumption for space heating and/or cooling, defined per unit of sales area and year. This indicator would gather all the techniques involving building envelope and the HVAC aspects. The indicator should not exclude the renewable energy consumption. In order to compare different buildings, correction factors with a scientific basis can be used to calculate the sales area (e.g. height, use factors for corridors, stairs, etc.). The time of use of the building can differ for different regions across Europe, but it is not recommended to correct it unless comparison between systems is being performed. Two alternatives can be used: the specific primary energy consumption, with factors from primary to final defined at national or regional level; or calculate the energy demand of the building through comprehensive models.

Technically, the thermal behaviour of the envelope (see Sections 2.1.6.1 and 2.1.6.3) is controlled by the air tightness, the heat transfer coefficient (U-value) and the ventilation air flow or air change rate, among others.

Cross-media effects

There are no environmental cross-media effects, as the materials or energy inputs to the integrative concept is similar to the inputs to a conventional construction method. Air-tightness is usually very high, so special attention should be paid to the correct design of the Indoor air quality management system.

Operational data

The three key components of the Passive House standard are the heat consumption (<15 kWh/m^2yr), the total primary energy consumption (<120 kWh/m^2yr) and the volume related air leakage at 50 Pa (<0.6 h^{-1}). For the design, some recommendations are given by the standard developers to fulfil the standard. In Table 2.12, recommended and best practice examples from existing buildings are provided (Feist et al., 2005).

Table 2.12: Recommendations and best practices of elements for the Passive House standard

Component	Recommended	Best practice
Insulation (envelope), U-value W/m^2K	<0.15	0.05
Thermal bridges	No thermal bridges	No thermal bridges
Glazing, U-value, W/m^2K	<0.8	0.5
Window framework without thermal bridge, U-value, W/m^2K	<0.8	0.75
Exhaust air heat recovery, efficiency, %	>75	92
Air leakage, %	<3	<1
Electricity demand for ventilation, $W/(m^3/h)$	<0.45	0.3

When primary energy is evaluated, a factor of almost 3 is given to the electricity supplied from the grid. Therefore special attention should be given to the electricity use in the store. The use of renewable energy would be a good option, but it is recommended first to reduce the demand and also increase the efficiency before the implementation of any renewable energy option.

Applicability

Integrative concepts are usually implemented during the design of new buildings. The concept is partially suitable for existing buildings, as several elements can be integrated without high costs. The climate can also influence the decision to apply this concept. For example, the Passive House standard was mainly developed by German and Swedish researchers and some designers state that the approach is not suitable for warmer Mediterranean countries. But the PassiveHaus institute made a study on how a Passive House would work in a Mediterranean country (Schnieders, 2009). For example, a Passive House in a hot climate (see Figure 2.13) would save great amounts of energy if a good insulation of the roof is achieved. The temperature profile during the day would be almost constant and the energy reduction would be significant.

Economics

Actually, the investment costs of a Passive House building or a Minergie certified one do not exceed 10–15 % of extra cost compared to a conventional construction. In addition, the life cycle cost analysis, shown in Figure 2.20, reveals that the Passive House lays at the minimum life cycle cost, as the heating system is quite simple and the heating power installed is not high. For more information about costs, see Section 2.1.6.1.

Driving force for implementation

The main driving forces are energy savings, cost savings, reduction of CO_2 emissions and, in case of major renovation of buildings, fulfilling of legal requirements. Environmental credentials communicated to retail stakeholders, such as customers and share holders, can also be an important driving force, e.g. in the sustainability report.

Reference retailers

The two Swiss retailers **Migros** and **Coop** already retrofitted existing stores according to the Minergie standard (Swiss Energie, 2007). All **Ikea** stores in Switzerland are also certified with the Minergie standard. For retailers, this standard sets maximum energy consumption values of **55 kWh/m^{2}yr** (for existing buildings) and **40 kWh/m^{2}yr** (for new buildings) for the sum of primary energy consumption of heating, cooling, warm water and basic electricity use. This standard gives freedom to architects and engineers for the design of the building, but the envelope is always a key element. Examples of retrofitted stores are shown in the Minergie database at www.minergie.ch.

Bio-Planet, in Belgium, belongs to the Colruyt Group and has established a new standard for their new supermarkets: the Passive House supermarket. The requirements for the new buildings are very similar to those proposed in the standard: increase insulation in cellar ceiling, wall and roof obtaining a U-value of 0.15 W/m^{2}K, increased air tightness, limited ventilation losses and highly insulated windows (U-value 0.75 W/m^{2}K).

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2.1.6.4 Integration of refrigeration and HVAC

Description

The main principle of the refrigeration cycle is the same as for heat pumps. A refrigeration unit removes heat Q_1 from a low temperature source and then transfers heat Q_2 to a high temperature source using an amount of electrical energy input, *W*. The performance of the system is usually measured with the COP coefficient of performance, COP = Q_1/W.

The refrigeration of perishable goods in stores is made by means of the vapour compression cycle. This process consists of four steps.

- Evaporation: a liquid refrigerant gets the heat for its evaporation, Q1, from the surroundings. This heat comes, directly or indirectly, from the goods to be refrigerated or frozen.
- Compression: the refrigerant vapour is compressed. A compression work is needed, W, usually fed as electricity.
- Condensation: the refrigerant is cooled to the saturation temperature and condensed. The produced heat, Q2, is usually removed to the surroundings by a dry cooler.
- Expansion: the subcooled liquid obtained expands in an expansion valve and a mixture of liquid/vapour is obtained, which is fed again to the evaporation cycle.

The pressure-enthalpy diagram, in Figure 2.21, shows how the cycle works. The continuous black line represents the L-V equilibrium curve and the intermediate area represents the coexistence of liquid and vapour phases. The blue line represents the cycle steps.

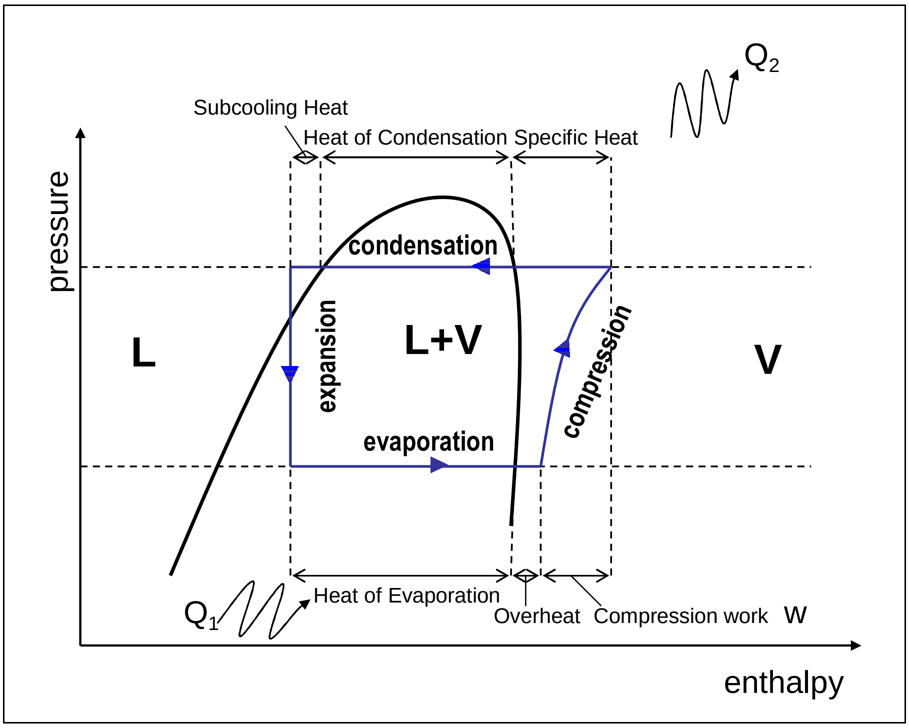
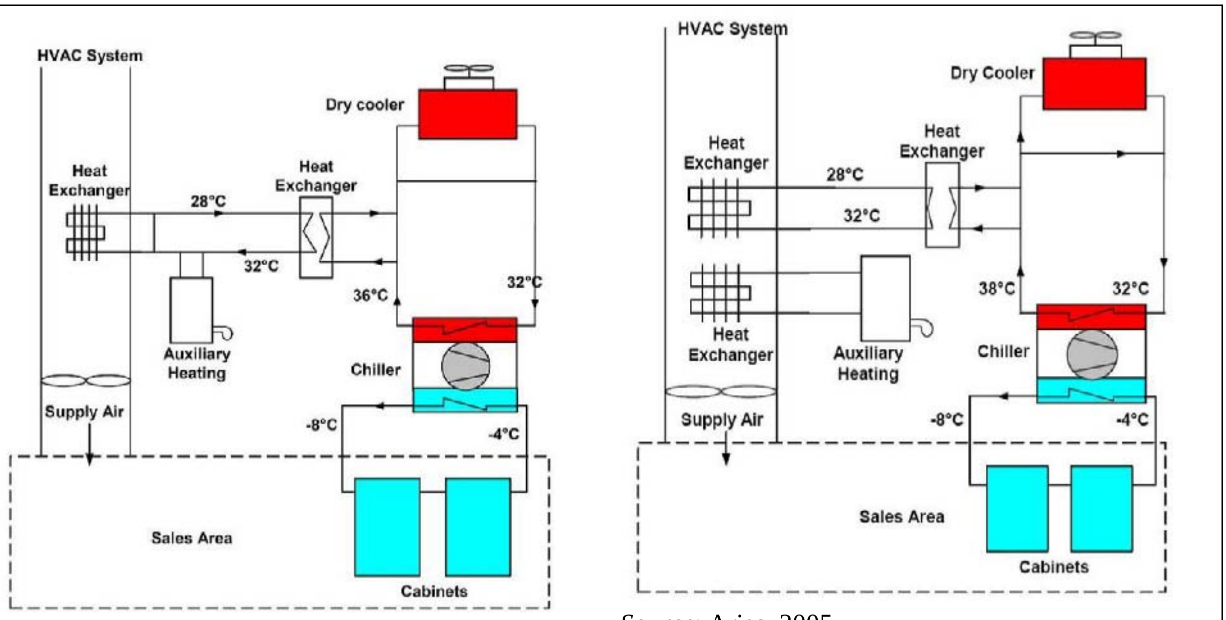


Figure 2.21: Pressure-enthalpy diagram for a typical refrigerant and vapour-compression cycle

Therefore, four unit processes are needed in a refrigeration cycle: compression, expansion (performed in an expansion valve) and two heat exchangers, one for evaporating (performed in the display cases) and the other for condensing (usually performed in dry coolers).

The recovery of heat from the refrigerant condensation is currently a common practice in retailers from many countries, like Sweden, Germany, Switzerland, Canada and others (IEA, 2005). The amount of heat is considerably large and it is an attractive resource for space heating and warm water production. The heat recovery from the refrigeration cycle would reduce significantly the primary energy consumption of many stores. This technique can be combined with other improvements of the energy efficiency of the building: if better insulation and optimised HVAC are implemented, the achievable energy and cost savings would be huge.

The integration of waste heat can be very simple. Arias, 2005, described several heat recovery cases from refrigeration. There are many possibilities for the integration as well as many configurations of the refrigeration system of a store. Figure 2.22 shows two examples for integration: a single heat exchanger would produce warm water from 28 °C to 32 °C to preheat the fresh air supply to the store. If additional heat is needed, an auxiliary heating system (e.g. a gas boiler), can be installed for the coldest period. The way the integration is performed can vary depending on the type of refrigerant, refrigeration cycle, indoor and outdoor temperatures, etc.

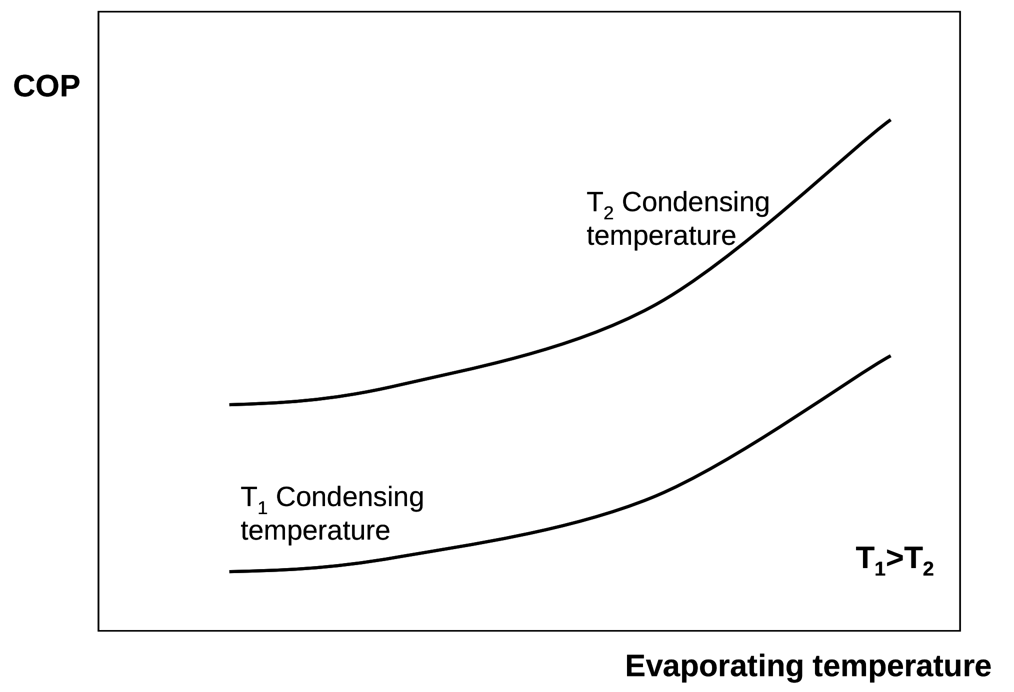


Source: Arias, 2005

Figure 2.22: Two examples of heat recovery integration with the auxiliary heating for stores

The design of refrigeration systems and the design of HVAC systems usually are not performed by the same engineering company and tend to be very independent in their performance for the same store. In these cases, the integration of both systems can lead to low efficiency reduction of the compressors and to the oversizing of HVAC installations, increasing compressors working hours and increasing maintenance costs. The integration design of heat recovery should take into account all the processes demanding energy for heating or cooling, in which the envelope has a high influence, and according to the best overall efficiency.

One important drawback of heat recovery is related to the condensation temperature, which has to be kept at a level, in which heat can be transferred to store, e.g. 38 °C. This would lead to higher energy consumption of compressors. Although the balance is always positive if compared to overall savings, the coefficient of performance, COP, can be decreased substantially (EFBPP, 2000). Figure 2.23 shows how the COP is affected by condensing and evaporation temperature. The use of heat pumps is a good option for recovering the refrigeration waste heat in building space heating. This would allow for optimising the coefficient of performance, as there is no need for increasing the condensing temperature.



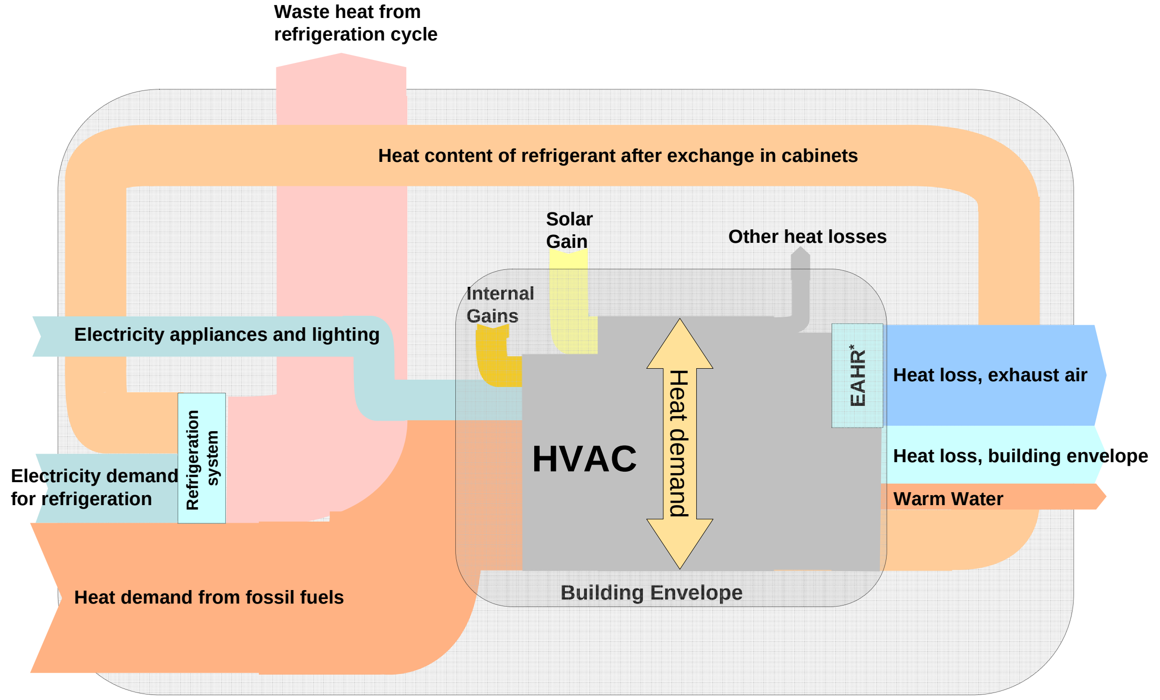
Source EFBPP, 2000

Figure 2.23: Coefficient of performance vs. evaporating temperature and condensing temperature of the refrigeration cycle

A boiler or other techniques should be used if the amount of heat recovered from the refrigeration cycle is not enough to meet the heat demand. This would depend on the climatic conditions and on the building performance. Some retailers produce more heat than needed and they sell the excess heat to closest stores or to a district heating system.

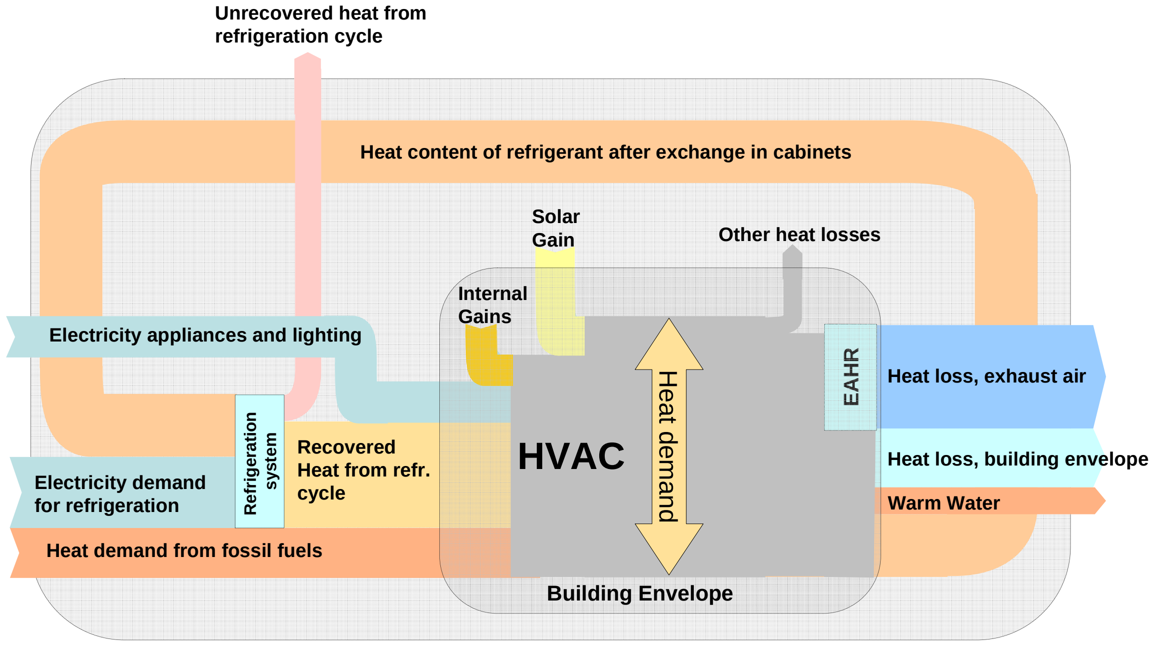
As explained, heat recovery integration can be performed in many different ways. For illustrating the energy flow, four generic Sankey diagrams are proposed. They represent four possible cases for a food retailer building.

- Case A, Figure 2.24. No integration of heat is performed. The needed heat is obtained from a fossil fuel boiler; the extra heat from refrigeration is removed by a condensing unit placed on roof. The envelope is responsible for an important amount of heat loss.
- Case B, Figure 2.25. Heat from the refrigeration cycle is recovered, but the envelope is not improved and extra heat is still needed from fossil fuels.
- Case C, Figure 2.26. Heat from refrigeration cycle is recovered and the building envelope is improved to the point where no additional fossil fuel for heat is needed.
- Case D, Figure 2.27. Heat from refrigeration cycle is recovered and the building envelope is improved to fulfil the most demanding standards. Therefore, extra heat is possibly produced.



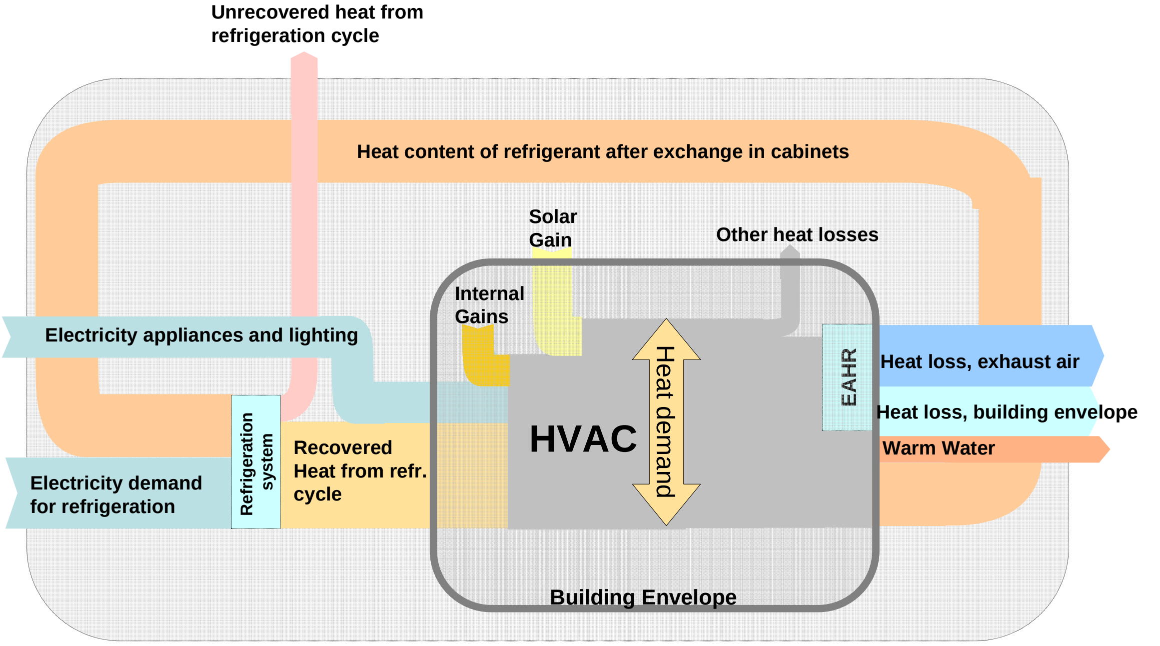
NB: EAHR: Exhaust Air Heat Recovery

Figure 2.24: Energy flow diagram (Sankey diagram) of a food retailer operation – Case A: No heat recovery, no envelope improvement



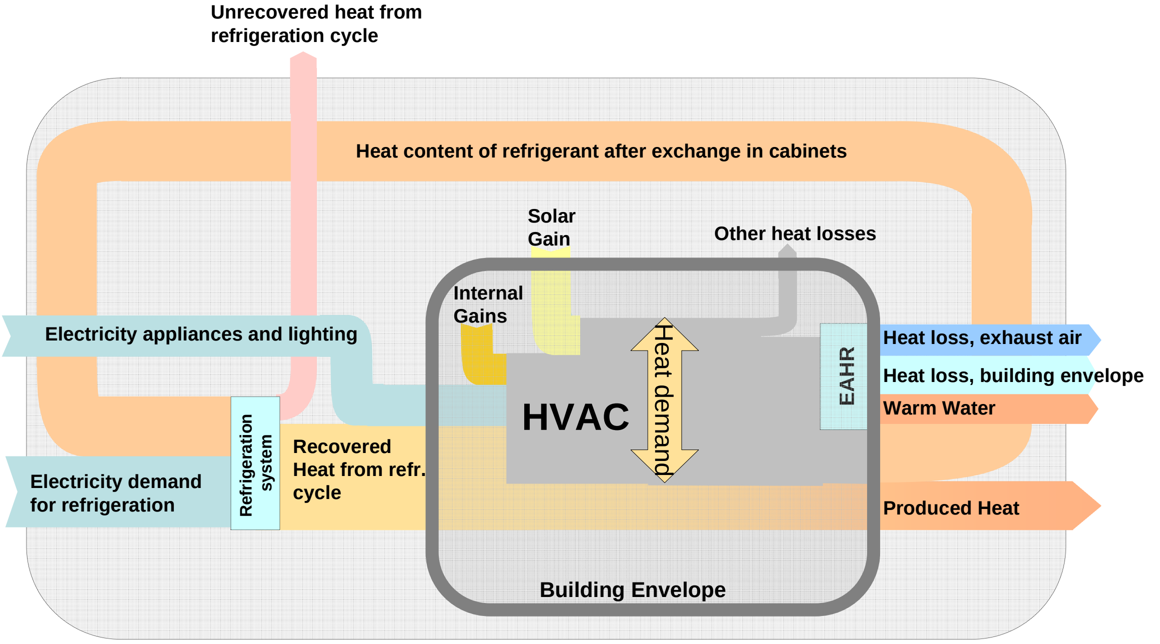
NB: EAHR: Exhaust Air Heat Recovery

Figure 2.25: Energy flow diagram (Sankey diagram) of a food retailer operation – Case B: Refrigeration heat recovery, no envelope improvement



NB: EAHR: Exhaust Air Heat Recovery

Figure 2.26: Energy flow diagram (Sankey diagram) of a food retailer operation – Case C: Refrigeration heat recovery, optimised envelope



NB: EAHR: Exhaust Air Heat Recovery

Figure 2.27: Energy flow diagram (*Sankey* diagram) of a food retailer operation – Case D: Refrigeration heat recovery, high insulated envelope and heat delivery to district heating

Less energy consumption would take place in cases C and D, where the improved building envelope plays an important role in minimising the heat loss of the building (see Section 2.1.6.1). As shown for case D, if the management is well performed, a food store can provide heat to building units or can feed a district heating installation. The energy input of cases A and B are higher than C and D because heat losses are minimised in better buildings and the heat content of exhaust air is also minimised. When a building is well insulated and air-tight, a good design of the ventilation system is required as moisture, odours and other problems with the indoor air quality can arise. As an example of the application of the different levels of integration (cases A, B, C and D), Figure 2.28 shows the results of the operation of more than 100 stores from a retailer in central Europe. This data represents the real performance of the retailer and it shows the different levels of application of heat recovery integration in the buildings. Best cases, C and D, represent more than 50 % of the stores. More than 40 % of stores produce heat to be sold to other buildings and more than 50 % do not need any extra heating system.

The retailer of Figure 2.28 is really one of the best performers in heat integration in Europe and it shows what results are achievable through the implementation of integration during the last 20 years.

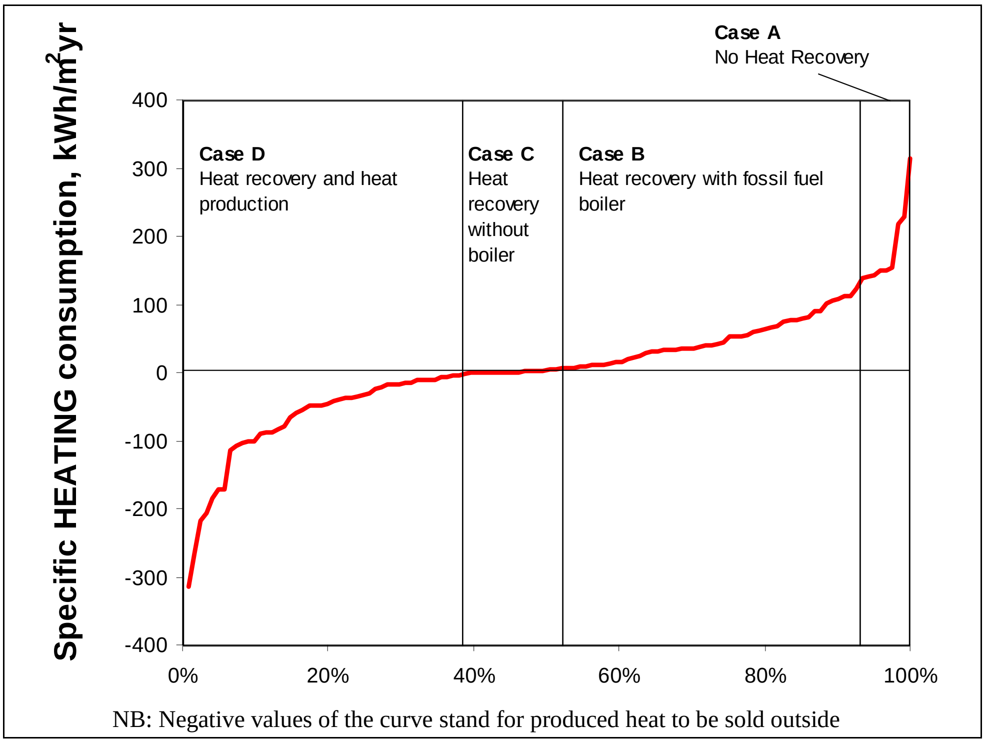


Figure 2.28: Store-specific heat consumption vs. cumulative frequency for a good performer

It is not the objective of this document to propose a unique solution or only one integration scheme. Such integration should be studied with caution and it will depend on the particular circumstances of the store and/or the retailer. The measures explained here should be taken into account for new or existing buildings and the operation of these systems would have different results depending on different factors.

- Building size and use: big retailers' stores are usually not alone in their buildings. So, the 'neighbourhood' (e.g. small shops in a commercial centre) is a potential consumer of the excess heat. As a general rule, a food store with a typical refrigeration load and an optimised envelope would recover enough energy to heat twice its own surface.
- HVAC design and maintenance: all the elements of the HVAC system should be correctly designed and maintained. Exhaust air heat recovery, on-demand control of ventilation with CO2 sensors and monitoring of air tightness and indoor air quality are strongly recommended techniques.
- Refrigeration system design: the amount of display cases inside a store varies a lot and depends on many factors: logistics, marketing, climate conditions, traditions, customers profile, etc. As an example, Figure 2.29 shows the trend lines of the specific length of display cases (per m2 of sales area) and the consumption of the refrigeration system for a middle-Europe retailer. It can be deduced from the chart that small stores use more

display cases and use more electricity per metre of display case. So, small stores offer more refrigerated products and the efficiency for refrigeration is lower. There are several reasons for this: the use of plug-in cabinets reduces energy efficiency, the improved logistics make the amount of frozen food higher than for big stores, the costs for heat recovery has longer payback times, etc. Therefore, the initial investment is not attractive for the store and a loss of efficiency is preferred by the retailer for economic reasons.

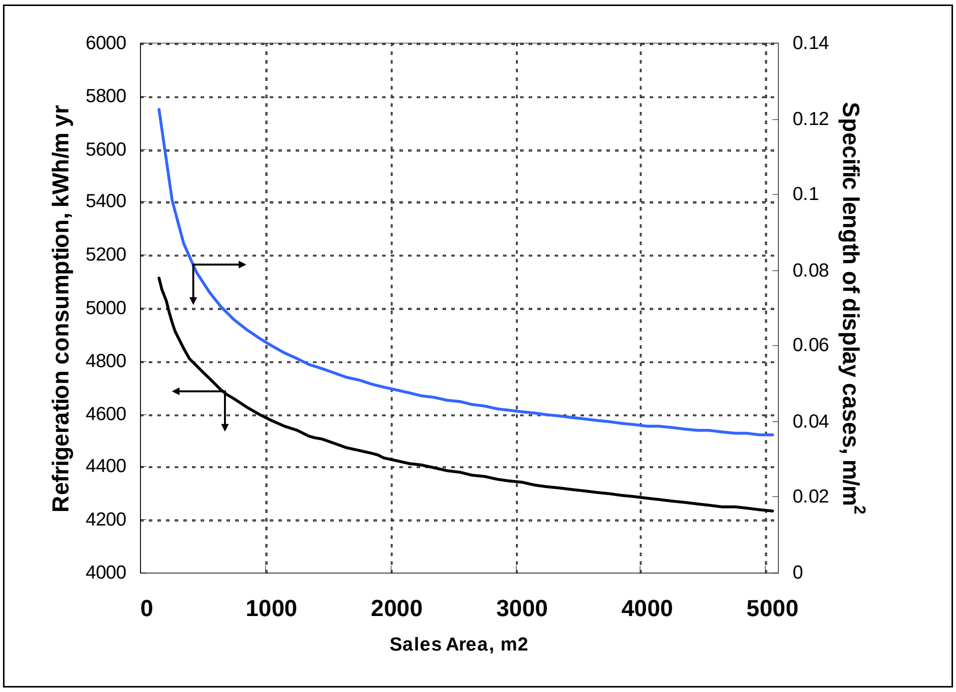
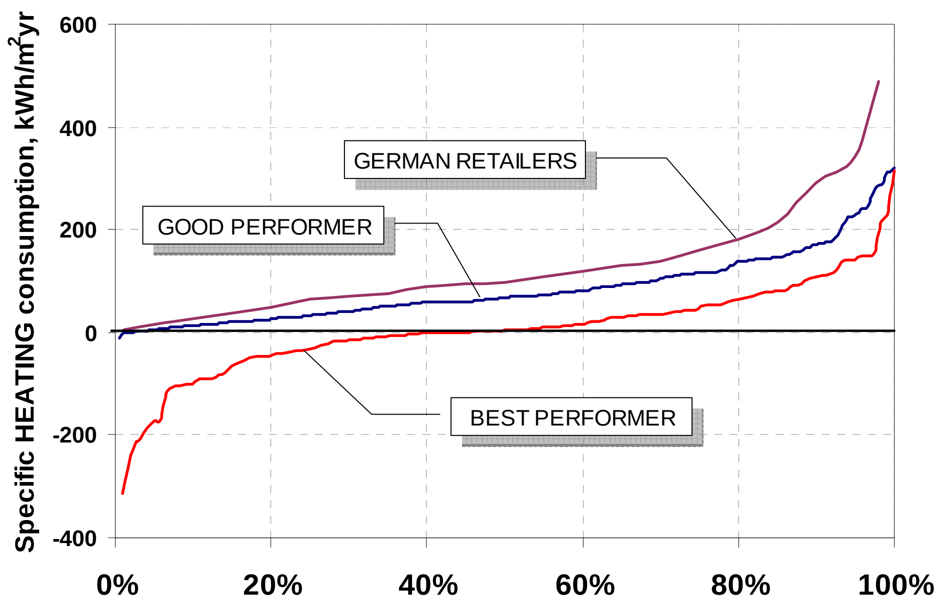


Figure 2.29: Specific length of display cases and energy consumption for refrigeration vs. sales area

Achieved environmental benefits

The number of refrigeration cycles possibilities and the number of ways to combine it with the HVAC system are almost infinite. Some retailers have provided, for this document, several data on how these integrated systems work and the environmental benefits that arise from their use. For illustrating the environmental benefits, the achievements of individual examples are not shown. It is preferable to show the cumulative curve of the specific heating consumption of three groups of stores, in Figure 2.30.

- Purple line, 'German retailers'. A benchmarking study for the German regulation EnEv 2009, performed by Arge Benchmark and publicly available, provides the behaviour of many different types of non-residential buildings in Germany. The curve shown in Figure 9 is the one for food retailers with a sales area of over 300 m2, with more than 200 stores.
- Blue line, 'good performer'. This cumulative curve shows the results for more than 200 stores of a middle-Europe company regional division. They recover heat with good envelopes and a good HVAC management in some stores.
- Red line, 'best performer'. This curve shows the results of more than 100 stores of another middle-Europe company regional division. They recover waste heat from the refrigeration cycle; they have optimised buildings and good HVAC management in many of the sampled stores. The negative values stand for produced heat, i.e., sold heat to nearby buildings.



NB: - 240 German stores (——),
- a sample of 221 stores of a middle-Europe retailer (——),
- 105 stores of the regional division of other middle-Europe retailer (——).

Figure 2.30: Specific heating consumption vs. cumulative frequency

Figure 2.30 also shows what the evolution of a good energy management of a retailer would look like. German retailers can be considered as the average behaviour, where few measures for heat recovery are implemented. The awareness for recovering heat and integrating the different elements of the building is undoubtedly growing, although it is a slow process and there are too many different approaches. 'Lighthouse' projects, as model stores, are frequently built. The most advanced techniques are all together in this model store. The cost for this approach is extremely high and the environmental benefit is insufficient for the overall performance of the company. So, the whole concept of a 'lighthouse' project store can not be considered as best management practice, although the techniques used to build it can be individually considered best practice.

When a retailer has decided to establish a standard of heat integration in all its stores, it will establish first a concept for the new buildings and a procedure to integrate such a system when a store is retrofitted. In few years, the overall performance will be increased and the specific heating consumption can be reduced to the level of the blue line of the chart. Here, the company can be considered a good performer: it reduces the energy consumption actively from year to year. There is still a wide gap for improvement but it will be covered because of a continuous improvement policy.

The company would have learnt from its own experience and would have increased the speed of improvement. Then, results would be similar to the red curve of Figure 2.30. This curve represents the energy profile of a company that started to apply the integration concepts in many stores in the 1990-2000 decade. The amount of saved energy and, therefore, saved costs are huge. In addition, the speed of amortisation is highly increased when they produce heat to be sold to their neighbours' buildings. Therefore, the negative part of the red curve does not represent cost savings but sales.

Evaluated in a quantitative manner, the average difference between German retailers ('normal performer') and the best performer is about 110 kWh/m^{2}yr. So, if a division of 150 stores of a 'normal performer' applies the heat integration, the savings would be of 16.6 GWh for the division (taking 1000 m^2 as the average area). If savings are assumed for natural gas, 3 800 t

CO_2 are not emitted. In specific terms, 25 kg of CO_2 per square metre of sales area and year are saved. This approach would produce the same results per store than the typical low-energy store of 'lighthouse' projects. So, it is worth noting the following.

- While the payback time of some low energy stores is usually quite long, the single measures proposed for a group of stores have significantly better economic behaviour.
- The economic response to sharp increases of energy tariffs is definitely better when a number a number of stores have been optimised and not when only one is saving energy.
- The generated knowledge also means benefits for the company. This usually takes place when improving an important number of stores. In the case of low or zero energy stores, the design, construction and maintenance is usually subcontracted with third parties and the gained knowledge is sometimes very limited.

When integrating the heat from the refrigeration cycle in the HVAC system of a building in a 'standard' food retailer, the objective, if possible, has to be to eliminate the energy consumption for heating. So, provided certain conditions are met, a food retailer store can eliminate the primary energy consumption for heating. Of course, it will depend on many factors, which are analysed in the 'Applicability' section.

The energy management system of a retailer has also to establish the target for each store. The monitoring system has to be comprehensive enough for the manager to propose targets and benchmarks, detect good practices and potential bad practices. More information about this issue is included the monitoring section (see Section 2.1.6.5).

Appropriate environmental indicator

As already explained for other management practices, the specific energy consumption per square metre and year seems to be a very relevant indicator for the sector, as many retailers are reporting this indicator. It is recommended to disclose the indicator for space heating and/or cooling, defined per unit of sales area and year. This indicator would gather all the techniques involving building envelope and the HVAC aspects and the heat recovered from refrigeration. Also, the energy savings or the produced heat from refrigeration per square metre and year would give an understandable indication of the environmental impact of heat integration.

Cross-media effects

There are no significant effects on other environmental aspects when a store is retrofitted to integrate heat recovery. Technically, an important issue to face during the design will be the Indoor Air Quality (IAQ) of the building. The ventilation system has to be carefully designed, as the reduction of air leakages can provoke more humidity and unwanted odours inside the building. Under-demand control with CO_2 sensors is strongly recommended.

Retrofitting actions in the refrigeration system, e.g. change of refrigerant, change of machinery, etc., would affect the energy flow of the system. For example, there is a significant impact when changing to a more efficient system, in which case less heat would be recoverable.

Operational data

Figure 2.31 shows a diagram about how the integration is performed in a concrete example. It would correspond to 'Case B' of the Sankey diagrams, shown in Figure 2.25. The implementation of these techniques as the standardized heating system is not trivial and takes a lot of effort. System planning, monitoring and management have to be optimised while training and awareness of workers is also a key issue.

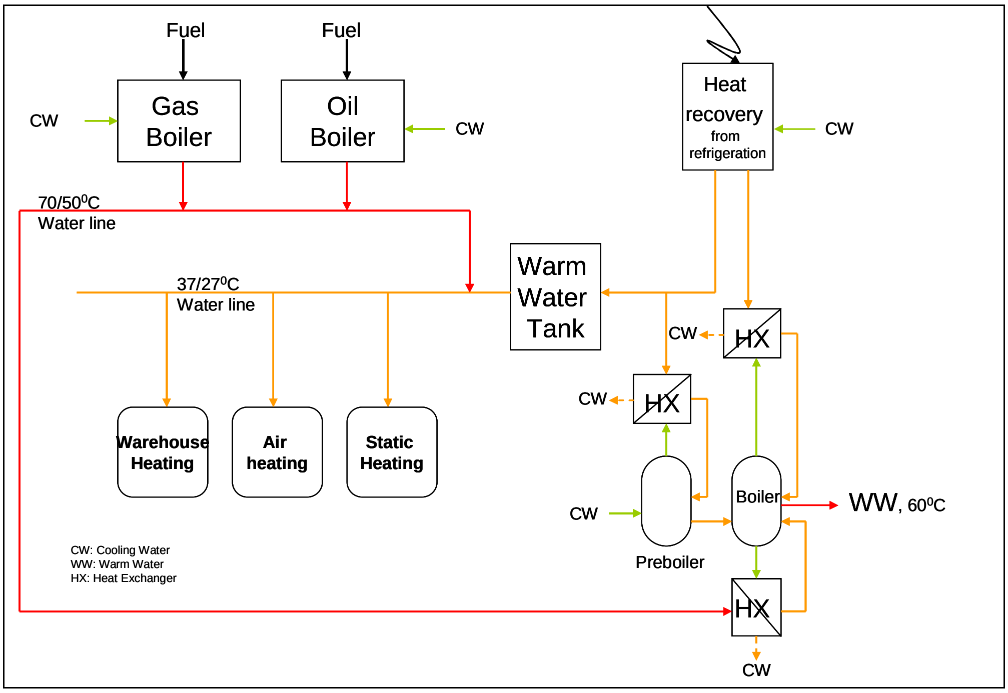


Figure 2.31: Integration of the recovered heat from the refrigeration cycle into the HVAC system

The heat recovered from the refrigeration cycle is used to produce warm water (for domestic and sanitary use).Part of the water is used to produce 37 °C water, which is employed as the heating fluid for the warehouse, air supply and the static heating systems. If the heat provided by the refrigeration cycle is not enough (as the case for large hypermarkets), a system of two natural gas boilers is used to provide the rest of the heat demand.

Figure 2.32 shows the heating power needed as a function of the outdoor temperature for the integrated installation of Figure 2.31. Fossil fuel boilers operate when the ambient temperature is lower than 1.5ºC. In Figure 2.32, this temperature is represented by the intersection point of the recovered heat line with the heating needs curve. The improved insulation of the building results in space heating needs of zero when the ambient temperature is higher than 10 ºC. Under these conditions, the required heat is gained from internal processes and is supplied by the ventilation system.

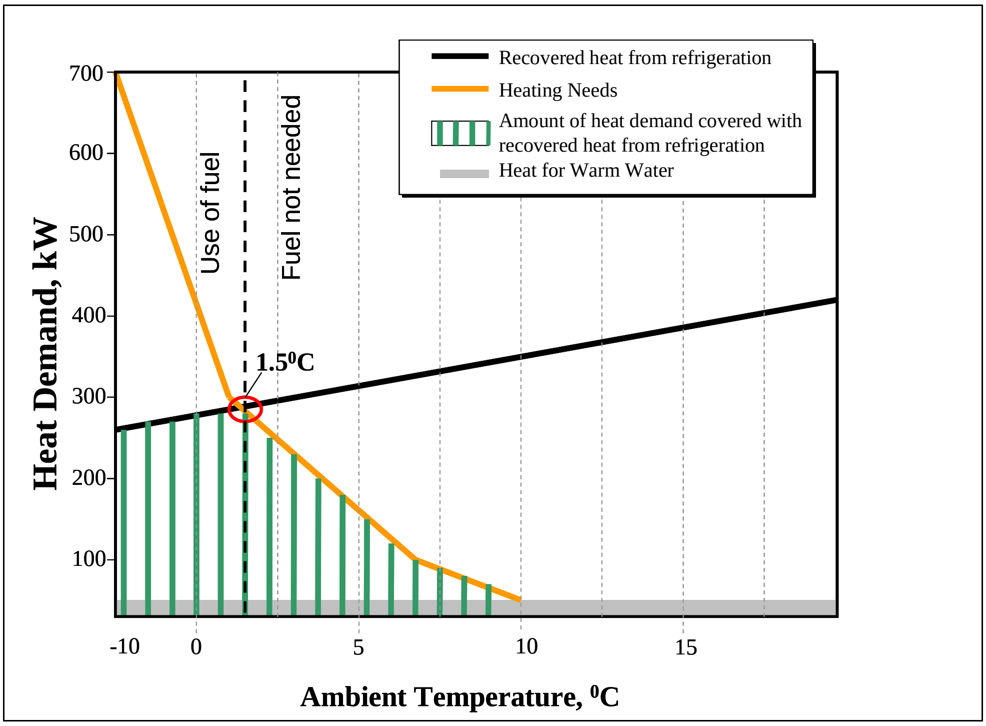


Figure 2.32: Heat demand vs. ambient temperature for an integration scheme example

Applicability

To apply this technique, specific for food retailers, important factors are given below.

- The refrigeration load. As explained, smaller stores offer more refrigerated goods per square metre of sales area and the efficiency in refrigeration is lower (see Figure 2.29). In addition, the trend to increase the refrigerated goods is also important. The size of the store does not influence the technical applicability of integrated approaches, but the cost-efficiency of the whole system is lower for small stores.
- Climatic conditions. In cold climates, the load for refrigeration is lower than for warmer regions. At the same time, the heat demand of northern European buildings is high, so the integration would depend on the quality of the building envelope. For the warmest climates, e.g. Mediterranean countries of Europe, the cooling demand can be very relevant and the air tightness of the building can make the internal gains to be very high. An optimised ventilation design is, therefore, necessary. Mechanical cooling at night and variable indoor temperature (e.g. 21–26 °C) are also recommended techniques.
- Ambient temperature. In the integration of the refrigeration cycle, there is a limit ambient temperature, which depends on the system design, where the waste heat generation rate is not enough to keep a comfortable temperature inside the buildings. An extra heating source may be needed but this again depends on the building envelope.
- Building ownership. Many stores are integrated in a residential or commercial building, which belongs to a third party. Better integration of heat recovery, therefore, must involve owners.

Economics

For new stores, the extra initial investment for the integration of heat recovery is not higher than 10 % of the conventional installation costs. The payback time is about 4 to 5 years. For this calculation, the conventional construction costs have to be estimated on the basis of fulfilling the requirements of national codes for the building. When a building is retrofitted, cost-savings depend on many factors, but especially on the initial state of the building, i.e., what amount of energy can be saved.

As an example, Table 2.13 shows the elements of the cost balance to perform an estimation of the payback time for a retrofitting scenario and the ratio investment per kWh saving. The period of time for this last parameter is the depreciation time: 20 years assumed for the building and 10 for the heating system. These periods are usually longer, so the calculated values of investment per saved kWh can be smaller.

Table 2.13: Example of payback time calculation procedure for the integration of heat recovery in a retailer building with improvement of the building envelope

Element	Value	Unit
Sales Area, **A**	2 000	$m^2_{s.a.}$
Envelope Area, $\mathbf{A}_E$	2 900	$m^2_{e.a.}$
Retrofitting cost, $\mathbf{C_R}$	75	EUR / $m^2_{e.a.}$
Investment for the envelope, $\mathbf{I_E} = A_E \times C_R$ (depreciation $\boldsymbol{d_e}$ = 20 yr)	217 500	EUR
Investment for the HVAC and integration, $\mathbf{I_I}$ (estimated) (depreciation $\boldsymbol{d_i}$ = 10 yr)	100 000	EUR
Energy savings, $\mathbf{E_s}$	250	kWh / $m^2_{s.a.}$yr
Energy costs, $\mathbf{C_E}$	0.08	EUR/kWh
Costs savings, $\mathbf{C_S} = C_E \times E_s \times A$	40 000	EUR/yr
Payback time, $\mathbf{t_{pb}} = (I_E + I_I) / C_S$	7.9	yr
Payback time, only for integration (rationale not shown)	6.3	yr
Investment per kWh saved (integrated approach) $\frac{I_E}{A \cdot E_s \cdot 0.60 \cdot d_e} + \frac{I_I}{A \cdot E_s \cdot 0.40 \cdot d_i}$	0.086	EUR / saved kWh
Investment per kWh saved (only heat recovery) $\frac{I_I}{A \cdot E_s \cdot 0.40 \cdot d_i}$	0.05	EUR / saved kWh

In the estimation shown in Table 2.13, apart from the achieved savings, results are really sensitive to envelope retrofitting costs. A set of values for this parameter, collected from the references (Petersdorff, 2006) is shown in Section 2.1.6.1. The investment in the building envelope would be lower per kWh saved in its depreciation time than for the heating system. Expressions in Table 2.13 can be used to calculate this parameter for shorter periods.

Other factors are also important and, therefore, the economic results can vary a lot from one retailer to another. Figure 2.33 shows how the costs for the integration of waste heat from refrigeration, HVAC and building envelope retrofitting would vary with the potential energy savings. Two scenarios for energy prices and retrofitting costs are assumed as examples, so four curves are obtained.

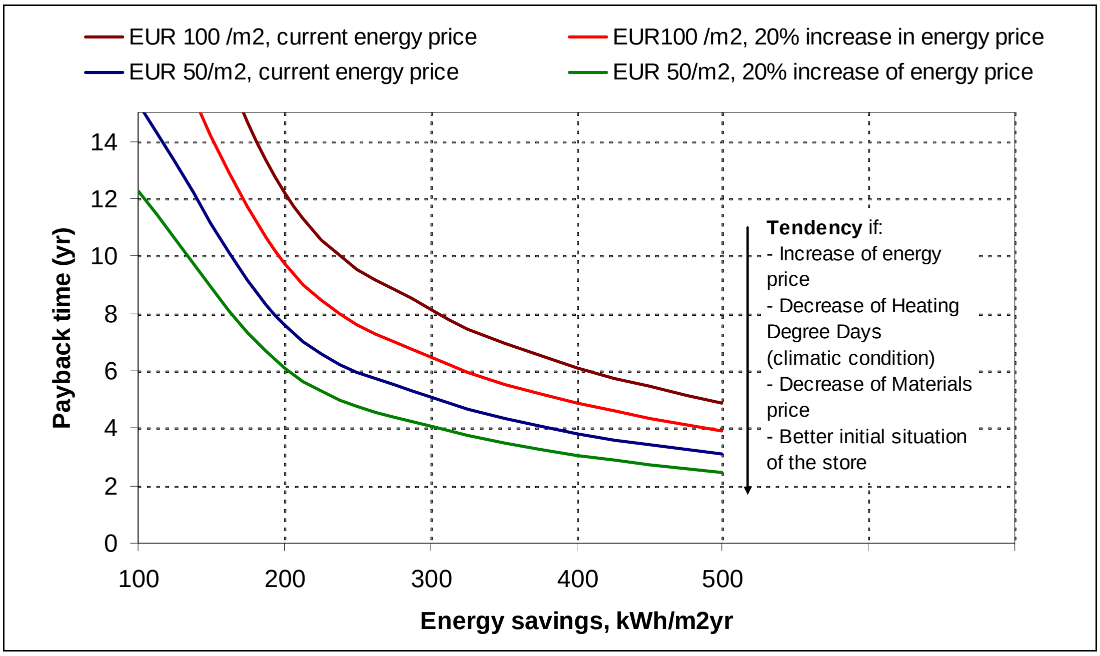


Figure 2.33: Payback time vs. energy savings for different scenarios of heating-refrigeration integration

As shown in Figure 2.33, future trends would reduce the payback time continuously. The energy price is going to increase in coming years and the price of insulation materials is decreasing as a consequence of the higher competitiveness in the sector.

Although there are strong reasons to save energy, such as the reduction of CO_2 emissions and the avoidance of resources depletion, the integration of heat from the refrigeration cycle has significant economic benefits for retailers. As an example, the estimation of payback time for the German retailers on heating consumption is shown in Figure 2.34. This chart shows the two payback time curves for the investment needed to fulfil the benchmark (0 kWh/m^{2}yr or no consumption for heating).

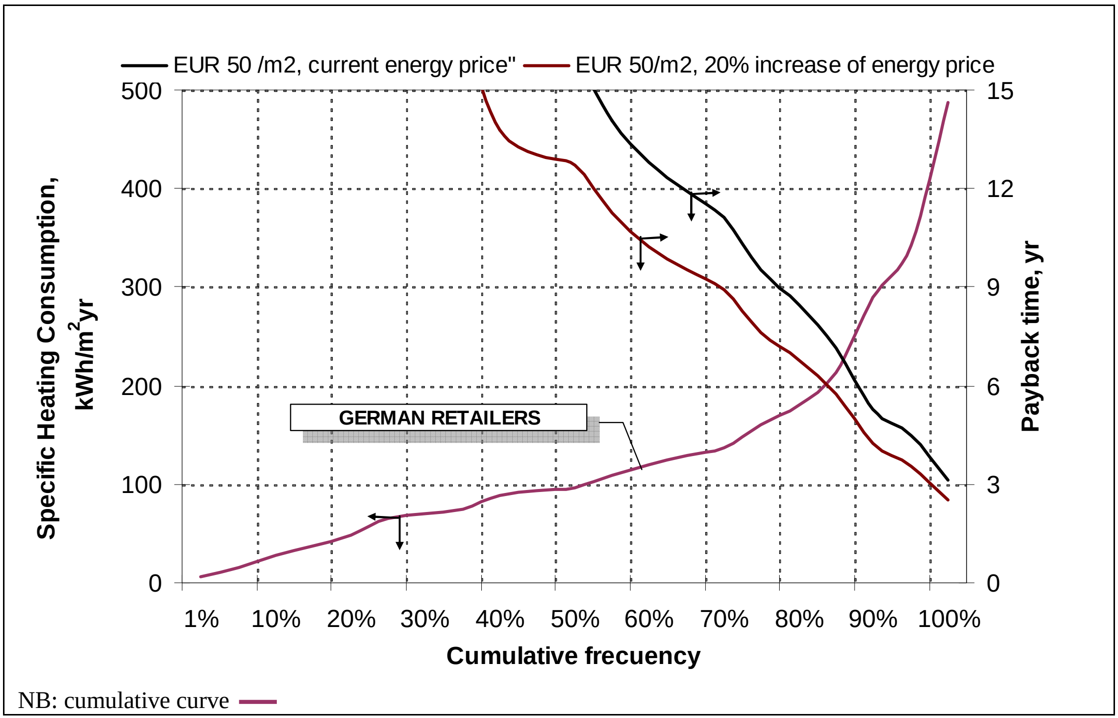


Figure 2.34: Specific heating consumption of German retailers and the associated payback time associated if the proposed benchmark is achieved

Driving force for implementation

The better environmental performance and the reduced energy consumption would be sufficient grounds for the implementation of the described measures as they are economically attractive and would ensure a better response to hypothetical future energy crises. Other motivations will also push retailers to implement energy efficiency measures in the HVAC system: fulfilling of existing and future regulations, achieving better conditions for clients inside the building, reducing the greenhouse gases emissions footprint of the retailer, etc.

Reference retailers

There are important retailers who have a strong commitment to improving their energy efficiency through the integration of heating and refrigeration. Some of them have developed technically sound concepts, not only for new but also for existing stores. Concepts from Lidl, Rewe, Migros and Coop are examples of these integration practices.

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2.1.6.5 Monitoring of stores in the energy management system

Description

The energy management system of a company, as well as the environmental management system, are Plan-Do-Check-Act (PDCA) processes (Figure 2.2), which have to be integrated into the business structure and have to produce energy and costs savings through a continuous improvement cycle. There are standards (EN 16001:2009 and the next ISO 50001) on how to integrate the energy management system in a company. These standards are based on the structure of ISO 9001 or 14001 and they are quite connected. Nevertheless, they do not give any absolute requirement nor do they guarantee an optimal performance (SEI, 2009).

An effective management system of a retailer, usually operating many stores, should be divided into:

- plan: establish targets, objectives, fulfil regulations
- do: establish energy policy, involve and train employees, measure and monitor energy performance
- check: control of deviations, corrective actions, audits, benchmarking
- act: management review, reporting, review targets, objectives.

For a retailer, one of the most sensitive parts of management is the monitoring. Many retailers in Europe are multi-site companies, with many branches or subsidiary companies which are difficult to monitor if there is not a strong commitment and effort from the top management, a training process of the employees and enough allocated resources. The best way to optimise the monitoring of the energy consumption of hundreds or thousands of stores is to integrate the energy and the environmental aspects into the business structure for control and reporting.

The application of energy saving measures to a number of stores requires a good management, as many resources have to be mobilised. In addition, a good monitoring system is required and controls all the performance indicators of all stores. Except for special energy uses, it is not enough to monitor only a part of the stores. Data collection is a task of the environmental management system that allows the company to (Carbon Trust, 2009a):

- detect avoidable energy wastes (undetectable in a simpler way);
- quantify the savings achieved by the implemented techniques or practices;
- identify the aspects of the company where a special effort should be made to save energy;
- increase knowledge of the company, increase awareness, establish targets and undertake benchmarking.

Monitoring alone does not producing energy savings. The dynamic behaviour of retailers, learning from the monitoring system, can produce great energy savings by an active benchmarking activity and by applying efficient techniques. The basic aspects measured by a central energy monitoring system are shown in the tables indicated below:

- In Table 2.14, a set of variables for monitoring energy resources is proposed. Four different categories are recommended: renewable (consumed or produced), fossil, mix and recovered.
- In Table 2.15, a set of variables for monitoring the processes consuming energy inside a store is proposed. The subcategories are: building, HVAC, lighting, refrigeration and others.
- In Table 2.16, several energy-related aspects which have to be covered are shown. Proposed subcategories are: climatic conditions, incidents, perishable food and building use.

In total, 35 parameters are proposed. A number for each category is given and a letter is assigned to the measured parameters. For example, 2b is category 2, store operation parameters is category b, Warm Water Generation. The period of time to measure each parameter can be different. For example, the lighting system can be controlled every day by an online system, while space heating or cooling are seasonal parameters. Other parameters only change in periods greater than a year (e.g. the length of refrigeration display cases) or have to be calculated after an established period of assessment (e.g. building heat gain or heat loss is calculated with the heating degree days). The relationship between the different main categories is indicated in the fourth column of each table ('linked to'), where an indication of what subprocess from other monitoring categories has to be included. For example, for oil use (1a), the disclosure between oil for space heating (2a) and oil for warm water generation (2b) should be considered. Meanwhile, when measuring the consumption of space heating, an indication of the energy source should be included (oil, gas, biofuel, geothermal or different sources of electricity).

The proposed processes and parameters to be controlled by the monitoring system, listed below, are gathered in a very comprehensive list. The sales concept (e.g. food or non-food), store format and size (e.g. hypermarket or supermarket) can influence the number of processes to be controlled. Retailers should decide the most relevant indicators to control the energy consumption of their operations. No information should be lost.

The recommended indicator is the specific energy consumption (measured in kWh/m^2yr), if possible, as primary energy. Other indicators (or alternative units for assessing the performance) are given. They can help to measure and understand the specific performance of different processes.

Table 2.14: Energy source parameters to be controlled in a store as part of a comprehensive energy monitoring system

Category	Subcategory	Flow/process parameter	Linked to (see Table 2.15)	Performance indicator	Alternative indicators/units
1. Energy sources	Fossil	1a Oil	2a, 2b	Energy consumption per year an per square metre of sales area: kWh/m²yr	kg/m²yr, L/m²yr
	Fossil	1b Gas	2a, 2b		m³/m²yr
	Renewable (cons)	1c Biofuel	2a, 2b		kg/m²yr, L/m²yr
	Renewable (cons)	1d Geothermal heat	2a, 2b, 2d		NA
	Renewable (cons)	1e Solar heat (for warm water)	2b		NA
	Recovered	1f Recovered heat from internal processes	2a, 2b		Ratio recovered heat/heat demand
	Recovered	1g Energy storage	2a – 2d, 2i – 2l		NA
	Grid	1h Electricity from grid	2a – 2d, 2g – 2o		NA
	Renewable (cons)	1i Green electricity	2a – 2d, 2g – 2o		% of green purchased electricity
	Renewable (prod)	1j Renewable electricity (produced)	(produced)		Ratio produced/consumed electricity
	Grid	1k. Electricity from CHP	2a – 2d, 2g – 2o		System efficiency
NB: annual consumption and production for a whole site, e.g. a store.					

Table 2.15: Store operation parameters to be controlled in a store as part of a comprehensive energy monitoring system

Category	Subcategory	Flow/process parameter	Linked to (see Table 2.14)	Performance indicator	Other indicators/units
2. Store operation	HVAC	2a Space heating	1a – 1d, 1f, 1h, 1i	Energy consumption per year and per square metre of sales area: kWh/m^2yr	NA
	HVAC	2b Warm water generation	1a – 1d, 1f, 1h, 1h		NA
	HVAC	2c Ventilation	1h, 1i		m^3/h person
	HVAC	2d Space cooling	1h, 1i		NA
	Building	2e Total heat demand	∑2a		NA
	Building	2f Total cooling demand	∑2d		NA
	Lighting	2g Internal lighting	1h, 1i		W/m^2
	Lighting	2h External lighting (e.g. parking, ads)	1h, 1i		W/m^2
	Refrigeration	2i Refrigeration (centralised)	1h, 1i		kWh per metre of display cases and year, kWh/m yr
	Refrigeration	2j Freezing (centralised)	1h, 1i		kWh/m yr
	Refrigeration	2k Refrigeration (plug-ins)	1h, 1i		kWh/m yr
	Refrigeration	2l Freezing (plug-ins)	1h, 1i		kWh/m yr
	Other	2m Appliances for special processes e.g. lamps store, electronics store	1h, 1i		NA
	Other	2n Appliances (standard use)	1h, 1i		NA
	Other	2o Other	1h, 1i		NA

Table 2.16: Energy-related aspects to be controlled in a store for a comprehensive energy monitoring system

Category	Subcategory	Flow/process parameter	Linked to (see Table 2.14)	Performance indicator	Other indicators/units
3. Energy-related aspects	Climatic conditions	3a Heating degree days	NA	NA	Kd
	Climatic conditions	3b Cooling degree days	NA	NA	Kd
	Incidents	3c Use of emergency power	1a, other	Energy consumption per year and per square metre of sales area: kWh/m^2yr	NA-
	Incidents	3d Use of emergency heat	1a, other		NA
	Perishable food	3e Length of display cases	NA	NA	m/m^2 yr
	Building use	3f Opening hours	NA	NA	h
	Building use	3g Sales area or heated and cooled area	NA	NA	m^2
	Building use	3h Heat loss (winter)	NA	NA	W/m^2
	Building use	3i Heat gain (summer)	NA	NA	W/m^2

Monitoring of energy sources and CO_2 emissions

The main environmental impacts of energy consumption are the CO_2 and GHG emissions and the resource depletion due to primary energy consumption. There are other associated impacts to the energy life cycle, but the mentioned impacts are able to create enough awareness. In this field, the energy management system of a large retailer has to be able to detect potential problems in the stores (excessive consumption, bad practices related to refrigeration, etc.)

The balance of energy should be performed in terms of primary energy consumption. Table 2.17 shows the conversion factors from final energy uses to primary energy consumption. With these factors, the total primary energy demand of a store can be calculated. The use of electricity is penalised by a high conversion factor, as the efficiency of electricity generation is usually low. The value of these factors depends on local and regional aspects, as renewables efficiency, electricity generation mix, etc. A weight of 0.1 is given to renewable energy to avoid the perception of 'free' energy or 'non-consumed' energy when dealing with renewable energy sources. This would take into account the whole energy life cycle.

Table 2.17: Conversion factors from primary to final energy use and associated CO_2 emissions per final energy use

Energy source	kWh primary/kWh consumed	kg CO_2 / kWh consumed
Fossil		
Fossil fuel for furnaces/heaters/boilers	1	0.277 for oil, 0.184 for gas
District heating	0.7	0.7 × (0.277 for oil, 0.184 for gas)
Recovered		
Recovered heat from exhaust air	0	0
Recovered heat from refrigeration		
Mix		
Grid electricity (HVAC, lighting, refrigeration, other)	2.7	0.544
Renewable		
Biomass	0.1	0
Geothermal heat pump		
Photovoltaic		
Outdoor air for heating/cooling		
Green electricity supply		
Solar hot water		
Source: (Carbon Trust, 2009b; DIN, 2007)		

Indirect greenhouse gases emissions from different energy sources and direct emissions from combustion processes could be easily calculated if an energy monitoring system is implemented. A specific production rate of CO_2 emission is given per kWh in Table 2.17. Some example factors are also given for several technologies. The value of these factors depends on local and regional aspects, on the country energy mix, technology efficiency, etc.

The control of the refrigerant leakages is also very important. They can be monitored *in situ* with the sensors, but the monitoring of leakages of a number of stores has to be deduced from refrigerants purchasing (although it is not the exact figure). The emissions of HFC refrigerants have an important GWP. Therefore, the accounting should be done in equivalent CO_2 and added to the carbon balance as direct emissions. More information on this aspect is shown in Section 2.1.6.6.

Monitoring of buildings and HVAC

- The monitoring of the HVAC system should also be very helpful if it is performed in a comprehensive way. The heating demand of a store can be easily controlled and it will give fundamental information about many aspects:
- the heat gain/loss through the building envelope
- the efficiency of the HVAC system
- the influence of the climate on the HVAC system and, therefore, on the building envelope
- the influence of external/internal factors, e.g. the works done inside the building, improvements, air leakages, changes in opening hours.

Here, two aspects should be pointed out. First, the amount of waste energy recovered from the refrigeration system should be monitored. Sometimes, there is no need for heat from external sources because of the refrigeration excess heat recovery (see Section 2.1.6.4). This does not mean that the system is efficient. Maybe, an excess of electricity is consumed in the refrigeration plant, or part of the recovered heat is lost due to the lack of pipe insulation, the small size of heat exchangers or due to the absence of consumers for the recovered heat. Best performers are actually selling the excess recovered heat (see Section 2.1.6.4)

The second aspect with some controlling difficulties is the 'quality' of the building envelope, as many factors actually influence it. The best way to control for the building envelope is to measure or to calculate the overall heat transfer coefficient, U-value, for the entire building, but the calculation procedure is complex and not easy to perform all the time. An approximated method is proposed, based on the definition of the U-value:

$$U = \frac{q}{A\Delta T} \qquad (2.1)$$

where

U	is the U-value (W/m^2K);
q	is the heat flux (energy per square meter) over a surface of 1 m^2 of building envelope (J/m^2s);
A	is the surface area for heat transfer, i.e. the area of the building envelope (m^2)
ΔT	is the temperature difference between building indoor and outdoor environments.

The U-value represents how the building is losing or gaining heat through the envelope and it is a function of the thickness and of the properties of the construction materials. But this parameter can be unsatisfactory to evaluate all the energy gains and losses of energy of a building. For this purpose, all the heat losses and gains due to all heat transfer aspects should be taken into account:

conduction: wall, roof, floor, windows, doors, frames, thermal bridges, etc.
convection: air leakages, fresh air for ventilation, pressure drops, heat recovery from exhaust air, internal gains (people, light, appliances), heating and cooling system, open windows, open doors, buffer sections, etc.
solar radiation: windows with single, double, triple glazing, glass bricks, solar shading, etc.

So, the amount of energy transferred by the building envelope is a complex issue. In this document, the shift to a more simplified expression is proposed:

$$U = k\frac{Q}{A_S HDD} \qquad \mathbf{(2.2)}$$

where

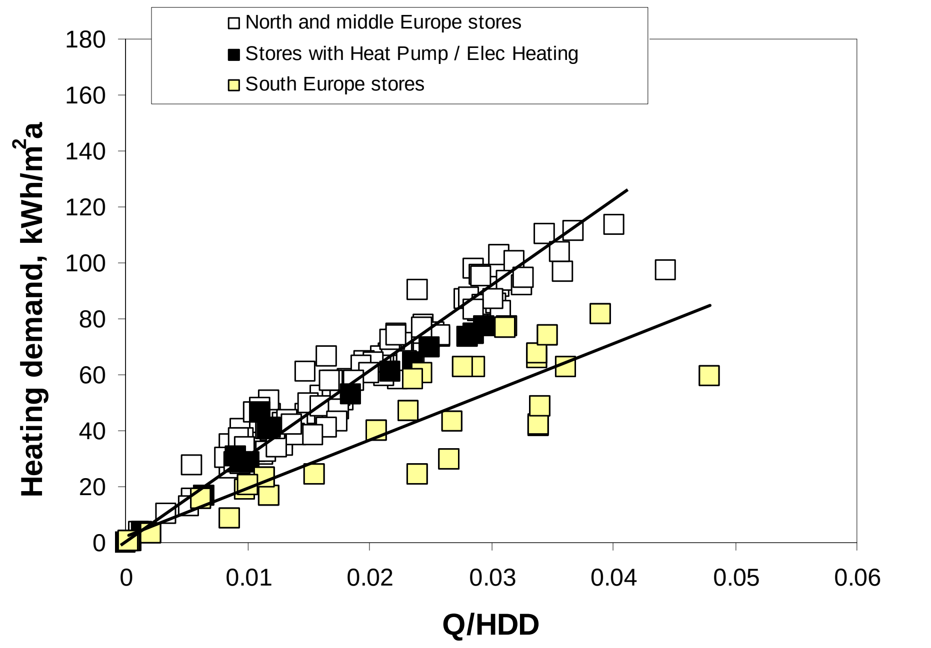
U is the U-value (W/m^2K);

Q	is the specific heat consumption (energy per square meter) per 1 m^2 of sales area (kWh/m^2yr);
A_s	is the area of the building envelope per m^2 of sales area
HDD	is the value of the Heating Degree Days
k	is a conversion factor and its value depends on the units

The value of k is constant, and the value of A_S depends on the design of the building shape and size. For many retailers, this factor would be constant, as the building design is quite similar. So, it can be stated that the U-value is proportional to the quotient Q/HDD:

$$U \sim \frac{Q}{HDD} \qquad \textbf{(2.3)}$$

Figure 2.35 shows the influence of this parameter on the heat demand for the buildings of IKEA for its European stores.



NB: data from 156 stores

Figure 2.35: Heating demand vs. Q/HDD parameter for IKEA buildings operating all over Europe

As this figure shows, there is no distinction between the buildings of north and central Europe, but the southern buildings are clearly identified in the other trend line of the graph. The trend lines are linear, so a direct relationship between heating demand and heat losses is proved. The climatic influence changes the slope of these trend lines. The amount of heat needed in a building placed in the south of Europe is much less than for a similar building (same Q/HDD value) in a middle or northern Europe location. The consumption for northern buildings is similar to those in central Europe. This fact is due to the building insulation, which is usually higher in northern Europe.

So, this kind of monitoring would detect problems but would also help the benchmarking process and the establishment of environmental targets in relation to the building envelope.

Monitoring of refrigeration
The refrigeration processes installed in a store consumes more than 50 % of the total energy demand. The monitoring of refrigeration systems is essential for any energy management system, as the vapour compression cycle (Figure 2.21) demands a high amount of energy, as electricity, for the compression step.

Some retailers have an excellent monitoring system of the refrigeration system. First, these retailers know exactly the length of display cases for refrigeration and freezing they have in each store. If they have refrigerated rooms, they transform the room area in length as a function of the product load. Second, they control separately the amount of electricity consumed by the refrigeration system. With these data, they are able to control:

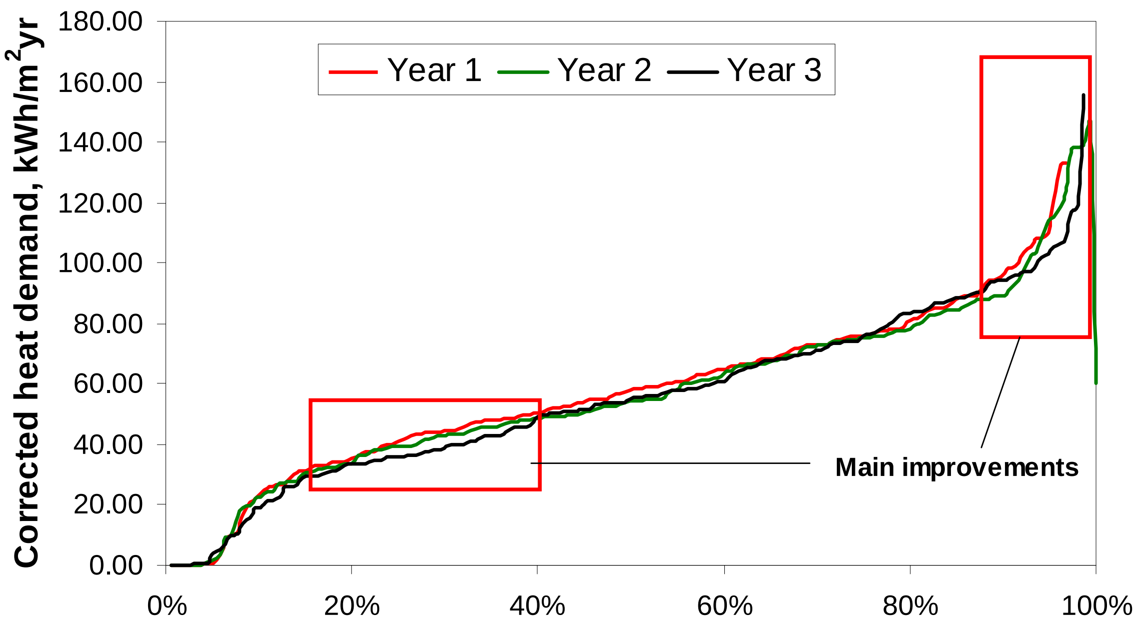
- the specific electricity consumption of display cases by calculating the amount of energy per metre of display cases consumed in a year, kWh/m yr;
- the specific electricity consumption per square metre of sales area, kWh/m2yr.

When a retailer proposes a benchmark, it is not easy to propose a value for the overall energy consumption of the refrigeration system, as each store can have different loads of perishable goods, as a question of logistics, tradition, local or regional aspects, etc. To improve the performance of refrigeration systems, it is better to propose a benchmark for the specific energy consumption of cooling display cases per linear metre of cabinets. Typical values vary from 2500 to 6000 kWh/m^{2}yr, with exceptions for stores with a high load of frozen food.

Monitoring of other aspects
For some aspects, the existing monitoring system would not be enough. This is the case for lighting, which is hardly separated from the overall electricity consumption. Nevertheless, the lighting of products at stores is highly important because of the high intensity needed for marketing purposes. It can consume more than 25 % of the total energy consumption of a store. Another important aspect is space cooling, which is not usually controlled even in warmer climates. It is highly recommended to monitor these aspects in stores, as they would be very helpful to optimise and to implement more efficient energy policies.

Climatic aspects such as HDD or CDD are not monitored by the companies as there are national agencies monitoring these parameters and this information can be downloaded from their web pages. The value is obtained annually and it can be very helpful to explain the energy consumption of heating or refrigeration.

Achieved environmental benefits
The environmental benefit of the energy management and monitoring of a retail company is the saving of large amounts of energy when simple measures are applied to all sites and are also related to the detection of bad practices CO_2 emissions would also be reduced and resources consumption would be lower. As an example, cumulative distribution curve evolution across 156 IKEA stores (all over Europe) for the heat consumption is shown in Figure 2.36.



NB: data from 156 stores

Figure 2.36: Corrected heat demand vs. cumulative frequency for Ikea European stores

The retailer of the example is operates all over Europe and a correction for the climate conditions and the opening hours have been performed in the curves shown in Figure 2.36. The difference between the three curves for three consecutive years seems to be minimal. The apparent low progress is reflected in the specific energy savings, which are 3.5 kWh/m^{2}yr. But, if the sales area of the whole group is taken into account, more than EUR 1 million is saved.

The implementation of an energy monitoring system would also:

- help a company to identify the areas where potential energy savings can be carried out;
- require the company to implement actions to improve its energy performance, from simpler to more complex ones;
- increase the awareness and the understanding of the processes consuming energy inside a store, generating a huge amount of knowledge which can be protected by the company;
- help to implement an energy policy, to establish targets and objectives and to increase the performance through a continual improvement process (see Description);
- allow the manager to select the best performance indicators;
- detect potential bad practices;
- detect best practices;
- allow to the manager to propose energy consumption benchmarks;
- control the implementation of new design concepts for new/retrofitted stores.

Appropriate environmental indicator

To monitor the energy consumption of stores, the specific consumption per square metre of sales area and per year is an appropriate indicator. The calculation of the three elements of this expression (energy, sales area, time) has to be harmonised in order to obtain comparable measures. It should be controlled at the process level, i.e. controlled per energy consumer at the store, such as refrigeration, lighting, heating, etc. Aggregated values can be used to measure the overall impact at the store level or at the company level.

Furthermore, the specific energy generation is a recommended indicator to be controlled by the monitoring system if an alternative energy generation installation is implemented by the retailer. The leakages of refrigerants should be also monitored, as they contribute largely to GHG emissions. The high energy consumption from lighting devices should also be controlled. The most common indicator to measure for this aspect is the power density of lighting, measured in W/m^2.

Figure 2.37 shows the most frequently used indicators for the energy performance of stores. This figure can help to understand the connections among indicators.

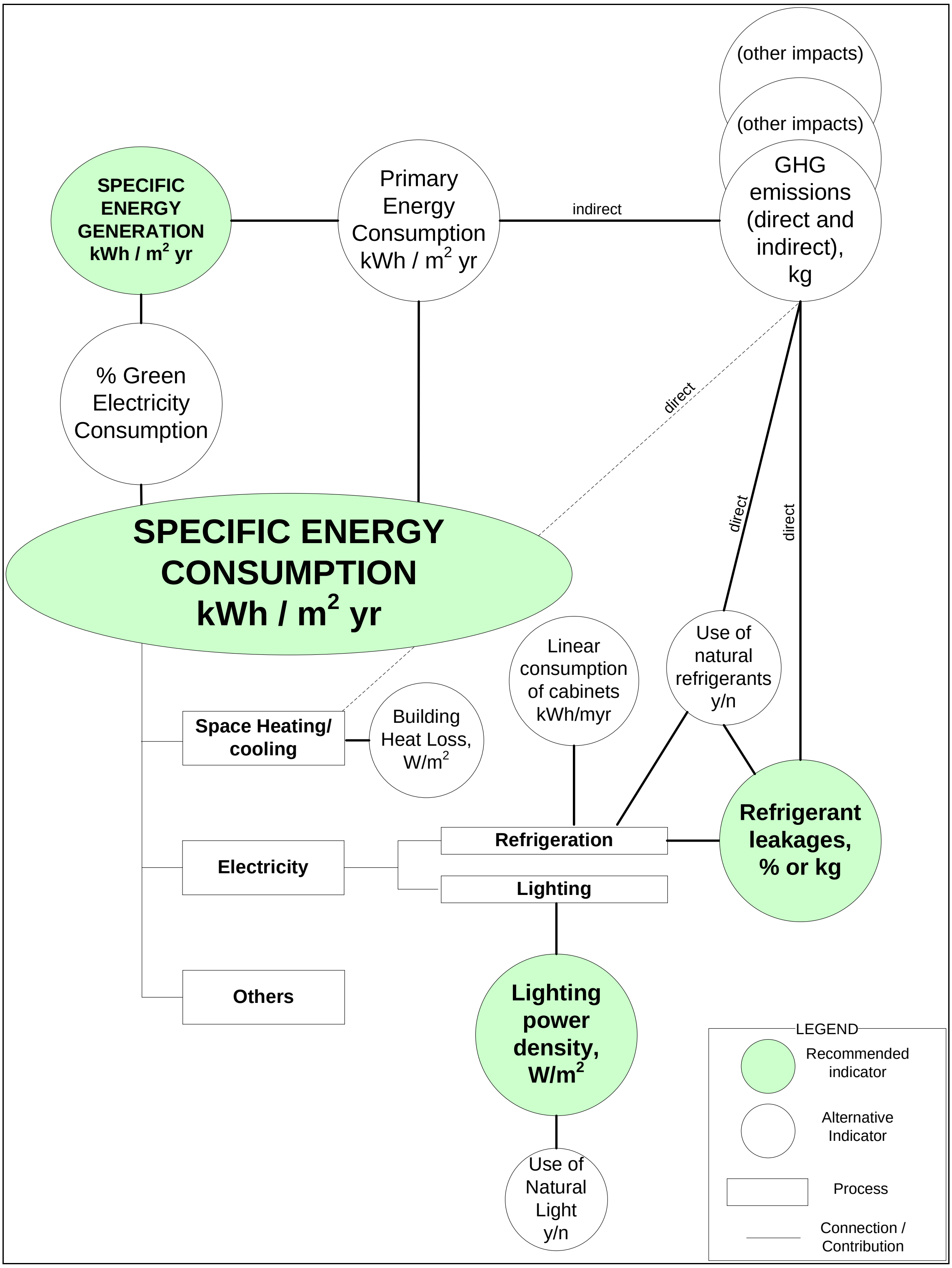


Figure 2.37: Indicators used frequently in the monitoring system of retailers and their connections

The use of correction factors, as a function of the climate, local conditions (e.g. for assessing GHG emissions), or different activities (presence of restaurants, bakeries, etc.), should be implemented with a sound scientific basis and with a clear definition of the purpose of the correction factor. For example, correction factors for building height can be implemented to compare the performance of different heating systems. Furthermore, correction factors can be used to assess the impact of the energy management system, as the example of Figure 2.36.

Cross-media effects
There are no any associated cross-media effects.

Operational data
No details about the operation of the monitoring system as such are given. The energy and the environmental results from a store are usually integrated into other business monitoring schemes and the methodology is usually quite different from one retailer to another.

Nevertheless, several monitoring concepts should be followed in the system.

- Planning and scheduling: several aspects do not need to be monitored in a continuous manner. For example, the heating system is not used in summer. However, other aspects, as refrigeration, should be controlled continuously. Other systems, such as lighting (without natural light) do not need a strictly continuous control because the consumption is usually constant throughout the year. Some retailers do not disclose the electricity consumption of lighting, but they check the lighting system in detail in all the environmental (energy) audits. This is a good achievement, but it would be a better practice to monitor it continuously.
- Staffing and resourcing. A good energy management system needs resources from the company. The implementation of a monitoring system should avoid existing staff overloading and scarcity of resources. Economy of the energy efficiency measures would justify this approach. The work can be done by a third party but improvements have to be initiated by the retailer.
- Data management. The acquisition of data by the energy manager should be fast, efficient and the data should be homogeneous in order to be comparable. Among other representing techniques, two types of charts are strongly recommended:
  - Random distribution chart (Figure 2.38): allows for fast detection of potential bad management practices (red bars) and best performers and also potential best practices (green bars). The energy management system can be evaluated through the amplitude of the variability of the stores. The average performance is rapidly detected through a visual scan.

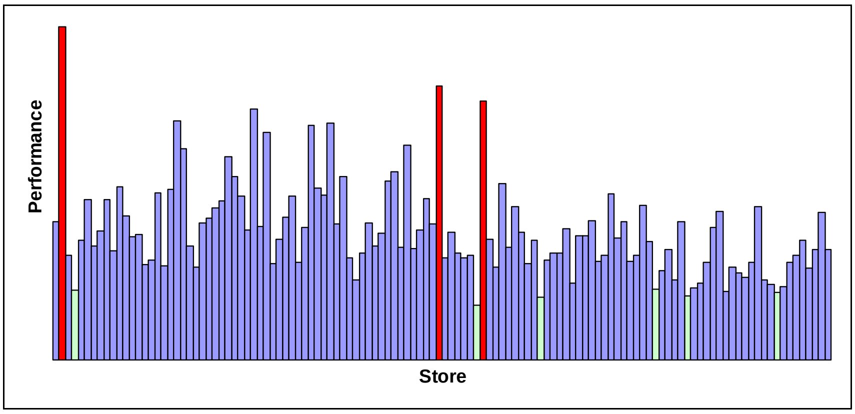


Figure 2.38: Example of random distribution of stores performance data

  - Cumulative distribution chart (Figure 2.39): this chart would also allow for detecting best practitioners, but with a clearer view of what benchmark can be proposed and what performance can be selected as best practice. The energy management system can also be assessed through the slope (at the 50 % cumulative frequency value): the lower the slope the more similar the performance of stores and the more homogeneity of the management system.

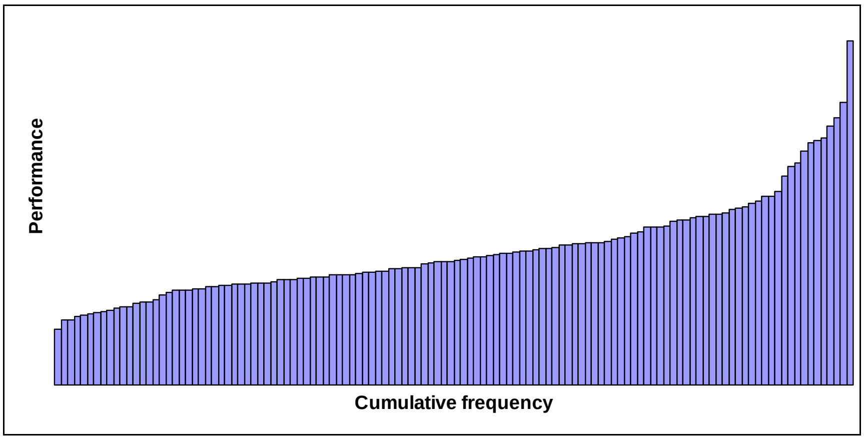


Figure 2.39: Example of cumulative distribution of stores performance data

- Monitoring of 'lab' stores. When a new measure to increase the energy efficiency of a store is tested, it is usually implemented in one or several stores. In these 'lab' stores, the monitoring system is even more detailed than usual in order to have a complete picture of the benefits of the new measure. Lab stores are usually the same for every new measure, although special climatic conditions or regional regulations can modify their location.
- Global monitoring or sample monitoring. The implementation of a comprehensive monitoring system in every store is recommended to achieve the best energy performance. Sometimes it is enough to make the sampling of a concrete measure, even if it is applied to the whole company. For example, to assess the behaviour of new LED lamps installed in all new freezers, it is not necessary to implement the same control and monitoring scheme of this special item in all stores. It would be enough to monitor a representative sample of stores.

Applicability

The monitoring of all the stores of a retailer is a huge task and with a significant degree of complexity, but there is no limitation to the size or type of retailer that can implement a comprehensive monitoring system. It is easier to monitor new or modern stores than older ones, but, again, the energy management system should deal with all operated stores. The retailer should decide which parameters should be controlled to have a comprehensive view of their environmental impact and their energy performance. The relevance of the parameter depends on the store format. For instance, clothing stores consume a large amount of energy for lighting (values of 60 W/m^2 or even more), and it supposes more than 70 % of their energy bill. So, metering and lighting zones control should be implemented for this process. This may not be the case for food retailers, where more than 50 % of the energy is consumed for refrigeration and less than 20 % of the energy is consumed for lighting.

Economics

Energy efficiency measures always produce cost savings. The problem to tackle is the period of time in which the adopted measures would pay back the investment, i.e. the payback time. For most retailers, a payback time greater than three years is unacceptable. Energy monitoring is required to calculate energy savings, and therefore payback times, for particular improvement options. A good monitoring system is, therefore, an essential component of any retailer's energy management strategy.

A good example of energy monitoring is shown in Figure 2.36. This chart is the result of many single measures. One single measure, for example, is to change the indoor temperature from 24 to 21 °C in several stores. The cost of this measure is not significant, but the savings, for all the company, are huge. The benefit from more complex and expensive measures would be more difficult to assess and/or to implement if the monitoring system is not comprehensive or precise. Therefore, the monitoring system is an essential tool in the decision-making process.

Another example of the benefits of implemented measures, assessed with a comprehensive monitoring system, is shown in Section 2.1.6.4.

Currently, the concern of retailers deals with the high costs of the monitoring of existing stores, when compared to new stores. Nevertheless, best practice is to control 100 % of stores or having that figure as an objective for the monitoring and implementing the techniques and staff training needed for that purpose. Then, growing knowledge and expertise will be symptoms of continuous improvement.

Driving force for implementation

A monitoring system, integrated into the energy management system, would provide a number of advantages, for example:

- improved insight into the energy aspects of the company
- improved knowledge and competitiveness
- additional opportunities for energy savings
- improved basis for decision-making
- better response to new energy regulations, market fluctuations
- improved reputation and public image
- improved control through a tool to check the effectiveness of implemented measures,
- facilitates other environmental monitoring systems.

Reference retailers

An important number of companies have implemented energy monitoring systems in new stores and existing stores. For this document, most of the information was collected from Ikea (Sweden), Migros and Coop (Switzerland), Carrefour (France), Colruyt (Belgium), and Royal Ahold – Albert Heijn (Netherlands).

Reference Literature

- Carbon Trust, *Monitoring and Targeting: techniques to help organisations control and manage their energy use*, www.carbontrust.co.uk, 2009a.
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2.1.6.6 Efficient refrigeration

Description

The main environmental impact of food stores operation is derived from the installed refrigeration systems. Refrigeration is essential for the conservation of perishable goods within the store and is a key element in the optimisation of logistics and the transportation of food. But the influence of refrigeration system in the carbon footprint of typical retailers in Europe is extremely important, as shown in Figure 2.40.

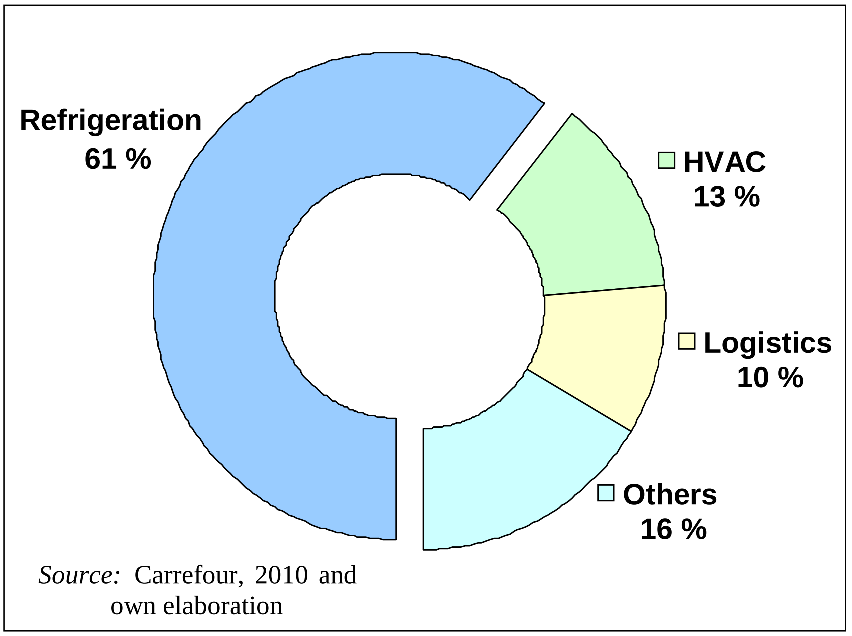


Figure 2.40: Carbon footprint breakdown of a retailer operation

The disclosure of the carbon footprint of refrigeration systems in supermarkets, hypermarkets and other food stores is usually divided into two categories:

- 50 % from the direct emissions of refrigerants. Halogenated refrigerants have high Global Warming Potential (GWP) values and, therefore, the leakages and disposal procedures of these refrigerants have a significant environmental impact. Some refrigerants are banned and the most common refrigerants are R404a and R134a. The leakage rate varies from one supermarket to another and its value mainly depends on the used refrigerant, installation design and maintenance practices. In the 1980s, the leakage rate was about 25 % of refrigerant charge in US stores. It has been reduced in modern systems and the reduction depends largely on the country, on the operation practice and other factors.
- 50 % from indirect emissions. These emissions are associated with the production of the electricity needed to run the refrigeration system. The main energy demand of the refrigeration cycle is the compression step. The mechanical compressors are fed with electricity, usually taken from the grid. The energy consumption of the refrigeration system actually accounts for more than 50 % of the total energy demand of a food retailer store.

The accounting of the Greenhouse Gases (GHG) of refrigeration systems is usually performed by the Total Equivalent Warming Impact (TEWI) method, which takes into account the amount of direct and indirect emissions. This methodology is explained below.

There is a strong connection between the energy performance of the refrigeration systems and the refrigerant. The change to a more environmentally-friendly refrigerant should be performed only if the overall impact is reduced. A new or cleaner refrigerant can cause an important increase of the energy consumption of the refrigeration system due to lower efficiency.

Direct and indirect GHG emissions and the whole energy consumption are the main influencing elements for taking into account the environmental performance in the implementation of new techniques. A proposed prioritisation is shown in Figure 2.21. Frequently, it is preferable to reduce the energy demand before applying other alternative techniques focused on improving the efficiency or introducing renewable energy.

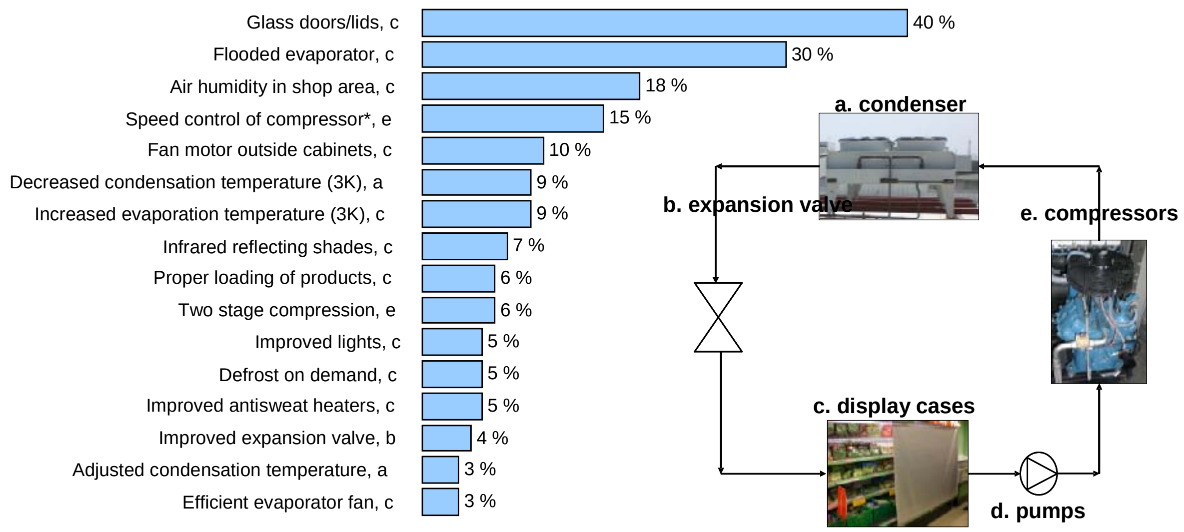
Table 2.18: Proposed prioritisation of techniques to consider for improving the energy performance of refrigeration systems

Priority	**Techniques to consider**	**Investment**	**Increased cost-efficiency?**
Reduce consumption (less use)	Energy saving measures: - display cases covering - improved design - better maintenance	Low	Yes
	New refrigerants and installations to reduce the carbon footprint, reduce the energy demand and/or to fulfil regulations	High	Depends on the system
Optimise efficiency (better use)	Energy saving measures: - smart control - under-demand fans, pumps and compressors - lighting optimisation	Low	Yes
	Energy balance of stores: heat recovery and cold storage	High	Yes
Use of renewable energy (cleaner use)	Green purchasing	Low	No
	Self-generation	High	No/depends on subsidies

Energy saving measures on existing systems

In a comprehensive study published in 2009 by the Federal Environmental Agency of Germany (Rhiemeier et al., 2009), the environmental benefit of several measures was investigated and quantified for some of them. These measures and their benefits are shown in Figure 2.41, with an indication of the location of the measure within the refrigeration cycle. A description of each individual technique can be found in that reference. The implementation of most of the measures is usually fast and has extremely low payback times, while their environmental benefit is considerable. The proper loading of products would be an example of this. Currently, most retailers already properly control the loading processes.

Attending to the location indicated in Figure 2.41, most important measures would have to be applied in the evaporation step, i.e., at display cases. Some of the measures would require the replacement of display cases, while others only require the addition or retrofitting of components.

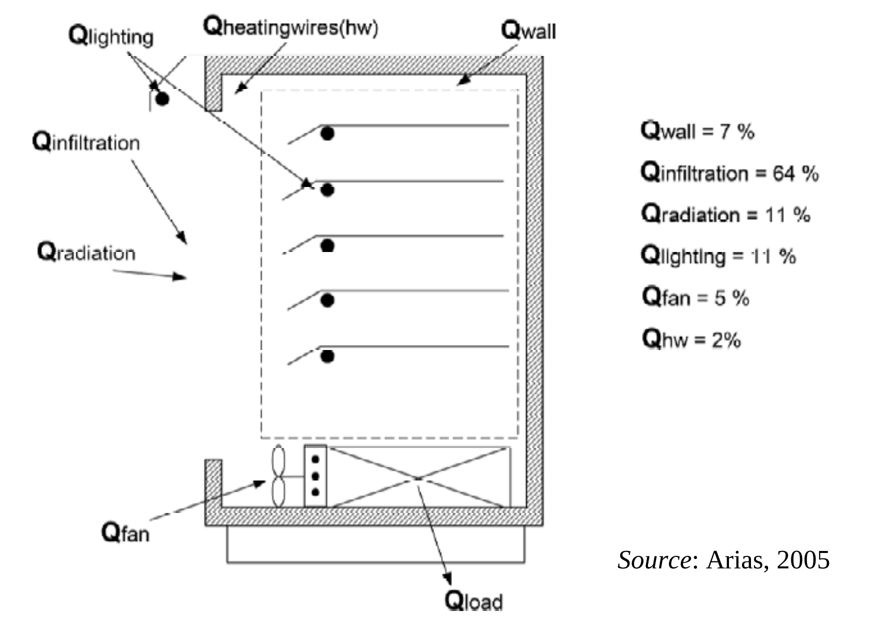


(*) Also fan or pump speeds at a, c and d
NB: The location of the measure in the refrigeration cycle (a, b, c, d, e) is shown
Source: Rhiemeier et al., 2009

Figure 2.41: Refrigeration energy saving measures and associated energy savings

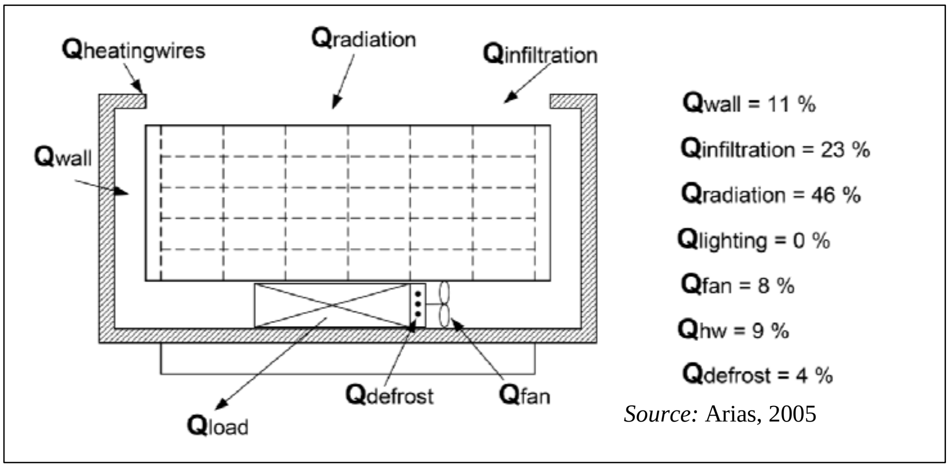
The interaction of the display cases with the surroundings is the most important aspect. As observed, the covering of cabinets achieves a maximum energy saving of 40 % of the refrigeration electricity consumption. The air humidity of the store, which gives condensation and frosting problems in cabinet walls, and store lighting, which increases the heat gain, are also very important interactions.

The thermal balances in the surrounding of open vertical and horizontal display cases for medium temperature, MT, and low temperature, LT, are shown in Figure 2.42 and Figure 2.43.



Source: Arias, 2005

Figure 2.42: Energy balance of an open vertical display case



Source: Arias, 2005

Figure 2.43: **Energy balance of a horizontal display case**

The refrigeration load has to compensate for a significant amount of external heat gain to maintain the operating temperature inside the display case. The number of opportunities to save energy at the display cases is very high. The most evident saving opportunity is the installation of doors or lids to avoid the infiltration of air, which is the highest heat gain in vertical cabinets (64 %) and also very important for horizontal display cases (23 %). The infiltration of heat is comprised of latent heat, due to condensation and dependent of store humidity, and sensible heat, dependent of the temperature inside the store.

The installation of glass lids in horizontal chest freezers is currently a common practice, as it is being implemented in many retailers. Although the ratio of heat loss is not high, 23 %, the amount of heat for low temperature devices pays back these glass lids. Also, heat gain through radiation can be avoided with thin metal layers on the glass doors. The opening frequency is a key factor with a very high influence on the performance of these freezers. Usually, a sticker indicates to the customer to choose the product before opening the door. An example is shown in Figure 2.44 .

Figure 2.44: **Vertical and horizontal freezing display case with glass doors (with a sign saying 'Please choose first, then open')**

For MT refrigeration, many retailers apply night covers for open cabinets. Nevertheless, the application of glass covers is far from being common practice. Retailers are aware of the achievable savings but the costs balance is not acceptable for most of them. Also, for some retailers, covering with glass doors of MT cabinets does not produce important savings (less than 10 %) due to the high opening frequency. The efficiency reduction of food loading would also be affected. Then, the payback time may be far from acceptable. In addition, the sales may be affected, as a barrier is placed between the consumer and the product, which can reduce the turnover of the store. But this seems to be far from the accomplishments of some retailers. Royal Ahold (Albert Heijn), in the Netherlands, decided to close with glass doors all the vertical cabinets for MT and all freezing display cases (Versteegh, 2010). Achievable savings are 20 % of the refrigeration energy consumption. In 2010, they retrofitted 250 out of 850 stores with doors in front of wall cabinets and they expect to retrofit 100 % of stores by 2015.

Figure 2.45 shows an example of normal refrigeration covered display case with glass lids. There is no evidence of the negative influence of glass doors on the turnover of a supermarket. Studies for closed chest freezers revealed that after a short adaptation period (one to two weeks) sales figures are the same as with open freezers. Achieved savings are high, about 40 %, and the economic behaviour of the measure justifies its application. For MT, with higher sales volume, a high opening frequency is expected. But, following the diagram shown in Figure 2.42, the theoretical energy savings are close to 70 % (Arias, 2005; Rhiemeier et al., 2009), so the benefit can be very great. Also, some retailers have detected some benefits from increased comfort and the impression given to consumers of better food preservation.

Figure 2.45: Vertical refrigerated display case with glass doors

The high lighting intensity focused on the refrigerated products is also an important source of heat gain in display cases. A differentiation between internal lighting and external lighting should be made: spotlights inside a display case are major sources of heat to be removed and can have a negative impact in the conservation of a product. Heat gains and health risks should be avoided, if possible, by removing the internal lighting system. If it is not possible, low energy solutions, like LED, should be used. Basic store lighting is unavoidable: the optimisation of the lighting system of the store (for example, the introduction of daylight and the use of low power density lighting) would be recommendable (see Section 2.1.6.7).

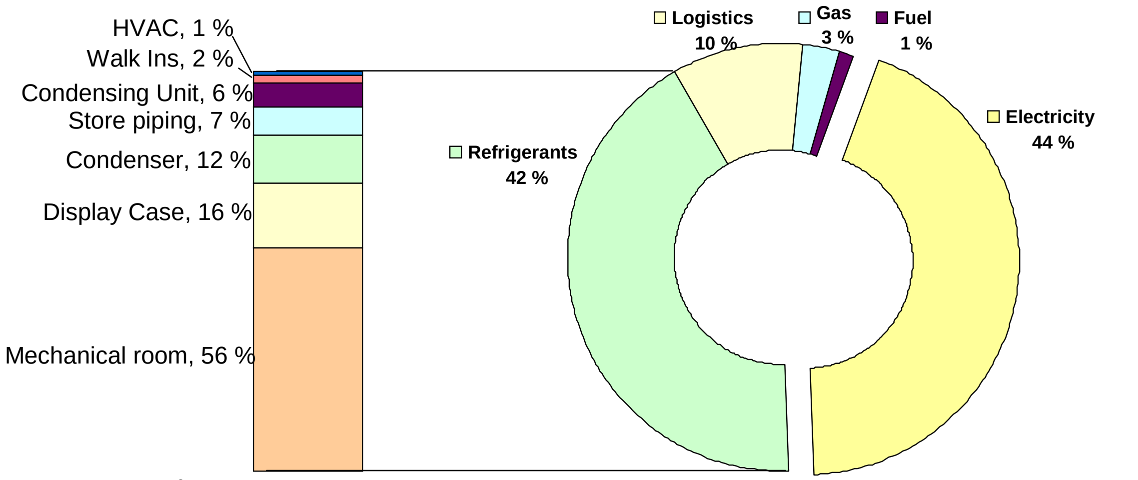
Other heat sources are less important and sometimes unavoidable. For example, heating wires to avoid condensation are often needed. Innovative surface layers can avoid the use of heating wires, but make the system more expensive.

The covering of display cases can change the heat balance within a store. Air conditioning design usually depends on the amount of coldness coming from the display cases. Good practitioners do not feed cooled air to the refrigeration zone and, usually, pump air from the refrigeration zone to other places in order to save energy in the space cooling system. Figure 2.46 shows the outlet air conduction to the ventilation system in a real example. When closed, the surroundings of the cabinets also need air conditioning and the 'coldness' gain is much lower. This would result in the redesign of the space cooling system due to a slightly higher demand. However, the overall energy balance would be positive. Also, the air inside the cabinets, which needs to be refreshed at a certain rate to avoid condensation, can be fed to the space cooling system.

Figure 2.46: Air duct from a refrigeration display case to the ventilation system

Use of cleaner refrigerants

The environmental impact of refrigerants has been a very important environmental concern since their potential for ozone depletion was discovered (chlorofluorocarbons, CFCs). Current regulations are highly strict with the use of ozone depleting refrigerants and currently used substances cause a low or zero impact on the ozone layer, but with a great GWP, especially hydrofluorocarbons – HFCs, such as R404a and R134a. The carbon footprint of commercial refrigeration systems associated with refrigerant leakages and disposal is very important.
Figure 2.47 shows the breakdown of the refrigerant contribution to a company carbon footprint.



Source: Carrefour, 2010 and Rhiemeier et al., 2009
NB: Left column shows the different locations of refrigerant leakages.

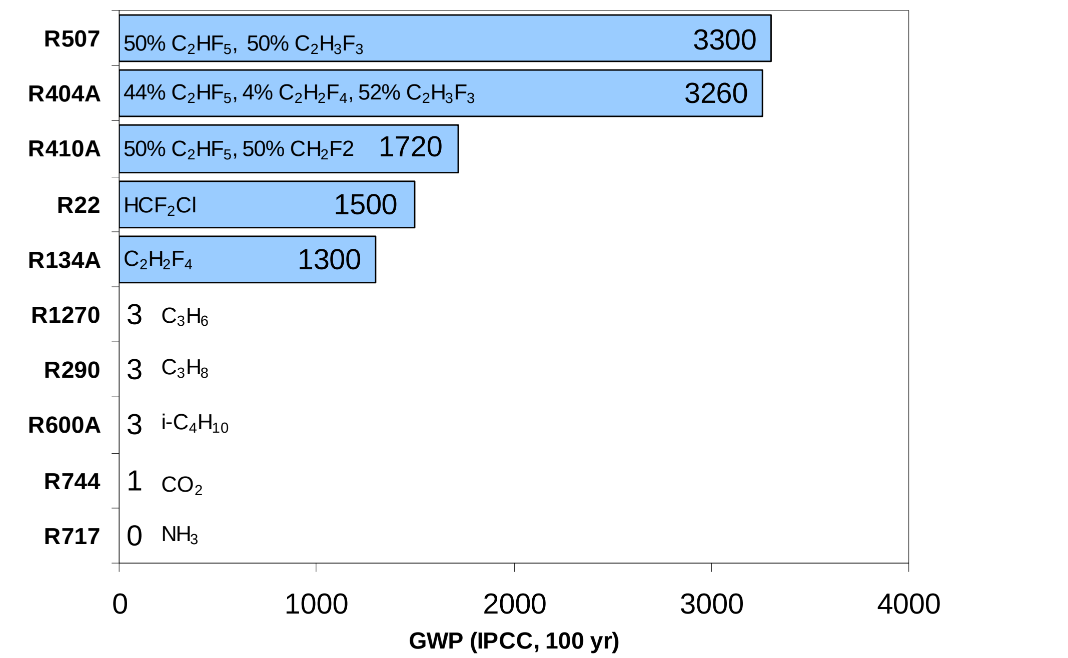
Figure 2.47: Carbon footprint breakdown of a typical retailer operation

Currently, the amount of leakages from refrigeration installations can significantly vary: it depends on the amount of fittings, maintenance practices, the complexity and operational conditions such as the compression ratio. Modern installations avoid screw joints, but they still have leakages which are produced from many small points and, therefore, leakage prevention is more difficult. The magnitude of leakages can vary from 5 to 10 % of the refrigeration charge.

A highly-tightened installation requires high investment and high operating costs. Many retailers are switching to non-harmful refrigerants. Rhiemeier et al., 2009, give a list of ideal specifications of refrigerants:

- zero ozone depletion potential
- low global warming potential
- high energetic efficiency:
  - high capacity for heat transfer
  - high heat conductivity
  - low viscosity
  - low pressure ratio condensing to evaporating pressure
  - low pressure drops in piping
  - high efficiency during compression
- chemically stable
- inert
- high dielectric strength with hermetical compressors
- non-flammable
- non- toxic
- non-corrosive
- inexpensive
- compatible with the refrigeration system's materials
- high heat of evaporation in relation to specific volume at compressor suction
- evaporation pressure above 1 bar (prevention of air entrance in leakages)
- freezing point below evaporation temperature
- condensing pressure below 25 or 32 bar
- good solubility with lubricants
- easily detectable for leak detection.

There is no refrigerant that fulfils all these requirements. Regarding the environmental impact, most retailers are implementing natural refrigerants. These are naturally occurring substances, such as hydrocarbons (propane, iso-butane), CO_2, ammonia, water and air (PSD, 2010). Their ozone depletion potential is null but also their GWP is very much reduced when compared to HFC and other refrigerants (Figure 2.48).



N.B: (CHFCs:R507, R404A, R410A, R134A, HCFCs: R22. HCs. R1270, R290, R600A and natural refrigerants CO_2 and NH_3)

Figure 2.48: Global warming potential of several commercial refrigerants

As shown, natural refrigerants have the lowest environmental impact and their use is commercially available. Hydrocarbons (HCs) have to be used in indirect cycles due to their flammability. They have very good physicochemical properties as refrigerants in comparison to HFCs. Secondary heat transfer fluids have to be used to reduce risk. Also, ammonia can be used only in indirect systems, due to its toxicity. The coefficient of performance, COP, of the ammonia refrigeration cycle is usually higher than from that of other refrigerants.

Carbon dioxide has excellent properties as refrigerant but two main drawbacks define its performance:

- The critical temperature is 31°C. For heat sink temperatures higher than 25 °C, the operation would be transcritical and the COP would be reduced.
- The saturation pressure at normal working temperature is very high if compared to other refrigerants. For MT refrigeration, it is higher than 100 bar (10 times higher than the pressure range of other refrigerants).

The high pressure of CO_2 cycles is a technical concern but has been solved. The high volumetric refrigeration capacity of CO_2 overcompensates the energy balance: less mass of CO_2 is needed to cool, so smaller compressors and smaller pressure ratios are needed. The overall energy consumption of CO_2 refrigeration systems is usually lower than for other refrigerants. In fact, many retailers have retrofitted the LT refrigeration to CO_2 cycles in a cascade combination with other refrigerants. MT cycles are currently being installed, although the relatively high pressures and the strong dependence of COP on ambient temperature is still a barrier for their implementation.

Figure 2.49 shows how the ambient temperature influences the coefficient of performance of refrigeration installations (Haaf, 2002). In that Figure, the assessed systems use CO_2 or R404a as the only refrigerant (direct refrigeration cycle) for low and medium temperature. For the lowest temperatures, the COP is even higher for CO_2. For intermediate temperatures (14–28 °C), the COP would be very similar. For the transcritical cycle, the COP is lower for CO_2. The authors of the study proposed the use of an additional cooling mechanism for the condensers, such as a water spray system, to enable application in warm climates.

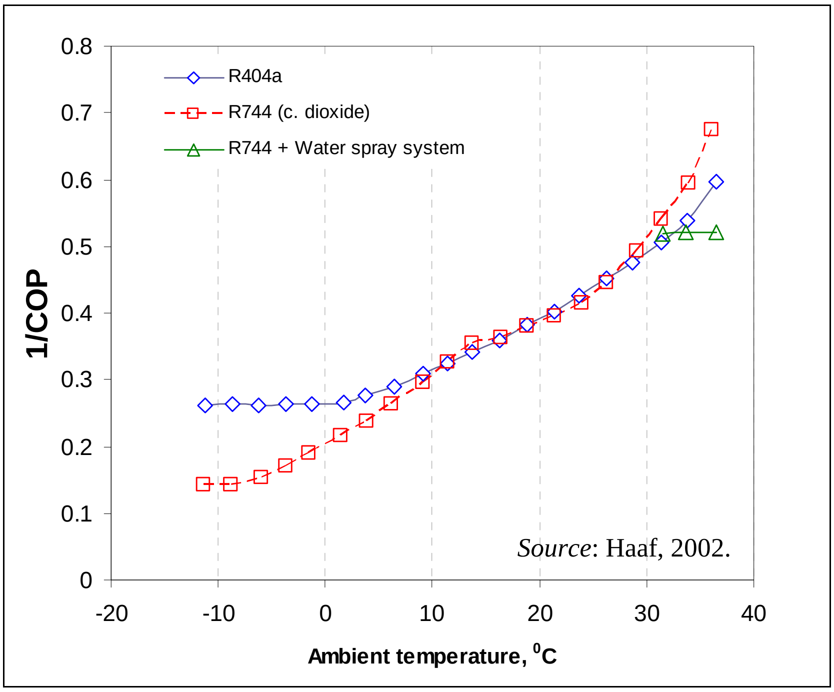


Figure 2.49: Comparison of energy consumption of direct evaporation refrigeration systems (CO_2 and R404a)

The performance of CO_2 installations depends on many factors, so comparison with HFCs and other systems should be performed with caution. Usually, the use of CO_2 reduces the specific consumption of display cases: Figure 2.50 shows a random distribution (with a disclosed average and standard deviation) of the specific consumption of refrigerated cases (measured as kWh per metre and year) for the overall performance of a number of stores in central Europe, with similar ambient temperatures, and sampled CO_2 refrigerated stores. No differentiation between MT and LT is provided.

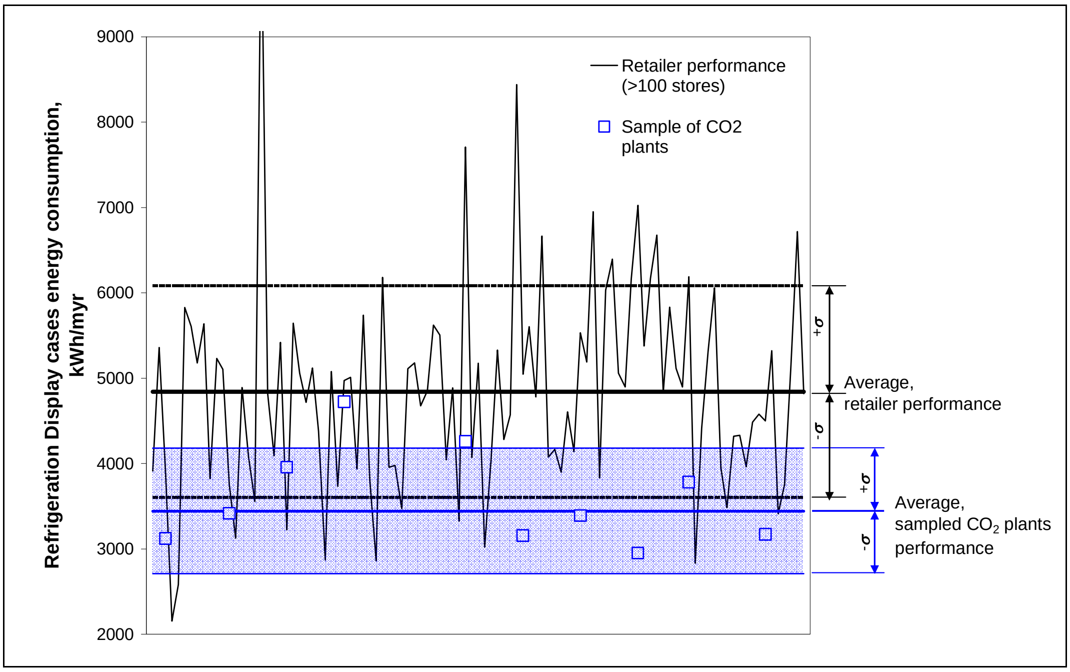


Figure 2.50: Random distribution of specific energy consumption of refrigeration plants in a retailer's division, located in central Europe, and sampled CO_2 plants performance

Carbon dioxide as refrigerant seems to be the choice of Migros, in Switzerland, which has implemented more than 150 CO_2 installations (47 transcritical cycles for MT refrigeration and 105 supercritical for LT) out of around 600 sites.

Achieved environmental benefits

Good energy management and the appropriate energy saving measures always produce an important environmental benefit, since the carbon footprint of the company is reduced and the consumption of resources is also decreased. Covering existing open cabinets for medium or low temperature produces 20 % of savings, although the achievable savings can reach 70 % of the refrigeration electricity consumption. In addition, for new stores, 20 % less power for compression is needed because of the lower energy losses in the cabinets.

In the case of the refrigeration installation, the balance of cleaner refrigerants and energy consumption should be assessed. For example, the use of secondary fluids with natural refrigerants like ammonia or hydrocarbons can drastically reduce the associated carbon emissions. However, the energy consumption will be higher. Integration of heat recovery and the use of cleaner sources can improve the results of these systems. Arias, 2005, made an interesting balance regarding this issue. On the one hand, an estimation of the energy consumption of a 2700 m^2 store with R404a direct system and heat recovery was performed. On the other hand, the same system was also assessed with an R404a indirect system with a water-glycol mixture as heat transfer fluid and heat recovery. The TEWI method was used to evaluate the GHG emissions associated with both systems. The TEWI method evaluates both indirect (due to energy consumption), and direct emissions (due to refrigerant leakages and fuel combustion). Table 2.19 shows the results of the energy balance for the 2700 m^2 store with both direct and indirect systems.

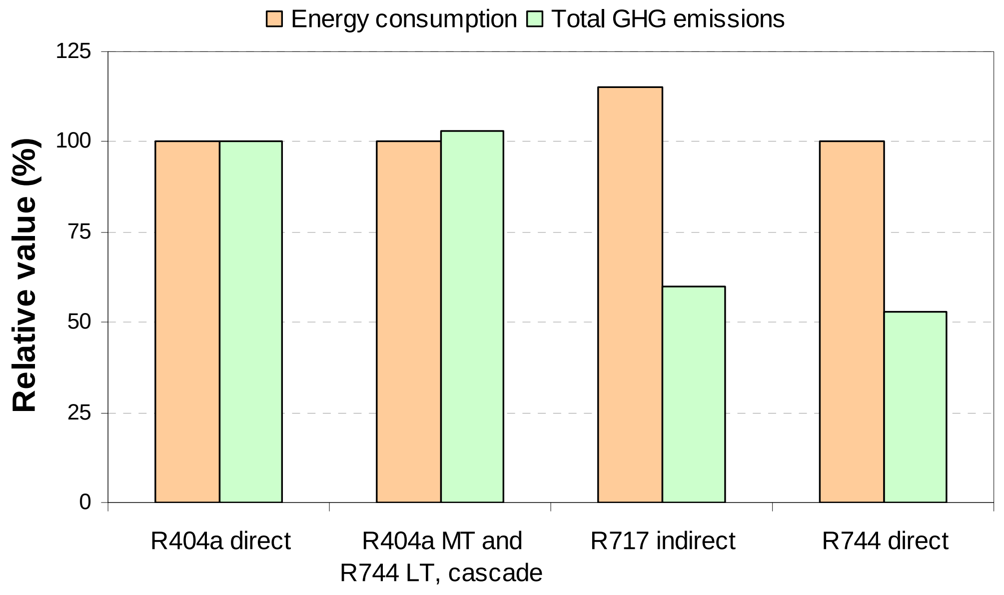
Table 2.19: Energy consumption of direct and indirect refrigeration systems and TEWI calculation

	Unit([1])	**Direct system + heat recovery**	**Indirect system + heat recovery**
Space heating	kWh/m^2	14	17
Space cooling		1	1
Refrigeration system		**180**	**188**
Other		180	180
Total energy cons.		**375**	**386**
Direct GHG emissions from refrigeration	kg CO_2 eq. $/m^2$ ([2])	70	8
Indirect GHG emissions from refrigeration		70	73
Total GHG emissions from refrigeration		**140**	**81**

([1])Balance per square meter of sales area
([2])Calculated with an average emissions value of 0.39 kg CO_2 per kWh (Europe).
Source: Arias, 2005, and own elaboration

The achieved environmental benefit is high, although the energy consumption is slightly higher. Avoided emissions sum to 60 kg of CO_2 per square metre of sales area (around 80 % from direct emission). The main contribution to this environmental benefit is the less R404a piping needed for indirect systems, so leakages are drastically reduced. In the case of energy consumption, the store actually recovers heat from the refrigeration cycle and, therefore, the energy consumption is highly reduced from the system without heat recovery.

The retrofitting of refrigeration systems usually do not lead to a higher energy consumption profile. In fact, the use of natural refrigerants would lead to zero indirect emissions and to lower energy consumptions. Usually, the system does not work at optimal performance before retrofitting. Rhiemeier et al., 2009, give several examples of this kind of refrigeration system. Figure 2.51 shows the relative energy consumption and GHG emissions of different systems.

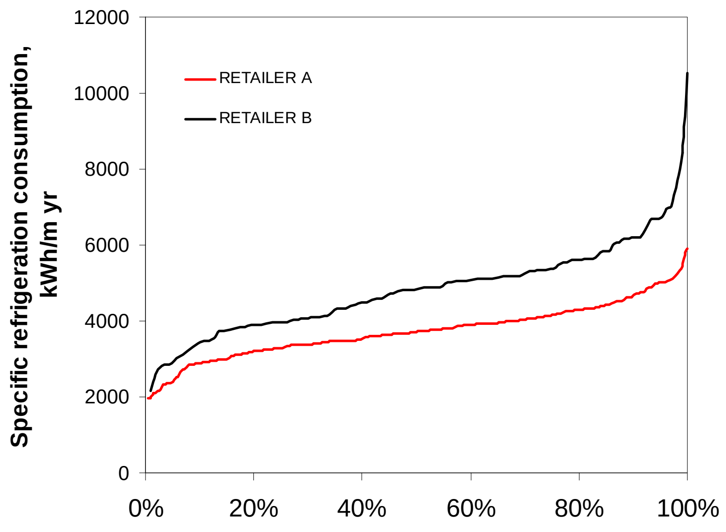


N.B: R404a direct = 100 %

Figure 2.51: Relative energy consumption and greenhouse gas (GHG) emissions for different supermarket refrigeration systems

The results shown are not intended to express a quantitative behaviour, as the systems depend on many external factors, but to indicate the potential of natural refrigerants in a qualitative manner. The initial situation of a system to be retrofitted is not the optimal (the case of R404a first case in Figure 2.51 is an optimal design) and the change to a more environmentally-friendly system usually produces great savings, apart from reducing drastically the carbon footprint.

A good management of refrigeration systems also produces great savings. Good maintenance and monitoring practices, combined with a restrictive energy policy in the company would lead to situations like that shown in the cumulative distributions of refrigeration energy consumption shown in Figure 2.52. These data belong to real retailers operating in a region on central Europe.



NB: Retailer A: 105 stores; Retailer B: 221 stores

Figure 2.52: Cumulative energy consumption distribution of two real retailers (central Europe)

Retailer A operations consume much less energy than retailer B. Good management practices of retailer A can be proved with the lower slope of the red line of the chart, as refrigeration energy consumption of different stores tend to the average value of the distribution. Comparing one retailer to another, achieved energy savings sums more than 1000 kWh/m or 100 kWh/m^2 of sales area (per year).

Appropriate environmental indicator
As seen in previous sections, three main indicators are used to measure the environmental performance of refrigeration systems:

- specific energy consumption, measured in kWh/m2yr
- specific refrigeration linear energy consumption, measured in kWh/m yr
- refrigerant leakages, % or kg per year
- carbon footprint, kg CO_2 per metre of display cases or per square metre of sales area.

The specific energy consumption is already described and is the recommended indicator for any process within the store. In this case, other specific indicators are used by the sector. The **specific energy consumption of the refrigeration system** refers to the length, usually measured in metres, of display cases. This indicator takes into account the efficiency of the system and it reflects the influence of refrigeration on the energy performance of the store, as shown in Figure 2.53. To convert this indicator to energy consumption per square metre of sales area, the length of refrigeration display cases per m^2 is needed. More frequent values for supermarkets vary from 40 to 100 m/1000 m^2. As many retailers also have refrigerated rooms, a correction from area to length should be performed.

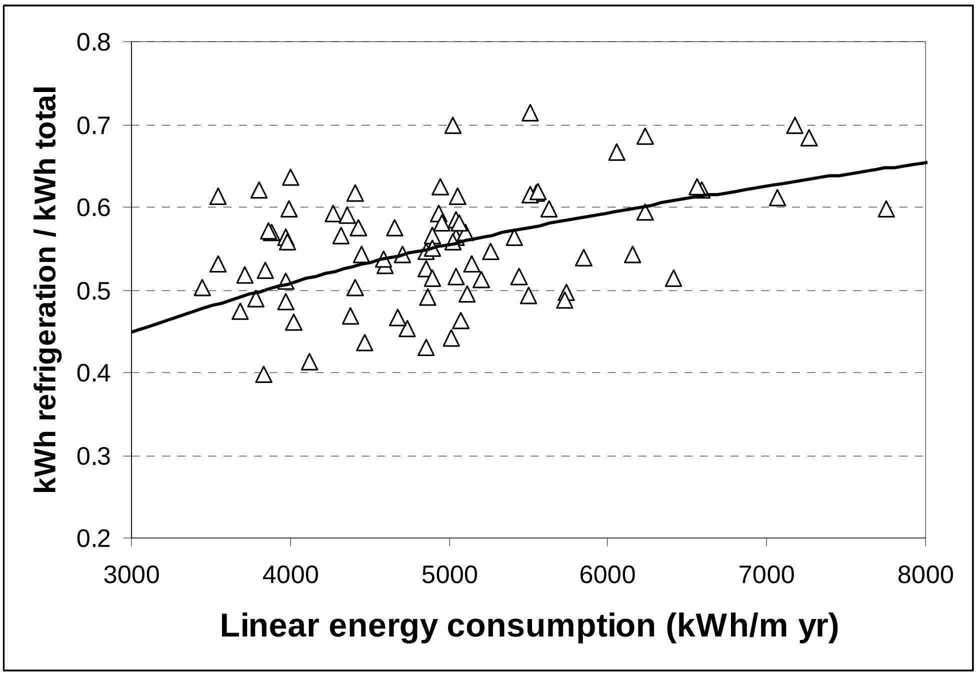


Figure 2.53: Contribution of refrigeration to overall specific energy consumption vs. linear energy consumption of refrigeration cabinets in 100 stores of a regional division of a retailer in central Europe

Refrigerant leakages are also quite important to control within the refrigeration system, as they are responsible for an important amount of CO_2 emissions. Retailers control this parameter as the total amount of purchased refrigerant to refill the installation, in kg per year. The tightness of the refrigeration installation can be controlled with the percentage of leakages referring to the total amount of refrigerant. The use of natural refrigerants would make this indicator less useful to assess the environmental performance, as the GWP of natural refrigerants is negligible.

The **carbon footprint of the refrigeration system** is the amount of emitted GHG referring to equivalent CO_2. The TEWI method has to be used, as direct GHG emissions are produced in the refrigeration installation. The TEWI describes the sum of indirect emissions, due to energy consumption, and direct emissions caused by installation leaks. The DIN 378-1 method, as described by Arias, 2005, has been used to calculate the total impact:

$$TEWI = GWP \cdot L \cdot n + GWP \cdot m \cdot (1-\alpha_R) + n \cdot E_a \cdot \beta$$

where

TEWI	Total Equivalent Warming Impact, kg CO_2
GWP	Global Warming Potential (mass of CO_2 with the same impact potential as 1 kg of substance)
L	Leakage rate (kg/yr)
n	Operating time, yr
M	Refrigerant charge, kg
α_R	Recovery fraction of refrigerant before disposal
E_a	Energy consumption, kWh/yr
β	CO_2 emissions from consumed energy life cycle.

An example of the TEWI calculation is shown in Table 2.20.

Table 2.20: Example calculation of TEWI for a refrigeration system

Refrigerant	R404a
Installation	Direct / Highly tighten
GWP	3260 kg CO_2eq / kg R404a
L	0.012 kg R404a / m^2 yr
n	1 yr
m(15 years)	0.013 kg R404a / m^2
α_R	0
E_a	200 kWh / m^2 yr
β	0.4 kg CO_2 eq / kWh
GHG emissions due to refrigerant leakages $GWP \cdot L \cdot n$	39.1 kg CO_2eq / m^2
GHG emissions due to refrigerant disposal $GWP \cdot m \cdot (1-\alpha_R)$	42.4 kg CO_2eq / m^2
GHG emissions due to refrigerant disposal $n \cdot E_a \cdot \beta$	80 kg CO_2eq / m^2
TEWI	**161.5 kg CO_2 eq / m^2** (≈2000 kg CO_2 eq / m)

Cross-media effects

For some natural refrigerants, the reduction of the carbon footprint actually increases the energy demand of the refrigeration cycle as secondary refrigerants are already used. Although the balance is still very positive from the environmental point of view, an optimised design concept should avoid the increase of the energy demand.

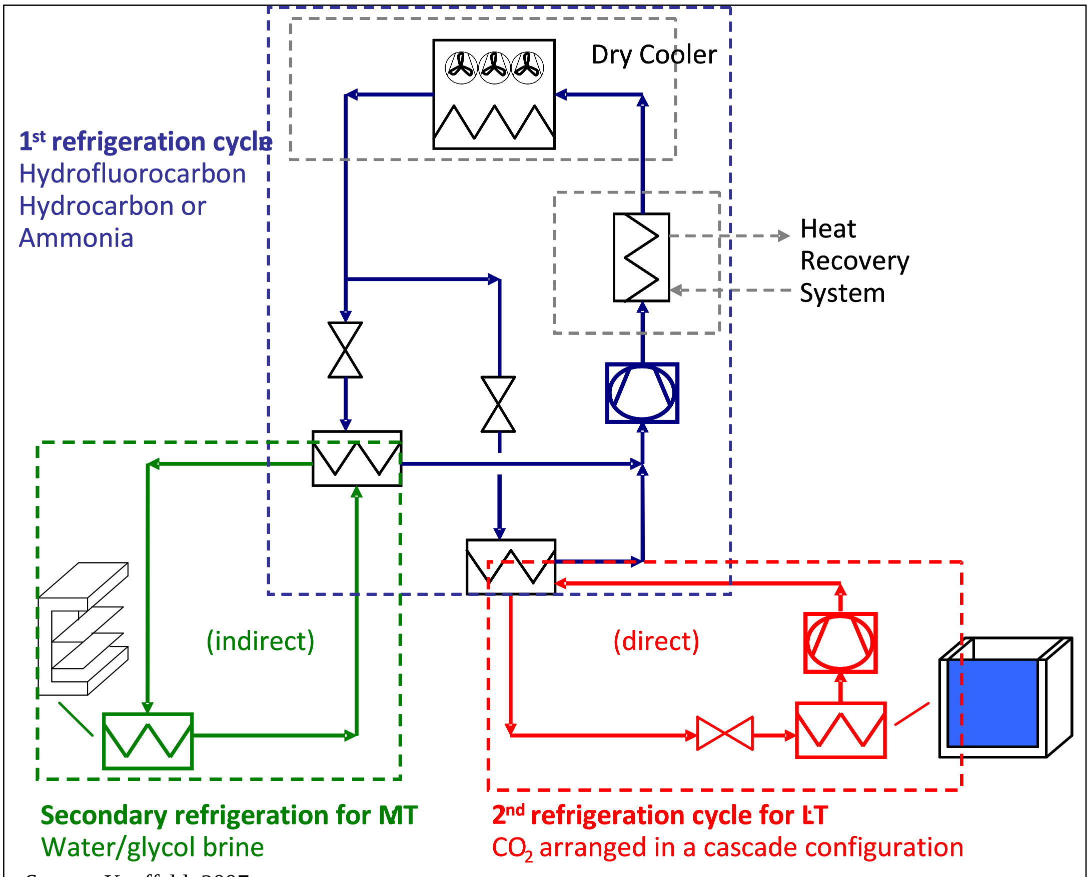
The Heating, Ventilation and Air-Conditioning (HVAC) system of the store can be affected by the covering of display cases. Open cabinets release cool air to the surroundings and reduce energy consumption of the space cooling system in summer. However, for winter periods, the space heating system has to compensate the heat loss caused by the cooling furniture. When the cabinets are covered, the space air cooling can become undersized, while the space heating oversized. The disrupted thermal balance of the store can also cause moisture problems, leading to condensation on glass lids. Therefore, integral approaches are required and not single measures. Here, the building and HVAC systems are also key factors.

Operational data

The shift to a more environmentally-friendly refrigerants requires extensive changes to the store infrastructure, including piping, materials, compressors and other accessories that are not compatible from one refrigerant to another. Many interesting options have been observed across many retailers in Europe. Most of them are being implemented in new stores, while existing stores are usually retrofitted because of legal requirements or major renovation.

The options preferred by many retailers are detailed below:

- CO_2 as the only refrigerant for LT and also for MT. High pressure operation in the transcritical cycle is required and the influence of climate conditions is quite important.
- CO_2 for LT. It has a high yield when included in cascade systems. The refrigerant for medium temperature is still an HFC, as R134a or R404a, in a high tightened installation. Although the technical performance can be optimal for this system, the use of HFC still has a high GWP and this option is not environmentally recommendable.
- CO_2 for LT and indirect system for MT. An example is shown in Figure 2.54. The first refrigeration cycle can still use HFC refrigerants, but in this case, the use of natural refrigerants is more feasible. A water/glycol brine or other thermal fluid could be used.



Source: Kauffeld, 2007

Figure 2.54: Indirect refrigeration for MT and cascade arrangement for CO_2 as the refrigerant for LT

For the different energy saving measures affecting the refrigeration installation, many technical options are available. As a general rule, an integrated approach is needed, as the change of one element can provoke new unknown situations and problems to be overcome. The most interesting example of the need for an integrated approach is the use of glass covers for refrigeration cabinets. The change from uncovered to covered cabinets actually removes a stream of cool air fed to the store, so the heating system would consume less energy in winter and the air conditioning system could be undersized for summer needs. Open cabinets also often act as humidity sinks as they cool fresh air and remove part of the water content in the air by condensation. If the cabinet is closed, air losses from cabinets are much lower and the water balance is drastically affected.

The problem of space cooling in summer can be very important. As an example, Figure 2.55 shows the humidity and the temperature chart for 21 days of a store in one month in summer. As seen, the implementation of glass doors in the refrigeration equipment affects the water content in the air and the humidity is increased by about 20 %. This will undoubtedly lead to condensation over the glass panes and maybe also over the products. The thermal balance of the store is also affected. As seen in Figure 2.55, the temperature control is also affected as the lack of a cool air stream causes the air conditioning system to be undersized. The average temperature inside the store is increased and the indoor environment can be uncomfortable for customers.

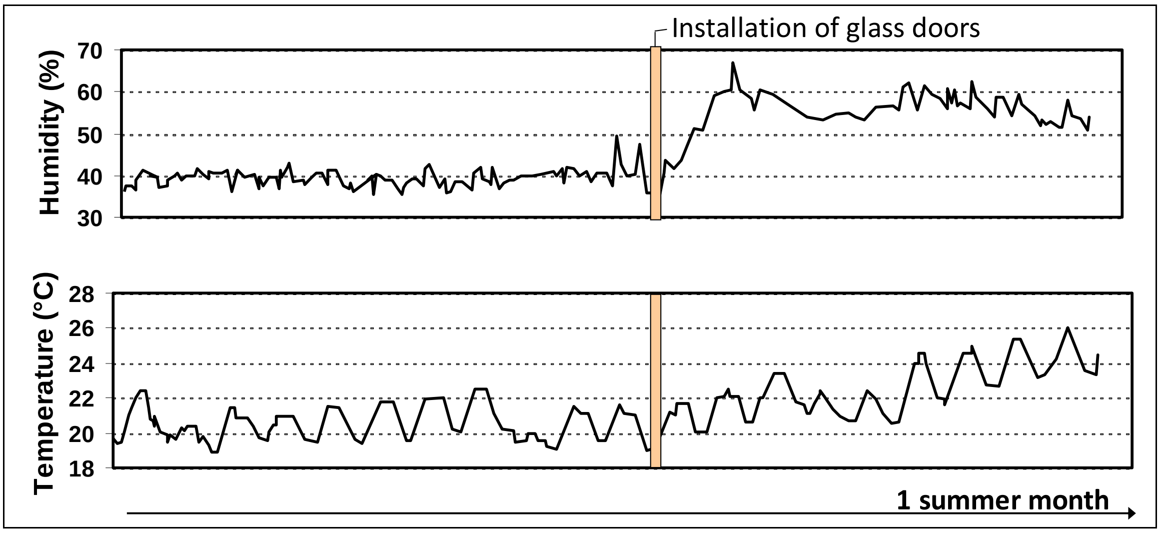


Figure 2.55: Humidity and temperature charts for a store in a 21-day period with and without glass doors in the refrigeration display cases

Retailers across Europe previously test this kind of measure in several stores to gain knowledge of the systems. To achieve best performance, information and knowledge sharing among all the Retail Trade sector stakeholders is highly recommended.

Applicability

The measures proposed in this section are applicable all over Europe and for new and existing stores. The engineering approach can change a lot from southern to northern countries, but the main concepts explained in this document are applicable to any climate condition. In fact, the will to reduce the use of HFC refrigerants should not be affected by the climate. The design concepts for some of the energy saving measures, such as glass covering of display cases, also highly affects the store thermal and moisture balance, which is also affected by the climate.

Technical feasibility and environmental behaviour of the proposed measures do not change for existing stores, but the payback time for existing stores is higher than for new ones and it can be longer than the desired value by the company. For new stores, the lower power needed for the refrigeration system also makes the energy saving measures more attractive, as less initial investment would be needed.

Economics

For the use of a cleaner refrigerant, the economic behaviour can not be measured in terms of payback time, as the whole installation will usually need to be changed. Taking the calculation process of Rhiemeier et al., 2009 for a specific store, the CO_2 abatement cost has been calculated for the foreseen leakages scenario in the application of the legislation. The reference system is a direct multiplex with R404a as the refrigerant. The results from a simple economic balance are shown in Table 2.21.

As shown, the main benefit of natural refrigerants is the abatement of direct emissions, which is very important (it reaches 47 % for direct R744 – CO_2 – refrigeration), while the energy consumption or the costs are quite similar. The investment costs proposed in Table 2.21 are derived from the references (Rhiemeier et al., 2009), while the electricity costs assumed are EUR 0.11/kWh. The CO_2 generation rate per kWh is the average value for Europe: 0.399 kg/kWh.

The use of CO_2 for LT in a cascade system with an HFC as the refrigerant produces the same GWP as the direct option with the HFC as refrigerant for LT an MT. There is a slightly lower consumption of HFC, but it is compensated for by the complexity of the cascade system, which makes the system consume more energy and be more expensive. These results differ from the study of the European Partnership for Energy and the Environment, EPEE (SKM Enviros, 2010), where an emission reduction of 17 % for the system R404a/R744 is calculated. Then, emissions would change from 229 kg of CO_2 to 188 kg and the costs for CO_2 abatement would be EUR 20.5 per tonne.

Table 2.21: Economic balance of several refrigeration installations

	Energy consumption	Total emissions	Total Investment costs	Annual Energy costs + maintenance	Total Annual cost	CO_2 abatement	CO_2 cost abatement
	kWh/m²yr	kg CO_2 /m² yr	€/m²	€/m²yr	€/m²yr	kg CO_2 /m² yr (%)	€ /tonCO_2
R404a dir	299	227	296	38	58	-	-
R404a/ R744dir	299	229	296	39	59	-2 (+1 %)	More CO_2 produced
R717ind	344	138	315	43	64	89 (-40 %)	71
R744dir	299	120	296	38	58	107 (-47 %)	0
Source: (Rhiemeier et al., 2009)							

For the energy saving measures in existing systems, the payback time seems to be a key element in the decision-making process. Generally, retailers do not accept payback times higher than 3 years for an energy saving measure to be applied. Nevertheless, energy savings have to be regarded as an environmental aspect of stores and not only as a term of the cost balance of retailer operations. So, more economic flexibility has to be given to the application of energy saving measures, as it is a real environmental aspect. For this document, an approximated analysis was performed for the covering of refrigeration display cases. The results are shown in Figure 2.56. As can be observed, the payback time is reduced when the energy savings are high, but there is a limit for the technical feasibility of the energy savings. Experts from retailers propose 40 % as the highest saving achievable. Royal Ahold (Albert Heijn) has obtained a value of 20 % of energy savings from the covering of their vertical display cases for LT and MT. To have less than 3 years of payback time, the cost for retrofitting has to be less than EUR 460 per metre of retrofitted display case. The obtained values fit well with the values shown in the references (Ligthart, 2007), where a payback time of 3±1 years is foreseen for 55 % savings at a door price of EUR 766/m.

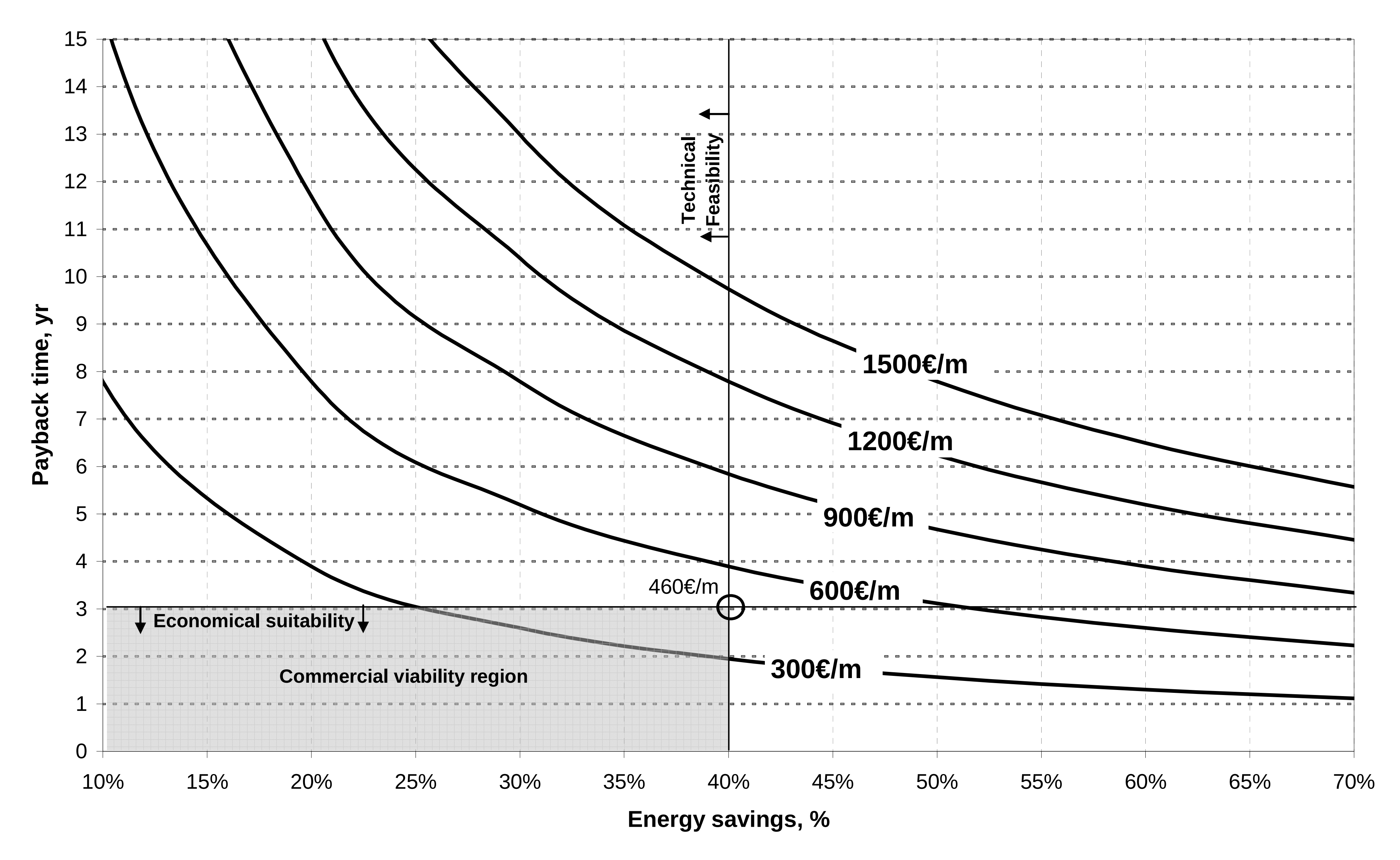


Figure 2.56: **Payback time vs. Energy savings for several retrofitting costs with glass lids on vertical pen refrigeration cabinets**

Driving force for implementation

The most important driving force for retailers is that the economic behaviour of the proposed measures produces cost savings. The best energy performance makes the company ready for future energy prices. In addition, retailers can improve their reputation through huge CO_2 savings. Also, fulfilment and going beyond future legal requirements is an important issue, as extra costs and resources can be derived from the lack of preparation to more restrictive regulations.

Reference retailers and stakeholders

Some retailers currently cover their normal refrigeration display cases, such as Royal Ahold (Albert Heijn) in the Netherlands. Many European retailers have already covered their chest or vertical freezers. The Swiss Coop has achieved great progress in terms of the achieved energy consumption of their refrigeration systems. For natural refrigerants, the market is currently moving on and very large companies, such as Ahold (NL), Carrefour (FR) or ALDI (D) are already implementing CO_2 refrigeration systems, although there is still a challenge for replacing HFC refrigerants.

For the refrigeration aspect, the role of suppliers is extremely important. Part of the information given in this chapter was provided by suppliers, such as Hauser (for covered cabinets) or Carrier (for CO_2 installations).

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2.1.6.7 Efficient lighting

Description

Lighting is a very important and sensitive aspect for products presentation at stores. The use of spotlights can improve the appearance of products and the general lighting concept of a store is usually connected to the retailer public image. Thus, the energy saving measures for lighting are limited to business and marketing aspects.

Generally, lighting is responsible for more than 20 % of the energy consumption in food retailers and more than 40 % for non-food retailers. The use of lighting inside a store is divided into two categories (Tenglemann, 2010).

- Natural light: it directly comes from the sun through store glazing. The orientation of the building, building surroundings and the availability of external light are the main factors affecting natural light systems. In addition, some retailers avoid the use of natural lighting devices because of their sales concept and, sometimes, to avoid unwanted gains of heat.
- Artificial light. Artificial lighting consumes a significant amount of electricity. Two types of artificial lighting have to be considered:
    - basic lighting: for store corridors, accesses, parking and general store lighting;
    - effect lighting: designed to produce a desired effect on a product. For example, a colourful effect for the liquor department, special low energy for refrigerators, spotlights to emphasise offers, etc.

In this section, a unique solution or measure for energy savings in the lighting concept is not given, but the description of several possibilities are provided.

<u>Lighting strategies and energy management</u>. A correct lighting strategy is able to produce significant energy savings (Philips Dynalite, 2010). The strategy for reducing lighting energy consumption should be included in the energy management system of the company: the energy policy and the energy objectives and targets should reflect the strategy for lighting as one of the most efficient measures to reduce lighting consumption. In addition, lighting should be considered one of the main sources of energy and costs savings. Philips Lighting (Philips Dynalite, 2010) gives some advice to set up a comprehensive lighting strategy with enhanced energy performance (Table 2.22).

Table 2.22: Lighting management concerns and energy-saving strategies

Strategies	Measures
Limit time of use: Eliminate unnecessary lighting energy use outside normal hours. Lighting that is not required can be switched off or dimmed.	Occupancy sensors, dimming, enhanced control, on-line systems
Optimise light output	Lamps efficiency upgrade
Design illumination	Grid relocation, de-lamping, illumination management control, occupancy sensors, step dimming
Daylight integration Enable sunlight to displace artificial lighting with sensitivity to occupants.	Dimming, occupancy sensors, daylight harvesting
Life-cycle operating costs Programmed lamp replacement is cost-effective	Maintenance
Enhanced lighting monitoring	Central control, online systems, maintenance
Low utilisation areas	Occupancy sensors, time control
Tariff sensitive control	Central control
Source: Philips Dynalite, 2010	

Definition of lighting strategy.
Lighting strategy should be defined in two ways.

- First: definition of lighting needs within the building. A disclosure of the light intensity across the store and the technologies used at each point are needed (LRC, 1997). For this aspect, the customer response, the economic balance and the environmental profile should be considered together. Two examples for a food retailer and for a non-food retailer are provided in Table 2.23.

Table 2.23: Disclosure of the specific lighting load for a food retailer and for a non-food retailer

Example 1. Food retailer		Example 2. Non-food retailer	
Section	**Load (W/m^2)**	**Section**	**Load (W/m^2)**
Whole store	23		
Grocery aisles	34	Stairs	5
Frozen foods	17	Entrance	10
Produce	16	Showroom	12
Meat	23	Restaurant	12
Bakery	23	Market hall	20
Florist	32	Warehouse	9
Checkout	31	Checkout	12
Food storage	12		

- Second: the lighting use profile. A well-controlled lighting system would optimise the use of lights by switching them off when not needed. This would reduce the need for light during the night time, during restocking or during special uses (LRC, 1997). Operational parameters should be carefully designed. The average load in use is not higher than 15 W/m^2. For the example 1 of Table 2.23, the profile of lighting use is shown in Figure

2.57. As shown, a daylight control system would allow for a considerable reduction in the energy consumption for lighting.

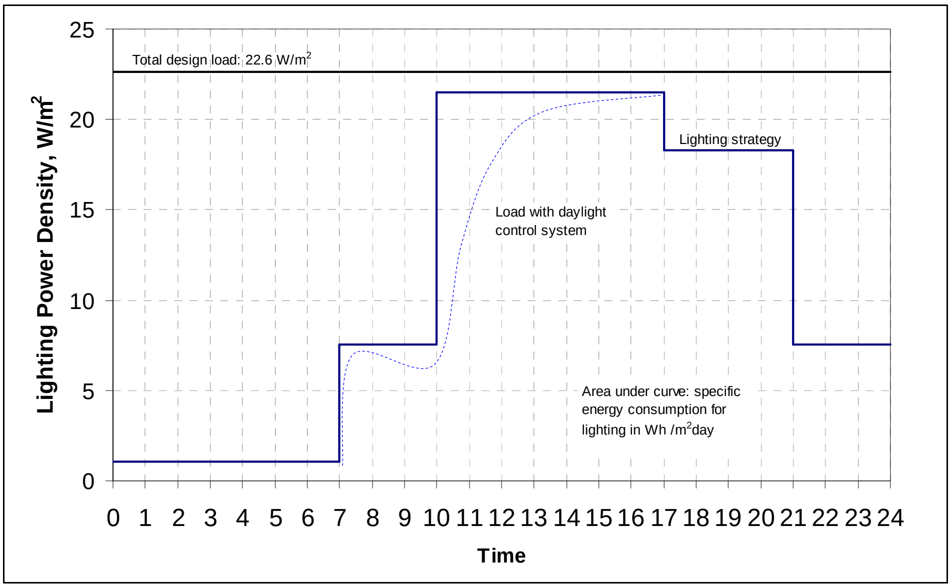

Figure 2.57: Specific lighting power, 24-hor profile

Daylight controlled lighting

If the building orientation allows for the use of natural light through the walls or through the roof, the installation of skylights and well insulated windows would produce an efficient light scattering, even independent of the type of light irradiation received (Tenglemann 2010). A central system is able to control the needed artificial light at different moments. In this system, daylight is considered to be a complement of basic lighting and should not be used for effect lighting.

There is an increasing interest in the use of skylights. The physical properties of the glass for this purpose have been improved and high insulating capacities are being used nowadays. Solar heat gain and light transmission are key factors to be optimised at the same time, as they usually have the opposite behaviour. A standard Insulating Glass Unit (IGU) consists of, at least, two glass panes, separated by a spacer and filled by air or by a special gas like argon.

For vertical panes, the heat transfer is performed by heat conduction (17 %), convection (17 %) and radiation (66 %). U-values (see Section 2.1.6.1) are around 1 W/m^{2}K for double glazing and gas filling, and around 0.6 W/m^{2}K for triple glazing. Nevertheless, the heat transfer through the glass can be increased by 50 % due to the increase of convection heat transfer. As shown in Figure 2.58, vertical gas filling has a slow natural convection process, but when these panes are shifted to a horizontal position, the heat transfer rate is increased due to the formation of many short and fast circuits.

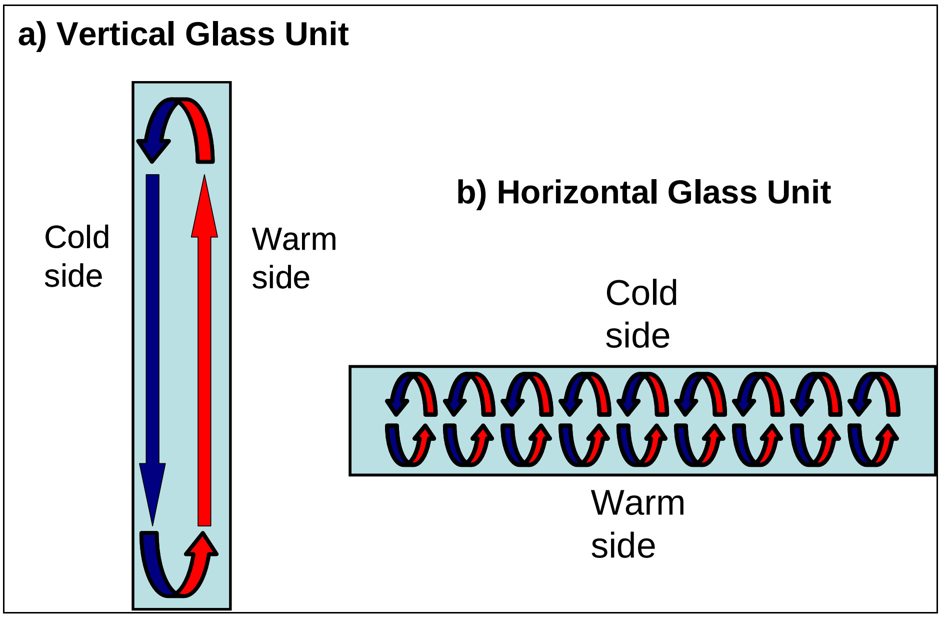

Figure 2.58: Vertical and horizontal natural convection flows in double glass panes

Figure 2.59 shows the variation of the U-value with the inclination of the window. For the horizontal configuration, the U-value can be increased more than 50 % for gas fillings. Best filling of panes for horizontal windows are aerogel and capillary slabs.

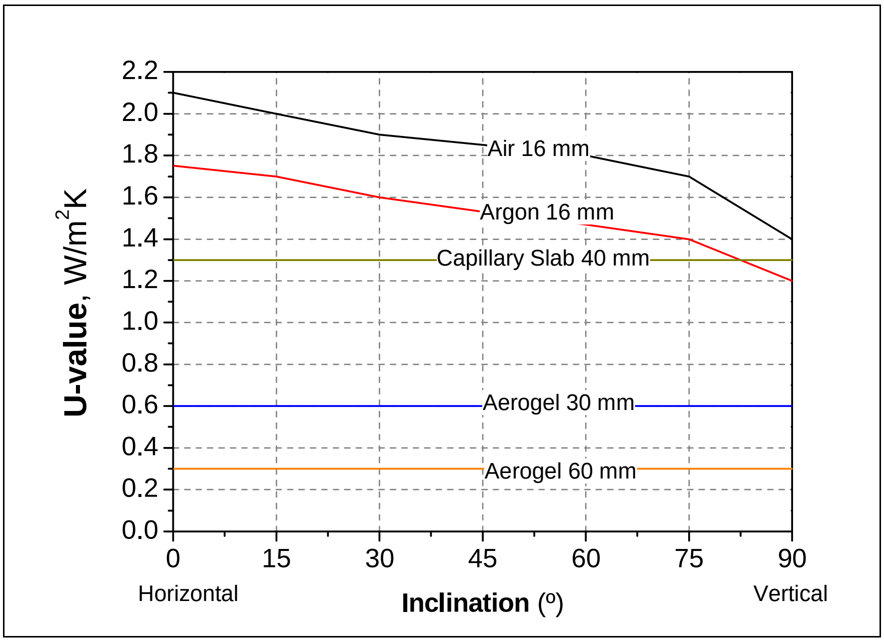

Figure 2.59: Dependence of the U-value on the inclination for different types of fillings

For aerogel filling, the U-value is the lowest for double pane, so the insulation capacity is really improved. In addition, the characteristics of this kind of pane for light diffusion are also good. The colour rendering index([18]) is maintained at 100 %. The use of translucent skylights increases the energy efficiency by reducing the overall consumption for lighting, while it

([18]) The color rendering index, CRI, is a quantitative measure of the capacity of a light source to reproduce accurately the colors of objects in comparison with an ideal light source prevents any disturbing glare. Also, the solar gain of this system can reduce the consumption of the heating system.

Efficient lighting

The reduction of energy consumption achievable by efficient or innovative lighting is about 50 % for supermarkets (without taking into consideration the lighting of refrigeration cabinets). The savings potential depends on the technology used and the renovation of the lighting concept that is being developed. Three concepts are very important in the design of an efficient lighting system.

- **Luminous efficacy** is the luminous energy perceived by the human eye, generated per unit of consumed energy. It is defined as the amount of luminous flux per installed light power. The unit is lumen (lm) and it is always based on light perceived by the human eye. This is a key concept in the design of the store lighting: taking into account the number of lumens per m^2 (i.e. illuminance) needed by the customer, the luminous efficacy of different devices would help in the minimisation of energy consumption. Illuminance, measured in lux or lm/m^2, is a measure of intensity of light (perceived by the human eye) that passes through a surface.
- **Colour Rendering Index**, CRI. It is essential for the correct presentation of products in the store. It should be maximized for that purpose. Also, the use of low CRI light sources with reduced energy consumption, as low pressure sodium lamps, should be applied for non-marketing aspects, as external parking or warehouses.
- **Lifetime.** This is also an essential aspect of lighting devices. The economic balance and the energy consumption for lighting are strongly dependent on the lifetime of devices. So, it would be a very important aspect for the maintenance and operation costs of a store.

Table 2.24 shows typical values for the luminous efficacy, CRI and lifetime of several lighting devices.

Table 2.24: Properties of several lighting devices

Lighting device	Luminous efficacy, (lm/W)	CRI	Lifetime, h
Incandescent tungsten	<20	~100	500–1 500
Fluorescent T12, magnetic ballast	<60	50-85	5 000–20 000
Fluorescent T8, electronic ballast	80–100	75-85	20 000–30 000
Fluorescent T5, electronic ballast	70–110	85	20 000–30 000
White LED, 4W	50–150	80	35 000–50 000
White LED, 13W, freezer application	50–150	70	35 000–50 000
Low pressure sodium lamp	100–200	5	<20 000

To achieve efficient store lighting, the specific power (W/m^2) should be minimised, maintaining a correct illuminance (lm/m^2 or lux) of the store. Relatively high illuminances should be avoided, daylight systems should be used and the illuminance of zones without impact in sales should be minimised. The installed specific power usually varies from 20 to 40 W/m^2. After retrofitting, the optimisation of the lighting system has lead to values even lower than 10 W/m^2 for several European stores.

After illumination optimisation, another important aspect is the selection of the lighting devices. There are a significant number of options and suppliers with enhanced technologies leading to the best efficiencies. Apart from the integration of natural light in the lighting control system and other technologies, preferred options are given below.

- Novel fluorescent technologies. T5 fluorescents with high performance (even higher than 100 lm/W) are being produced and are available. They are often used in the basic or general lighting of stores. Achievable lighting savings are high with these systems, the CRI is around 85 and the lifetime is usually higher than 20 000 h. The temperature dependence and the influence of on/off cycles in their performance are the main drawbacks of fluorescent systems.
- Light-emitting diode, LED. The development of LED lighting has been very significant in recent years. The performance of LED devices has increased exponentially. The lifetime of these devices is higher than for fluorescents and they do not depend on switch on/off cycles, so the maintenance costs are reduced. They do not generate infrared radiation, so they do not produce the amount of heat that incandescent bulbs produce. Nevertheless, they need to remove heat by conduction or convection and a heat sink is needed (DOE, 2006). In addition, the cost of LED is much higher than for other lighting options and LED emission tends to be directional.

The use of the different innovative technologies depends on the approach of each retailer. There is not a unique solution for the development of an efficient lighting system. In fact, many retailers are refusing to use LED for general or basic lighting because of the high costs associated with this technology. The use of novel fluorescent technologies is good enough to save a significant amount of energy in general lighting. On the other hand, LED does not generate heat as infrared radiation and it is becoming a very interesting option for lighting inside freezers and refrigeration cabinets. The energy consumption of the refrigeration system would be reduced as the heat gained from the lighting system would be negligible. The safety of the food preservation would also be increased, as less damaging radiation affects the refrigerated goods. In addition, the illuminance across the freezer shelves is more homogeneous. A study from Price Chopper (LRC, 2006) shows that optimized LED in freezers reduces the energy consumption while uniformity across the shelf is improved (Figure 2.60).

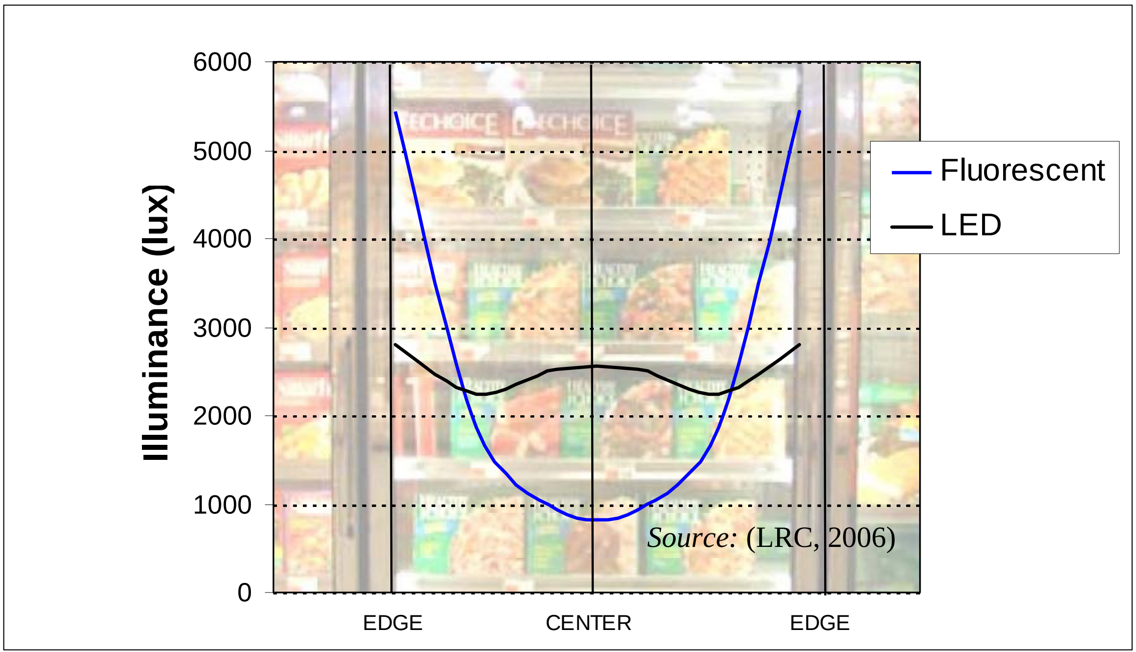

Figure 2.60: Average illuminances on freezer shelf

Achieved environmental benefits

The use of efficient lighting systems produces significant improvement in energy performance. Currently, there is no doubt about the great savings that innovative lighting system can produce in non-optimised stores. The attention is usually focused on the effect of the new system on sales and on the economic balance of the lighting system, which is not always considered acceptable. In some cases, customer satisfaction is also enhanced through improved illumination. In addition, the use of natural light has a positive effect not only on customer satisfaction but also on staff working in the store (Tenglemann, 2010). The achievable savings depend on the store configuration, store needs, sales concept and on the availability of resources. The influence of the retailer energy policy and the lighting strategy is also quite important in this respect. Table 2.25 shows three examples of retrofitted stores. Achievable savings are 50 % for the three cases.

Table 2.25: Energy savings from lighting system retrofitting

Retailer/suppliers	Store location	Average current lighting consumption	Applied techniques	Energy savings from initial situation
Tenglemann/Okalus, Philips	Mülheim, Germany	17 % of total consumption	Natural light LED at freezers T5 35W for basic lighting, etc.	Reduction of 50 % of lighting load
Unknown/Fobsun	Lyon, France	10731 kWh/yr (tested section)	Substitution of T8 with LED	Reduction of 50 % of lighting consumption
Migros/Unknown	Frauenfeld, Switzerland	Unknown	Substitution of T8 with LED, LED at freezers	Reduction of 50 % of lighting consumption

The fast development of new lighting systems is causing suppliers to be highly involved in the development of new innovative concepts. The retail sector is a very important client for developers, as very specific needs of this sector should be covered. So, more examples and information are given by suppliers. Philips and Osram are two suppliers who, among other projects, have retrofitted a great number of stores and achieved important energy savings in the lighting systems of retailers such as Sainsbury's, Edeka, Migros and Plus.

Appropriate environmental indicator

To monitor the lighting energy consumption of stores, the specific consumption per square metre of sales area and per year is an appropriate indicator. The calculation of the three elements of this expression (energy, sales area, time) has to be harmonised in order to obtain comparable measures. For the lighting of stores, technical performance indicators are also commonly used by retailers as they are quite related to the energy efficiency of these systems. The specific lighting power density, measured in W/m^2, is related to the energy efficiency of the lighting devices: two main technical parameters influence this indicator:

- the illuminance (measured in lux or lm/m2) is defining the lighting needs (influenced by commercial purposes), but has no environmental meaning;
- for lighting devices, the luminous efficacy, lm/W, is a very important parameter of lighting devices with a direct impact in the energy consumption of stores.

Cross-media effects

The reduction of energy consumption for lighting will produce great economic and environmental benefits. Nevertheless, lighting is also an important source of internal heat gains inside a store. The change to a more efficient system, with improved design and less heat production would affect the HVAC system. If the lighting and HVAC systems are retrofitted simultaneously, the design should take into account the new situation.

In addition, the use of a more efficient system and devices with higher luminous efficacy can produce unwanted glare to customers.

Operational data

The different approaches to reducing the lighting energy consumption usually agree on the main target: to reduce the lighting load with the increase of the luminous efficacy of installed devices. The identified best performers are new T5 fluorescents and LED technology. Similar performances are achievable with them. A recent study (Qin et al., 2009) has shown that LED is even worse in heat dissipation and real efficacy than T5 fluorescents. Some results from this study are shown in Table 2.26.

Table 2.26: Luminous efficacy and heat dissipation of lighting devices

Parameter	18W T8 fluorescent lamp	14W T5 fluorescent lamp	1W LED	3W LED	LED
Rated efficacy (lm/W)	61.1	96	45	40	107
Measured efficacy (lm/W)	60.3	96.7	31	30	78.5
Heat dissipation factor	0.77	0.73	0.9	0.89	0.87

Although the results from the aforementioned study point to the best performer as being the T5 fluorescent lamp, LED still has huge improvement potential. In fact, the efficacy of these systems has grown exponentially during recent years. The performance of such devices is affected by many factors, such as ambient temperature or the on/off cycles. On the one hand, T5 fluorescents do not work properly under low temperatures and are seriously affected by on/off cycles. On the other hand, LED is performing better at low temperatures, does not lose heat as infrared radiation and is not affected by on/off cycles. With these performances, retailers have decided to use T5 for general lighting and LED for very specific purposes, such as food illumination inside freezing cabinets.

Applicability

Lighting is a very sensitive aspect of retailing. Goods presentation is directly connected to sales and it is also part of the public image of retailers. Nevertheless, new lighting systems are more efficient, consume less energy and, in most cases, improve the lighting concept of stores. So, the application of new devices to existing or new buildings is only dependent on economic balances, as there is not any specific technical drawback for existing stores. Hundreds of existing retrofit kits for T5 or LED technologies are being commercialised. For example, screw bulbs with single LEDs inside are quite popular for changing existing incandescent bulbs. LED tubes in a T8 tube are also commercially available. T5 fluorescents to be adapted to existing T8 magnetic ballasts also require electronic adaptors, called retrofit conversion kits (Carbon Trust, 2009).

The application of natural light and day control lighting depends on the building configuration and can be mandatory in some Member States in the EU. Usually, the installation of windows in the roof is economically viable in new buildings. Some retailers have installed natural light in the major renovations of their buildings. The performance would also depend on the surroundings and in the availability of natural light.

Economics

The use of natural light in a store has a direct impact in the energy use of the store, reducing operating and maintenance costs. A positive impact on customers is also expected, which can also have an impact on sales. Nevertheless, retrofitting costs for skylights are high and expected payback times are relatively high. No specific data are available for this technique.

The payback times of retrofitting existing T12, T8, T5 fluorescents, halogens and incandescent bulbs to high efficacy T5 or LED would always be short, although it depends on the lighting concept before and after retrofitting. LED in freezing cabinets have payback times shorter than 4 years. T5 fluorescents with high efficacy for general and basic lighting have payback times shorter than 1 year (Tenglemann, 2010).

A store in Lyon, France, retrofitted 40 T8 fluorescents with LED in T8 tubes to be adapted to existing luminaries. The investment was about EUR 1100 and the expected maintenance costs were EUR 720/yr less than the costs for the existing systems. The calculated payback time for the installation is 1–2 years (Fobsun, 2009).

Driving force for implementation

As for other energy saving measures, economic performance will be enhanced due to costs savings. Better environmental performance will also increase retailers' reputations and lower store energy consumption would make companies better prepared for future energy tariff increases. The use of novel technologies for lighting can also improve the presentation of goods in stores.

Reference retailers

For the use of natural light, the installation of daylight controlled systems in the Tenglemann Kimamarkt in Mülheim, Germany, is remarkable.

The use of LED in freezers is quite extended in Europe: Royal Ahold (Albert Heijn), in the Netherlands, Migros and Coop in Switzerland, Sainsbury in the UK and others are good examples of this. The use of LED for general lighting is not extended for economic reasons. For the moment, several retailers have tested this technology in basic and specific lighting.

The use of new T5 fluorescents is also quite extended in Europe due to the good energy and economic performances of these devices. New Carrefour Supermarkets and Hypermarkets and Ikea are examples of T5 integration.

The lighting concepts and strategies followed by Coop and Migros in Switzerland fit with the SIA 180/4 requirements and the average installed load for lighting is not higher than 15–18 W/m^2. Tenglemann Klimamarkt uses 10 W/m^2 with the daylight control system. Ikea stores are also an example of low lighting load.

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2.1.6.8 Simple secondary measures for reducing energy consumption

Description

The main environmental impact of energy use is mainly allocated to the energy aspects mentioned so far: building (envelope and HVAC), refrigeration and lighting. The consumption of these processes represents more than 90 % of the energy consumption of a store. Nevertheless, the energy consumption of other aspects, such as the electric appliances, can be quite significant for non-food retailers, such as specialised retailers in electronic equipments, lamps, etc. This chapter is covered in the electricity aspects of the techniques portfolio of Table 2.3 because main practices to be covered involve electrical energy consumption.

In this section of the document, several identified practices to improve the energy performance of retailers' activities are summarised and include:

- use of efficient appliances
- monitoring and management of the energy performance of energy consuming products in exhibitors
- energy performance of distribution centres
- internal and External communication and
- training.

Use of efficient appliances

The impact of appliances can be significant for the energy consumption of a store, especially for non-food retailers. Plug-in freezers or fridges used as display cabinets should not be considered as a secondary electric appliance and its consumption should be accounted for the whole refrigeration system (see Section 2.1.6.5).

Selection of small appliances (e.g., cash registers, appliances of staff rooms, computers) should be made with regard to reduce the environmental impact of their life cycle (e.g. selection of eco-labelled products). One of the most important aspects of their life cycle is energy consumption. The best energy rated equipment should be preferred. For the selection process, it is also quite important to avoid oversizing. The number of appliances and their power load should be optimal. A strategy should be defined in the energy management of the store to optimise the performance and the lifetime of appliances.

For the purchasing of high energy consuming appliances (e.g. elevators, escalators, ovens and others), it is also recommended to optimise lifecycle costs. More efficient equipment usually requires a larger initial investment but produce great savings. A clear statement on this should be included in the energy management policy of the company. A high standardisation level of the company in these aspects is also recommended.

Monitoring and management of the energy performance of energy consuming products in exhibitors

Non-food retailers selling electric appliances usually show the performance of their products to customers. This is a very important aspect of the marketing of electric appliances. The consumption of exhibitors is usually low if it is compared to other processes, e.g. lighting. Nevertheless, excessive or useless electricity consumption should be avoided. It is recommended to control separately the performance of exhibitors or, at least, to monitor them continuously or periodically through energy audits.

The business standardisation procedure for exhibitors should take into account the energy consumption in the optimisation of their marketing concept. A good example of this is the minimisation of basic store lighting in the store sections for lamps, bulbs and other lighting devices, where there is an excess of illumination and the basic lights can disturb the appreciation of the different lighting products.

Energy performance of distribution centres

Distribution centres account for 5–10 % of the energy consumption of retailers and for 10–20 % of the carbon footprint. Internal processes are quite similar to those shown for stores, except for those relevant to product presentation. There is no need for enhancing the presentation of products through lighting, and there is no need for the same display cabinets as used in supermarkets. The conservation of perishable food is the most important aspect, which is performed by refrigeration installations. Therefore, the size of the refrigeration system of a distribution centre is much higher than those installed in supermarkets or hypermarkets.

The techniques described for buildings, heat recovery or refrigeration are also applicable to distribution centres. Main differences to take into account are given below.

- Optimisation for energy efficiency. A distribution centre does not have a sales area, so the application of energy efficiency measures is not affected by marketing issues.
- The refrigeration system. A distribution centre is placed in a large industrial building with a significant area to be refrigerated at very low temperatures. The refrigerant leakages are highly significant in these centres. The use of CO_2 or ammonia in cascade or indirect configurations is more effective for larger installations, and the costs associated with more expensive configurations (e.g. indirect ammonia-brine systems) are reduced (Rhiemeier et al., 2009). The building envelope is also a key aspect in the performance of the refrigeration system, as cooled rooms are extensively used.
- Only basic lighting is used. The illumination needs are those defined in national or regional regulations for work places and no enhanced product presentation is needed.
- A significant area is cooled to conserve perishable goods. So, the role of the building envelope is a key aspect in the energy performance of distribution centres.

Communication and training

The standard CEN 16000 for energy management systems (CEN, 2010) establishes that, for the implementation and operation of the system, the organisation has to ensure that all workers are aware of:

- the organisation's energy and energy management programmes
- the energy management requirements, including activities of the organisation to control energy use and improve energy performance
- the impact of energy consumption and their activities to achieve the energy objectives and targets
- the benefits of improved energy efficiency.

Personnel with tasks which can cause impacts on the energy consumption have to be competent with enough training and experience. A process for the identification of training needs in energy aspects is also required.

Regarding communication, all of the people working for (and on behalf of) the organisation have to be informed about the energy management and the improvement of the energy performance. A periodic and transparent communication procedure of the company to the public and interested parties is essential in a good energy management system. Therefore, a correct balance between performance, perception and communication is needed. It is not good practice to have intensive public campaigns while the energy objectives and targets are not ambitious or just few measures have been implemented. Good performers have to communicate what practices they have put into practice to improve their image and to make customers aware of the benefits of improved energy performance.

Achieved environmental benefits

The benefits of single practices proposed are not easily measured. Energy audits would be needed to evaluate the achievements of an environmental management system, but the allocation of energy savings to specific measures is not always easy to perform. In case of communication and training, the benefits for the company are significant and contribute to creating awareness and a proper atmosphere for the implementation of the energy management system.

Environmental benefits of energy savings in distribution centres are also significant and comparable to those achieved with the implementation of saving measures at stores.

The benefits from efficient appliances are important but difficult to measure, as the control of different electricity consumption is usually not performed except for lighting and refrigeration.

Appropriate environmental indicator

The energy consumption per square metre of sales area and year is an appropriate indicator. It can be used as an indicator of the overall performance and, it can also be divided per source or section. Indicators already explained (see Section 2.1.6.5) can be used to control this practice. In addition, the presence of an energy management system in place to drive continuous improvement is a proper indicator.

Cross-media effects

The improvement of energy performance by described measures does not have any cross-media effects.

Operational data

An important number of techniques are covered in this section. Two examples of them are shown below: one for the management of specific energy uses of stores and the other for external communication concepts within a retail trade company.

<u>Energy management of specific needs</u>

One particular non-food retailer periodically audits the energy consumption of its stores. It is a good performer but notably has an excellent monitoring and energy management system. Energy audits from this company usually check all the energy consuming processes. Figure 2.61 shows the energy performance of some internal processes (excluding HVAC) of this retailer for three of its stores. It is quite interesting how the external lighting influences the breakdown of energy consumption of stores 2 and 3. The audit process would reveal where excessive consumption profiles come from. Also, non-conformities would be identified and corrective actions would be proposed.

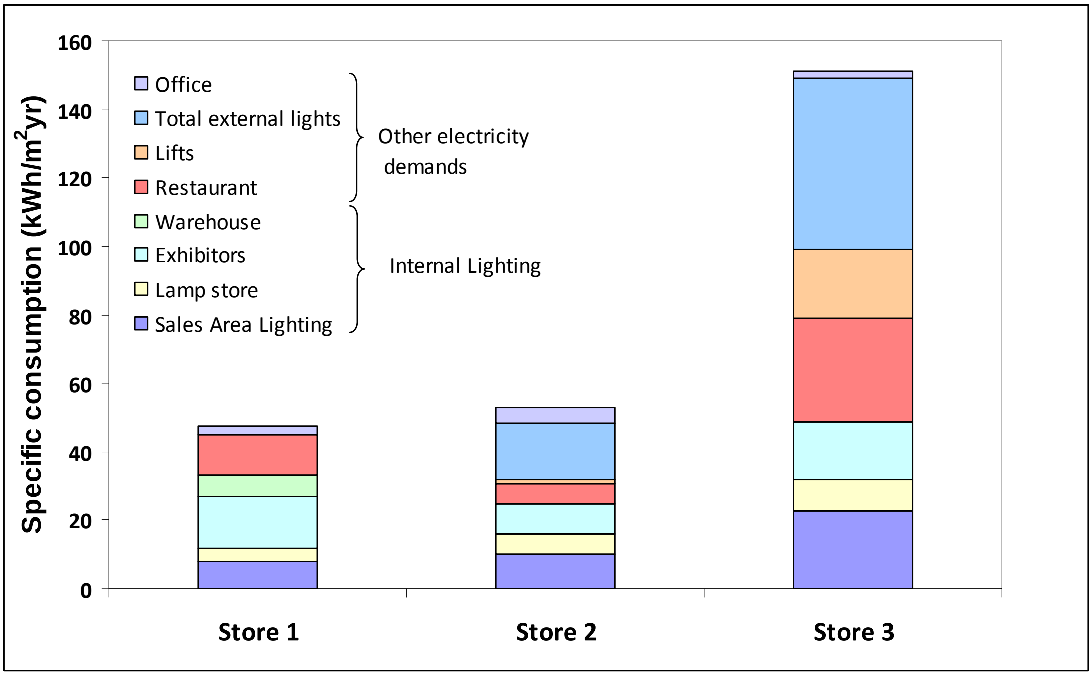

Figure 2.61: Specific electricity consumption of three sampled stores of a non-food retailer for different electricity uses

External communication

The environmental impact produced by retailers' operations is relatively low compared to the impact produced by the supply chain or even by the consumer. Nevertheless, the influence of a retailing company and the capacity to reduce impacts are higher for direct aspects and it is really limited for the supply chain and also for consumers. The retailer has to optimise their communication procedures, not only to change consumers' perception but also to influence other actors of the whole chain.

Applicability

There is no limitation on the size, type or geographical location of the retailer to perform a comprehensive management system, taking into account appliances, distribution centres, specific energy uses or communication and training.

Economics

All the energy efficiency measures produce costs savings, although the decision-making process always depends on the payback time and other economic parameters. An example of the use of simple measures to improve performance is shown in 'Achieved environmental benefits' of Section 2.1.6.5. For the economics of practices at distribution centres, see the similarly described techniques for stores.

An indicator of the economics of energy management is the number of cost-saving techniques being implemented in the whole company. Most of them are described in this document. Staffing and allocation of resources are also very sensitive economic aspects of energy management systems.

Driving force for implementation

Best management practices would improve the environmental profile of the company but also other important driving forces have to be regarded: improved business performance, cost savings, better response to market fluctuations and better reputation are examples of driving forces to consider in the implementation of described techniques.

Reference retailers

An important number of companies have implemented good practices to improve the performance of the aspects described in this section: Rewe, Royal Ahold (Albert Heijn), Carrefour, Migros, IKEA, Coop, etc.

Reference Literature

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2.1.6.9 Use of alternative energy sources

Description

As stated in the general introduction of the techniques to improve the energy performance of retailers (see Section 2.1.2), priority should be given to the reduction of the energy demand of stores. Excessive energy use should always be avoided, even if the main source of energy is renewable or if the carbon footprint of the store has been offset.

The integration of alternative energy sources is usually considered a building aspect and it is strongly connected to the energy management system of the building (Tassou et al., 2010). The European Directive for the energy performance of buildings (EP, 2010) states that the energy performance of a building shall be determined taking into account the positive influence of renewable energy sources and cogeneration, but also from natural light and district heating. Several techniques for the use of alternative energy sources have successfully been introduced in retailers' buildings. Usually, the initial investment for these techniques is higher than that required for conventional fossil or grid-based ones. Nevertheless, the life cycle costs of these techniques can be lower than for conventional ones, although this aspect depends on an important number of individual factors.

The links between retailers 'activities and alternative energy sources are:

- warm water generation
  - solar thermal tube collector
- heating/cooling
  - biomass-fired boilers
  - geothermal Heat Pump
  - cold Storage
  - other processes as CHP, heat pumps
- electricity
  - implementation of renewable energy sources on site/ investment on renewable energy sources at other locations
  - purchase of available 'green' electricity.

One of the objectives of the use of renewable energy sources is to build a zero energy building (ZEB), which is a building with a high level of energy efficiency, with an energy demand equal to or less than the energy production from renewable energy sources on site. A positive energy building (PEB) is, therefore, that with higher renewable energy generation than demand. The usual definition is calculated on a yearly basis: zero or negative energy consumption over a year.

The ZEB/PEB approach is considered a natural progression from demanding standards, as the Passive House concept. A ZEB/PEB can be designed using mature technology and retailers are applying this concept for some of their buildings. Long payback periods are foreseen, although the life cycle costs would be always the lowest for optimal ZEB/PEB. According to Kolokotsa et al., 2010, there are a large number of techniques to integrate into a ZEB/PEB:

- improvement of the envelope
- innovative shading devices (automated/seasonal devices)
- improved air tightness and ventilation
- high efficiency heating and cooling devices
- use of renewable energy sources
- implementation of efficient energy management, monitoring and control systems.

Two types of ZEB/PEB are observed: autonomous buildings and 'net' zero energy buildings. An autonomous building is not connected to the grid and it produces its own energy, storing it when necessary. A net zero or positive energy building is connected to the grid as a source or as a sink of electricity. From the technical point of view and from a life cycle perspective, the use of the net zero energy concepts are more environmentally friendly, as they avoid storage systems, and flexibility for the appliances is gained (Hernández, 2010). The autonomous building should be restricted then to specific applications or site conditions.

The main barrier for the implementation of a net ZEB/PEB is the economic cost of the implemented solutions, although the techniques involved are commercially available. In the case of autonomous buildings, some cost-efficient solutions have been proposed for isolated zones, but with the used technologies are still in an early stage of development. This is the case of some renewable-energy integration case studies using hydrogen as energy storage (Milo et al., 2011).

Many existing retailers' buildings are far from achieving zero energy consumption, as the needs of a store make the specific energy demand to be, generally, more than three times the need of a household or a normal office. Only the energy intensity of refrigeration and lighting processes within a store would require a huge renewable energy input to balance the consumption. Nevertheless, integrated concepts as described in previous techniques (see Sections 2.1.6.1 to 2.1.6.4), and the techniques involving net ZEB/PEB, would minimise the energy consumption and significantly improve the environmental performance of retailers' operations.

Achieved environmental benefits

Alternative energy sources do not reduce the energy consumption of retailers' activities but an important reduction of the primary energy demand is achieved. An important benefit from the use of renewable energy use is the reduction of associated CO_2 emissions. To achieve a comprehensive balance of the techniques, a life cycle perspective should be used. For example, the use of roof PV installations does not emit CO_2, but the life cycle analysis reveals that many impacts are associated with the production of PV panes. However, the life cycle perspective also reveals that these techniques have positive environmental balances after three or more years of use.

Appropriate environmental indicator

As for measuring the energy performance of other techniques, the specific consumption of alternative energy sources per square metre of sales area and per year is an appropriate indicator. The calculation of the three elements of this expression (energy, sales area, time) has to be harmonised in order to obtain comparable measures. In addition, for on-site generation (e.g. from roof PV installation), energy generation should be given in the same terms, e.g., kWh/m^2yr, to give a comparable measure of generation to processes consuming energy.

In addition, the percentage of renewable energy used in the store, fed from green purchasing or own generation, should be provided. In the case of ZEB/PEB the excess generation percentage in relation to consumption can be provided (0 % for ZEB and >0 % for PEB).

Cross-media effects

No cross-media effects are detected.

Operational data

The implementation of renewable energy techniques in retailers' buildings is becoming common practice. Some data from company reports are shown in Table 2.27.

Table 2.27: Implementation of renewable energy sources at retailers; sites

Retailer	Technology	Location	PV Area (m^2)	Installed Power (kWp)	Energy generation
Ikea	Ground source heat pump	30 installations in Europe	NA	500-1000	NA
Ikea	Wind turbines	7 locations at FR and DE	NA	100 000	NA
Colruyt Group (Colruyt, 2009)	Wind turbines	Dassenveld, distribution centre, BE	NA	1 650	1 850 MWh/yr
Colruyt Group (Colruyt, 2009)	Wind turbines	Ghislenghien, D.C., BE	NA	2 000	4 400 MWh/yr
Colruyt Group (Colruyt, 2009)	Wind turbines	2 Wind Farms, BE	NA	4 600	7 500 MWh/yr
Colruyt Group (Colruyt, 2009)	Wind turbines	Wind offshore	NA	44 400	142 000 MWh/yr
Colruyt Group (Colruyt, 2009)	Roof-PV	4 Distribution centers, BE	44500	2 730	2 200 kWh/yr
Colruyt Group (Colruyt, 2009)	Roof-PV	17 Stores, BE	12600	1 240	1 040 MWh/yr (80 kWh/m^2yr)
Spanish retailer	Roof-PV	Store, southeast of ES	7000 m^2 (sales area)	116	161 MWh/yr (23 kWh/m^2yr)
Carrefour Spain	Roof-PV	Several stores in ES	NA	NA	109 MWh/yr
Carrefour Spain	Roof-PV	Alovera, Distribution centre, ES	NA	1 000	NA
Ikea	Roof-PV	Several locations in Europe (20 sets)	NA	2 000	NA
Ikea	Solar water heating	60 installations	NA	-	NA
Ikea	Biomass burning	20 burners	NA	150–1 400	NA

Apart from the examples shown above, many retailers are implementing novel renewable energy techniques. Examples of these are Rewe, Tesco, Metro Group, Leroy Merlin, Ikea and many others.

The case of Ikea's renewable energy installations is remarkable. It is a non-food retailer, so no heat recovery from refrigeration is possible for them. So, apart from windmills and photovoltaic installations, Ikea is implementing a number of techniques for space heating and cooling, as biomass boilers, ground source heat pumps and air source heat pumps. They also use solar water heating. Another particularity of Ikea is their international character: they are placed all over Europe and they have to develop different solutions for each site to cope with the climatic conditions, the demand of the building and local aspects (subsidies, infrastructures, etc.).

For this document, Colruyt Group provided detailed information during the meeting of the Technical Working Group about their renewable energy installations in Belgium. Figure 2.62 and Figure 2.63 show the solar photovoltaic generation of stores (more than 80 kWh/m^2yr) and the installed power at distribution centers.

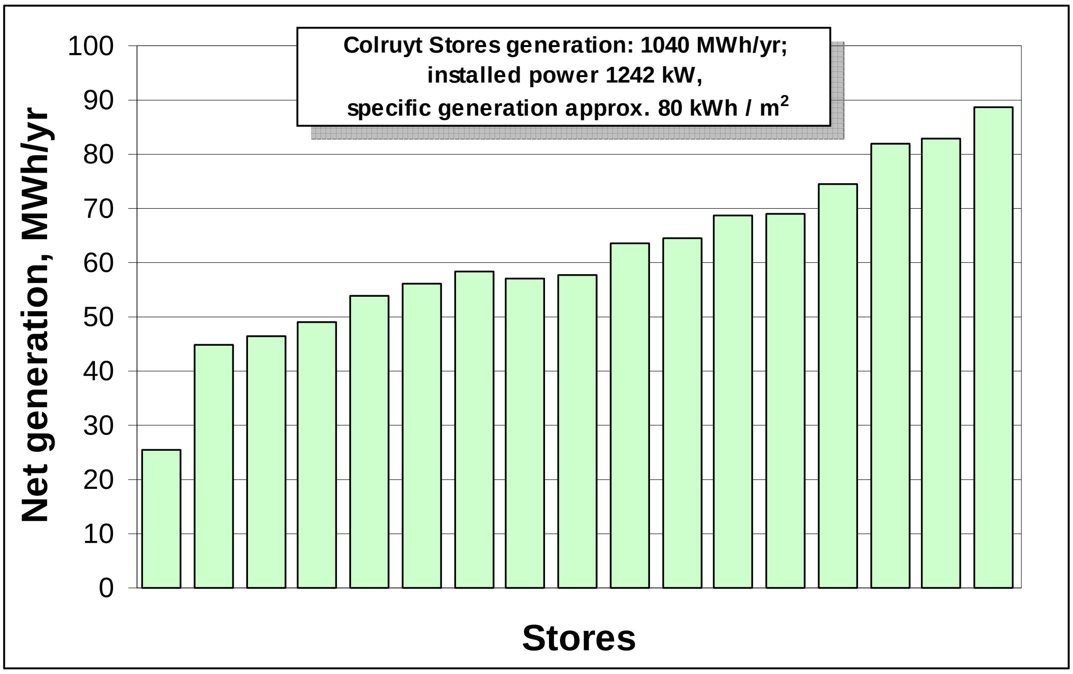

Figure 2.62: Energy generation by solar photovoltaics at 17 Colruyt stores in Belgium

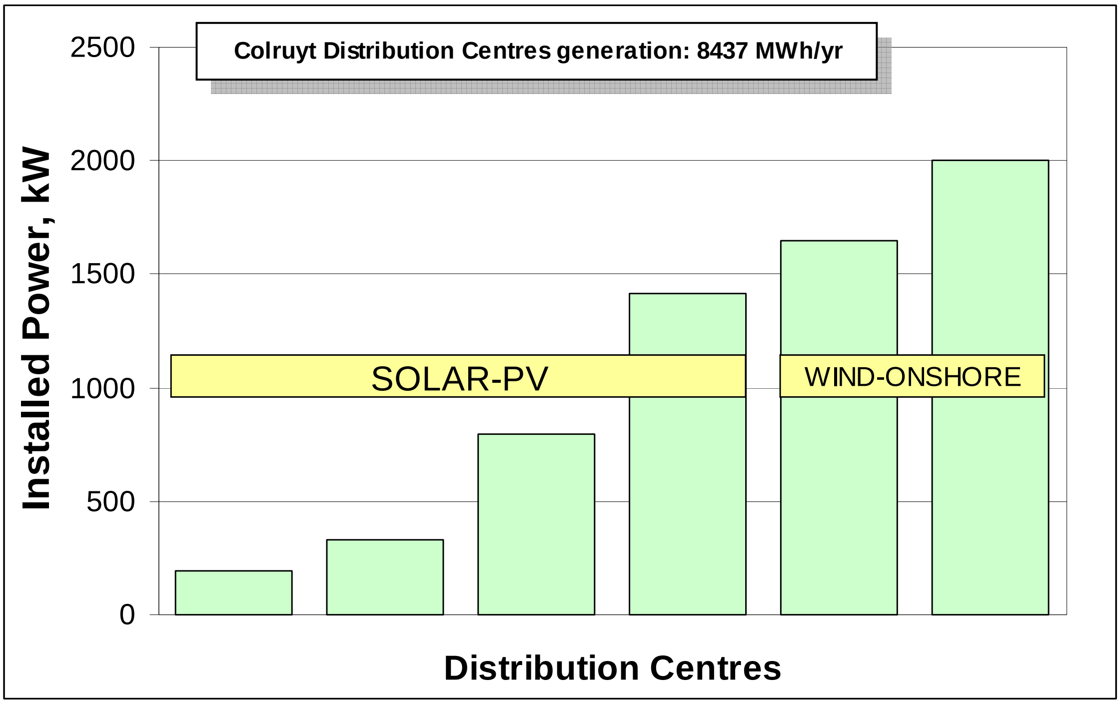

Figure 2.63: Installed power at distribution centres of Colruyt in Belgium

Applicability

For the use of alternative energy sources, such as solar power, solar thermal heat or geothermal heat pumps, the location can be a key factor for the applicability of the measure. System efficiency should be considered in the design phase prior to its implementation. The integration of the technique within the building can also be a determining factor in the selection and implementation of the technique.

Economics

The use of alternative energy sources does not produce energy savings but compensates the energy consumption of the store. So, these techniques are measures to compensate the energy consumption and the carbon footprint of the operation. Own generated energy is also usually more expensive than external energy sources, like electricity from the grid or district heating. In addition, the costs of renewable energy sources are quite dependent on national or regional subsidies.

An example of the economics of an alternative energy source is a Spanish retailer, which implemented a 100 kWp roof PV installation in a new store of 7000 m^2. The payback time of the installation is about 11 years and depends on the received subsidies. The initial investment is higher than EUR 500.000 and the specific energy generation per year is 23 kWh per sales area squared metre. Subsidies of EUR 0.29/kWh are foreseen when the generated electricity is sold to the national electricity grid.

Driving force for implementation

The use of alternative energy sources will reduce the rate of energy resource depletion and reduce greenhouse gases emissions. In addition, the visibility of many measures contributes to retailer image.

Reference retailers

An important number of companies have implemented alternative energy sources to improve their performance: Colruyt Group, Rewe, Leroy Merlin, Metro, Tesco, Carrefour, etc.

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2.2 Best environmental management practice to improve the sustainability of retail supply chains

2.2.1 Chapter structure

This chapter provides retail stakeholders with information on how retailers can improve the sustainability of their supply chains by reducing the environmental impact of their products and suppliers, and by encouraging more sustainable consumption. Following a basic introduction in Section 2.2.2, the scope of this chapter is described in Section 2.2.3, and a number of important driving forces for retailers to manage their supply chains are presented in Section 0. The breadth of this chapter's scope, including multiple products, processes and environmental impacts, necessitates an introductory overview of the scientific understanding of major environmental impacts associated with important product groups (Section 2.2.5). Examples of 'hotspot' environmental impacts, and responsible processes, are detailed for a cross-section of priority products in Section 2.2.5.3 to Section 2.2.5.7. Subsequently, best practice is described in line with other chapters in this document.

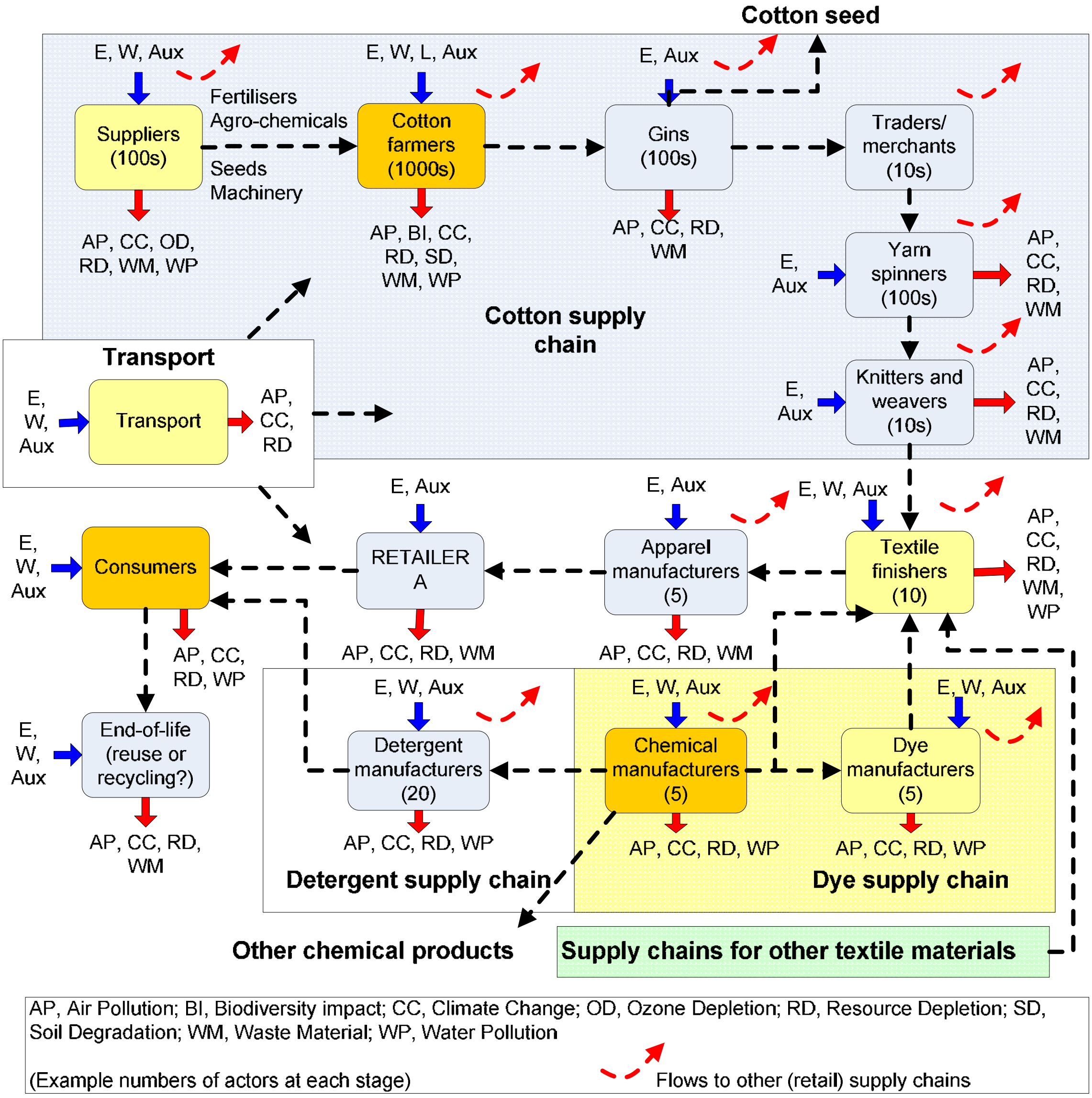
Practical retailer actions to improve supply chain sustainability are categorised and described as distinct approaches and techniques in Section 2.2.6. Techniques regarded as essential prerequisites for effective supply chain management are detailed in Section 2.2.6.1 to Section 2.2.6.3. Techniques involving retailers stipulating environmental standards or improvement requirements for products and suppliers are detailed in Section 2.2.6.4 to Section 2.2.6.6, whilst Section 2.2.6.8 outlines a technique for retailers to encourage sustainable consumption. Section 2.2.6 outlines how retailers can collaborate on research to drive supply chain sustainability. Where possible, categorical and quantitative data are provided to measure and propose best practice. However, this chapter necessarily relies heavily on descriptive examples of existing retailer best practice to improve supply chain sustainability. These examples are presented as case studies that clearly indicate how and why they represent best practice.

2.2.2 Chapter introduction

Production and consumption of retail products is a major driver of global environmental pressures. In particular, the production and consumption of food is estimated to account for 30 % of environmental pressure in the EU-25 (EC, 2006). Typically, over 90 % of the environmental impact associated with products arises during production and consumption, compared with less than 10 % during handling by the retailer (EC, 2009). IKEA estimates that raw-material extraction, supplier operations, and customer transport and use contribute 56 %, 10 %, and 28 %, respectively, towards the lifecycle GHG emissions of their products (IKEA, 2010). Many products sold by retailers are grown and manufactured in developing countries with poor environmental standards (weak regulations and poor management practices), or sourced from relatively small suppliers not subject to rigorous environmental regulation. Consequently, retailers and large food manufacturing companies are often the entities with the greatest capability to influence the environmental performance of suppliers who are at the front-line of many global environmental impacts.

There is increasing recognition that business-as-usual supply chain models are inadequate to deal with the projected global supply challenges for critical products including food. In a recent report on food strategy, it was concluded that 'a system that is able to reconcile the often conflicting goals of resilience, sustainability and competitiveness, and that is able to meet and manage consumer expectation will become the new imperative' (Ambler-Edwards et al., 2009). Retailers are seen as key drivers of the necessary changes: 'Collaborative relationships around the supply network will take on a new importance…Retailers in particular will need to adapt their practices to alter the balance of risk and reward throughout the supply chain' (Ambler-Edwards et al., 2009). Retailers are strategically-positioned to drive significant and continuous environmental improvement throughout their supply chains, and entire value chains through their influence on customers. The potential positive environmental influence of retailers' market power is enormous.

Large individual retailers may purchase hundreds of thousands of products from many thousands of suppliers, who themselves coordinate multiple operations and subcontractors. Figure 2.64 demonstrates that even relatively basic products, such as textiles, are typically supplied via an extensive network of independent operating units, including sub-suppliers and contractors who do not have direct contracts with retailers. Consequently, ensuring product traceability and quality is an enormously complex task, even before consideration is given to assessing and reducing environmental impacts. Yet supply chain management provides retailers with the greatest opportunity to drive environmental, and wider sustainability, improvement. Through effective supply chain management, retailers can play a central role in addressing global sustainability challenges, and achieving European policy targets.



N.B: Orange boxes represent environmental hotspots; yellow boxes represent higher environmental risk. In some supply chains, multiple stages between the farmers and retailers may be performed by single entities.

Figure 2.64: Simplified value chain for a cotton garment, broken down into constituent supply chains, indicating the major inputs and outputs, and hotspot stages

2.2.3 Scope of this chapter

Supply chain sustainability of course relates to the three pillars of sustainability (Figure 2.65). Economic aspects of supply chains are well represented within the market system in which retailers operate, and are reflected in standard financial accounting procedures. Environmental and social aspects are not well represented within existing trading and accounting practices. The UN's Global Compact initiative has provided guidelines for businesses to measure and improve supply chain sustainability, much of which is relevant to retailers.

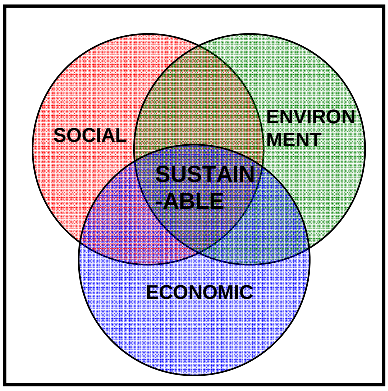


Figure 2.65: The key components of sustainability

Important aspects of social and environmental performance are listed in Table 2.28. This document is focused on environmental aspects, but recognises that retailer actions to reduce the environmental impacts of product supply chains need to be coordinated with actions to improve social conditions (e.g. in supplier codes of conduct), within an acceptable business economic framework, in order to secure genuinely sustainable supply chains over the longer term. The broader definition of 'improved supply chain sustainability' is therefore used.

Table 2.28: Supply chain social and environmental aspects relevant to the United Nation's Global Compact principles

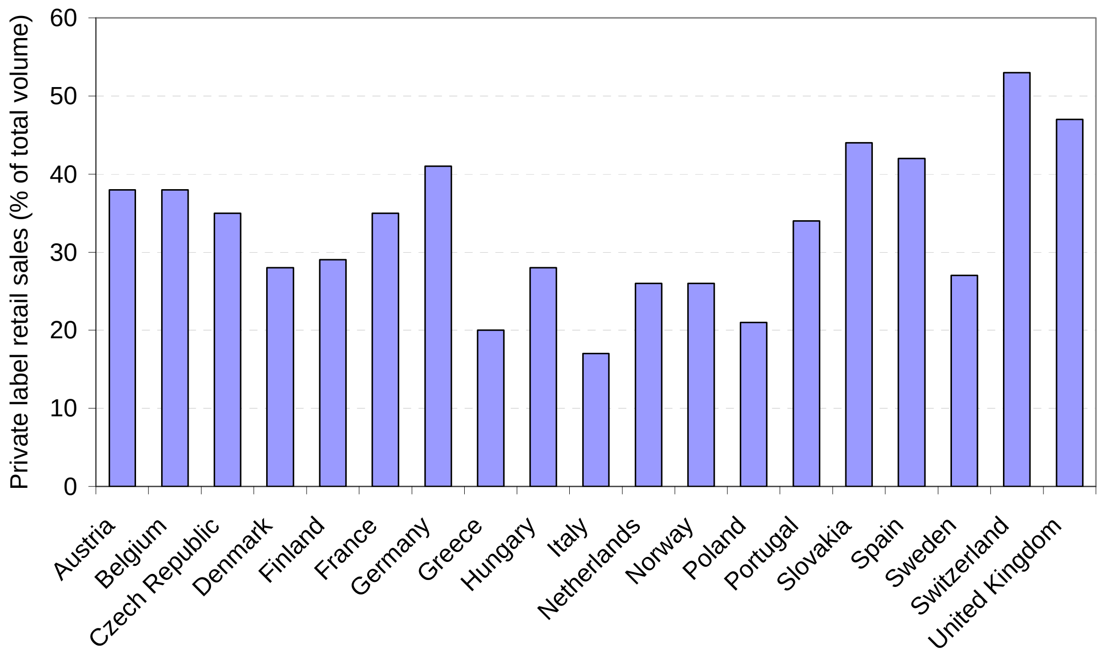
Social	Environmental
Forced/child labour	Material toxicity and chemicals
Working hours	Raw material use
Wages and benefits	Recyclability/product end-of-life
Humane treatment	Greenhouse gas emissions
Non-discrimination	Energy use
Freedom of association and collective bargaining	Water use and waste water treatment
Occupational safety	Air pollution
Occupational hygiene and conditions	Biodiversity

Retailers are in the early stages of assessing and improving supply chain environmental sustainability, and different retailers are employing a range of approaches and techniques to achieve this objective. The objective of this chapter is to provide an overview of these techniques, identify the most effective ones, and propose best practice. This chapter deals with the supply chain from producer to retailer, with reference to transport and logistics, consumption, and product end-of-life in relation to optimisation of product lifecycle impacts through supply side actions (Figure 2.64). Retailer best practice techniques with respect to transport and logistics and product end-of-life are referred to in more detail in Chapter 2.3 and

Chapter 2.4 respectively, whilst best practice techniques with respect to direct retail operations are covered in Chapter 2.1.

The opportunity for retailers to influence product supply chains is greatest for, but not restricted to, their private label (own-brand) products. The scope of retailer influence, and the applicability of some improvement techniques, depends on the proportion of private label sales within product groups sold by individual retailers. The sales share of private label products varies considerably across retailers and countries (Figure 2.66). Private label products account for over 25 % of European retail sales, highest in Switzerland (53 %), the UK (47 %), Slovakia (44 %), Spain (42 %) and Germany (41 %) (PLMA, 2010). Some examples of private label shares for larger retailers are 29 % for REWE, 90 % for Migros, and 98 % for Marks & Spencers (Fennel, 2009; M&S personal communication). Many small retailers do not sell private label products.

Improvement of branded product supply chains is primarily the responsibility of brand manufacturers, who are outside the scope of this document, but some techniques referred to in this chapter are relevant. In particular, retailers can employ choice editing, green procurement (Section 2.2.6.4) and promotion of ecological front-runners (Section 2.2.6.8) to branded as well as private label products.

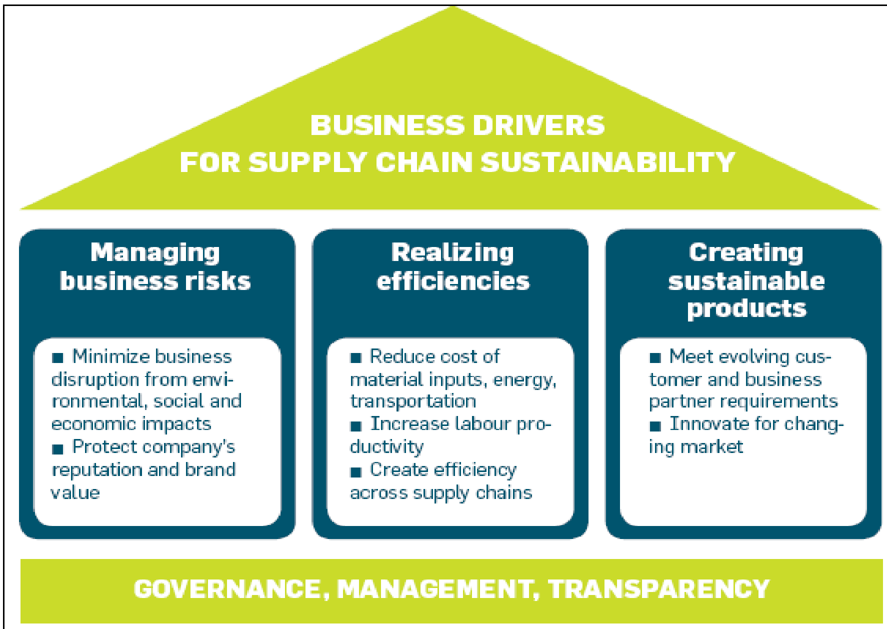


Source: data from PLMA , 2010

Figure 2.66: The shares of private label products in retail sales across some European countries

2.2.4 Drivers of retailer supply chain improvement

There is increasing awareness across businesses about the importance of managing supply chains to reduce their environmental impact, in the context of both corporate responsibility and business planning. The strong business case for improving the sustainability of supply chains has been made by the Business for Social Responsibility (BSR) global consortium (Figure 2.67).



Source: UN Global Compact and Business for Social Responsibility (2010)

Figure 2.67: Business drivers for retailers to improve supply chain sustainability

Taking a proactive approach to improving supply chain sustainability is not just about ensuring longer-term business viability, but is associated with stronger contemporary business performance (Accenture, 2009). Based on the business drivers to improve supply chain sustainability listed in Figure 2.67, but also economic trends, evolving environmental awareness, and the strategic importance of retailers as supply chain 'gate keepers', the critical driving forces for retailers to reduce environmental impacts across their supply chains may be summarised:

- resource price volatility: response to large increases in commodity prices, and insurance against future price volatility;
- risk management: realisation that fundamentally unsustainable rates of resource consumption in supply chains pose a major risk to future business viability;
- image and public relations: stakeholder (notably customer and shareholder) concern over environmental issues such as climate change;
- demand and marketing: increasing customer demand for 'ecological' products, and retailer positioning to market these more profitable value-added products;
- corporate responsibility: retail directors/governance responding to increasingly evident environmental problems;
- regulation: the prospect of regulation imposing restrictions or costs on environmentally-damaging activities and products (e.g. a carbon tax)

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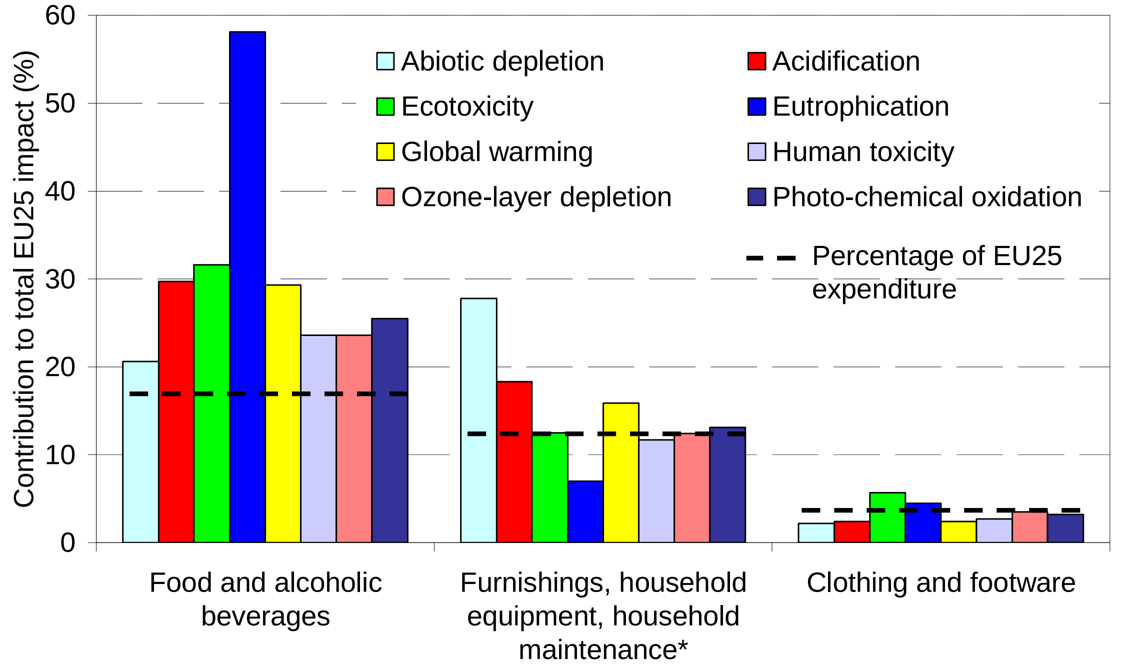
2.2.5 Scientific understanding of supply chain environmental impacts and improvement options

2.2.5.1 Identification of some priority product groups

Efficient supply chain improvement requires accurate information on environmental impacts associated with products. Selection, improvement, and labelling practices should be targeted towards products, processes, aspects, and stakeholders (usually suppliers or customers) with the greatest improvement potential. Improvement potential is determined following consideration of: (i) the scale and intensity of environmental impact; (ii) the feasibility and economics of improvement options. It is essential that supply chain intervention is informed by evidence obtained from applied supply chain research.

A considerable amount of information has already been published regarding environmental pressures associated with particular product groups. Two recent EU studies provide some useful initial guidance as to where actions might be targeted in order to efficiently reduce the environmental impact of product supply chains. Some summary findings from the Environmental Impact of Products (EIPRO) study (EC, 2006) are presented in Figure 2.68, Figure 2.69 and Table 2.34. Research was based on environmental pressures classified according to eight impact categories (biotic depletion, acidification, ecotoxicity, eutrophication, global warming, human toxicity, ozone depletion, photochemical oxidation) and aggregated NACE code activity groupings which correspond only approximately with retail classification of broad product groups.



NB: (*) Includes electricity and fuel use associated with household appliances and maintenance.

Figure 2.68: Contributions of three major product groups to environmental pressures in the EU25

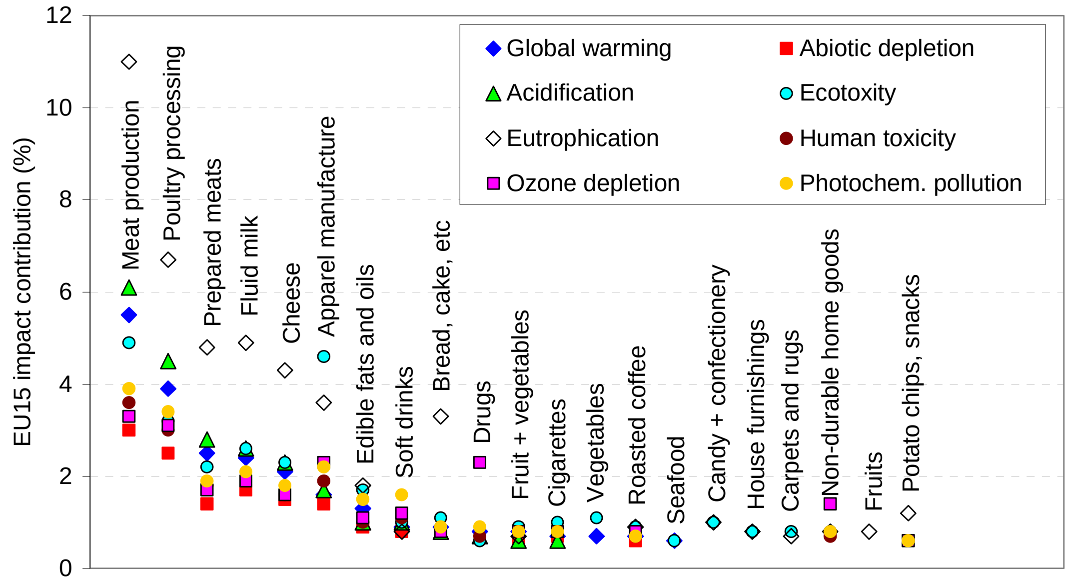
'Food and alcoholic beverages' is the largest contributory group to major environmental pressures, on average accounting for 30 % of EU environmental pressure, and over half (58 %) of the eutrophication pressure (Figure 2.68). 'Furnishings, household equipment and household maintenance' is responsible for a smaller but substantial share of EU environmental pressure, most notably abiotic depletion and acidification. This reflects the inclusion of product energy consumption during consumer use in impact assessment, and highlights the importance of considering upstream (consumer and end-of-life) product impacts at the design phase –

particularly for energy-consuming devices. 'Clothing and footwear' makes a smaller but significant (3 %) contribution to environmental pressure in the EU-25 (Figure 2.68). When environmental pressures are normalized according to expenditure (dashed lines in Figure 2.68), the food and alcoholic beverages product group has the greatest environmental pressure intensity per EUR product sold. However, pressure intensities per EUR product sold vary by less than a factor of two between the clothing and footwear and food and alcoholic beverages groups. There is considerable scope for improvement across all product groups, and these results highlight that:

- supermarket retailers selling multiple product types should prioritise food and drinks products for supply chain improvement;
- nonetheless, it is important for retailers specializing in household furnishings and clothing and footwear to reduce environmental impact across their product groups.

The EIPRO study also ranked more disaggregated product groups according to their environmental pressures. Figure 2.69 summarises these results for product groups relevant to the retail sector. There is a general correlation in the relative contribution that different products make to different impact categories, but there are also some notable divergences where particular products appear to be 'hotspots' for particular pressures. For example, production and processing of meat and dairy products make a particularly large contribution to eutrophication compared with other pressures, whilst the manufacture of drugs has a particularly large ozone-depletion effect, and manufacture of apparel makes particularly large contributions to ecotoxicity and eutrophication.

These results emphasise the importance of considering multiple environmental impact categories in product lifecycle assessments. For example, it is well known that meat and dairy product supply chains are associated with high GHG emissions, but the relative contribution of these supply chains to eutrophication and acidification pressures in Europe is even greater than their relative contribution to global warming pressure. Thus, any actions aimed at reducing the GHG intensity of these supply chains should also address emissions of acidifying gases to air and diffuse emissions of nutrients to water.



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

Figure 2.69: The relative contribution of different product groups to eight environmental impacts in the EU-25

2.2.5.2 Classification of widely used environmental standards

An important mechanism to improve product supply chains is certification of products and suppliers according to appropriate, widely recognised third party environmental standards. A large number of such standards exist, but they vary widely in their geographical and product coverage, and their environmental scope and stringency. This document recommends extensive use of appropriate third party standards – for green procurement by retailers (Section 2.2.6.4) and to identify front-runner environmental products to consumers to encourage green consumption (Section 2.2.6.8). This section provides a brief overview of how these standards can be classified by retailers according to the level of environmental protection they represent. Firstly, readers are guided to the informative websites of the Global Ecolabelling Network (http://www.globalecolabelling.net/) and the Ecolabel Index (http://www.ecolabelindex.com/ecolabels/). This document cannot be exhaustive in terms of third party environmental standard classification, and focuses on the most widely used standards, primarily those for which sales data were provided by retailers (Table 2.29). These standards, and the classification criteria outlined below, are intended to offer retailers and verifiers a practical and indicative, but not exhaustive, basis for retailer performance assessment in relation to product supply chain sustainability.

In the first instance, there are a range of standards that may be used by retailers for green procurement. These are classified into "Basic", "Improved", and "Exemplary" (Table 2.29). Basic standards (Table 2.29 and Table 2.31) are defined as a group of requirements that aim to avoid the most environmentally-damaging practices, and approximate to minimum legal environmental requirements in Europe. The main requirements of basic standards are:

- compliance with local regulations
- record keeping for important environmental aspects (especially land use, chemical use, water management (Table 2.31)
- implementation of an environmental management plan (see GlobalGAP AF2.2.2 and AF5.1.1 requirements in Table 2.31)
- in some cases, exclusion of the most damaging practices or products (e.g. red-listed fish)
- in some cases, specific benchmarks for a minority of important environmental aspects.

Improved standards (Table 2.29 and Table 2.32) are defined as a group of specific requirements that address important environmental aspects more rigorously and more completely than basic standards. In addition to requirements contained in basic standards, improved standards include the following requirements in relation to important environmental aspects:

- specific management practices associated with significant environmental improvement (UTZ criteria in Table 2.32)
- compliance with quantitative environmental performance benchmarks (e.g. BSI benchmarks listed in Table 2.46 in section 2.2.6.4)
- demonstrated continuous improvement within a specified framework (e.g. UTZ criteria in Table 2.32, BCI criteria described in Case study 2.7).

Exemplary standards (Table 2.29 and Table 2.33) are defined as a group of specific requirements that address important environmental aspects sufficiently robustly and completely that certified products may be defined as environmentally sustainable (e.g. FSC, see Table 2.33). For products whose primary environmental impact is the depletion of renewable resources, such as wood and fish, exemplary standards may be quite narrowly defined as requirements for a sustainable harvest rate and avoidance of ecosystem damage through biodiversity loss, soil erosion, seabed damage, etc. Thus, the Forest Stewardship Council (FSC) and Marine Stewardship Council (MSC) labels are classified as exemplary. The Programme for the Endorsement of Forestry Certification (PEFC) introduced new requirements for certification of national forest certification schemes in 2010 that compare with FSC requirements in terms of completeness (PEFC Council, 2010). However, there is concern about the rigour and consistency of the verification process performed by PEFC approved national forest certification schemes hitherto (WWF, 2009; Technical Working Group, 2010) – consequently, PEFC certification has been classified as improved, rather than exemplary, in Table 2.29.

Table 2.29: Proposed classification of widely recognised third party environment-related standards commonly used in green procurement

Level	Widely used standards	Product groups	References
BASIC	GG: Global Good Agricultural Practice (and benchmarked standards)	Crops and livestock	GlobalGAP, 2009.
	OT: Oeko-Tex 1000	Textiles	Oeko-Tex, 2010
	NPC: National/regional production certification (e.g. Red Tractor British origin certification)	All food	Assured Food Standards, 2010.
	RLF: Red-listed fish (deselection)	Fish	Greenpeace, 2010; IUCN, 2010; MSC, 2010.
IMPR-OVED	BCI: Better Cotton Initiative	Cotton products	BCI, 2010
	BCRSP: Basel Criteria on Responsible Soy Production	Soy (feed supporting dairy, egg and meat)	ProForest, 2004.
	BSI: Better Sugarcane Initiative(*)	Sugar products	BSI, 2010
	4C: Common Code for the Coffee Community Association	Coffee	4C Association, 2010
	FT: Fairtrade (an exemplary **social** standard)	Agricultural products from developing regions	Fairtrade, 2009
	RA: Rainforest Alliance (products from the tropics)	Agricultural products from tropics	SAN, 2010
	RSPO: Round Table on Sustainable Palm Oil	Palm oil products	RSPO, 2007 RSPO, 2009
	PEFC: Programme for the Endorsement of Forestry Certification	Wood and paper	PEFC Council, 2010
	RTRS: Round Table on Responsible Soy	Soy (feed supporting dairy, egg and meat)	RTRS, 2010
	UTZ	Cocoa, coffee, palm oil, tea	UTZ, 2010
EXEMP-LARY	FSC: Forest Stewardship Council	Wood and paper	FSC, 2002
	MSC: Marine Stewardship Council	Wild-catch seafood	MSC, 2010

(*) The BSI standard is still awaiting official EU recognition as a voluntary scheme, and although it is not yet in use by retailers or food processors, criteria contained within it and wide stakeholder participation in its development suggest it will be a good standard.

In the second instance, products may be certified and labelled with standards that, by definition, identify them as front-runner ecological products (Table 2.30). Such standards are used to inform environmental selection by customers, and are usually associated with a considerable price premium. Therefore, they are not suited for universal green procurement. Environmental requirements for the award of widely recognised ISO Type-I environmental labels such as the EU Ecolabel, Blue Angel and Nordic Swan are based on multi-criteria lifecycle assessment of product groups, and are updated to reflect the best performing products within their respective product groups (e.g. the top 10–20 % for the EU Ecolabel: EC, 2010). For reasons outlined in Section 2.2.5.11, organic certification is also regarded as an exemplary front-runner standard (Table 2.30). Organic certification should be at least compliant with regulations EC No 889/2008 and EC No 834/2007 on implementation of organic production and labelling. Some standards, such as the Global Organic Textile Standard, go beyond basic organic requirements to ensure high levels of environmental performance throughout the processing chain (GOTS, 2008).

Table 2.30: Labels commonly used to identify environmental front-runner products to customers

Front runner label	Product groups	References
EL: Environmental labels (Blue Angel, EU Ecolabel, Nordic Swan) (†)	Non-food products	Blauer-engel, 2010; EC, 2010; Nordic Ecolabelling, 2010
OC: Organic (EC standard, GOTS, KRAV, Soil Association…) (†)	Food and natural fibre products	EC, 2007; EC, 2008; GOTS, 2010; KRAV, 2009; Soil Association, 2010

Key aspects and environmental benefits of standards listed in Table 2.29 are summarised in Section 2.2.6.4 in relation to choice editing and green procurement. Key aspects and environmental benefits of front-runner labels listed in Table 2.30 are summarised in Section 2.2.6.8 in relation to labelling for consumers.

Table 2.31 to Table 2.33 contain some of the most relevant environmental requirements taken from one example standard at each level of classification for green procurement standards. The GlobalGAP basic standard, applicable to all farms, contains few mandatory environmental requirements (Table 2.31), although there are additional standards for specific types of crop and livestock production (GlobalGAP, 2010).

Table 2.31: An example of relevant environmental requirements contained in a basic environmental standard

Environmental requirements from the general GlobalGAP standard (All-farm control points)
AF 2.2.2. A management plan that has implemented strategies to meet the objectives of this specific control point (site management) has been developed. (This plan should include one or more of the following: habitat quality, soil compaction, soil erosion, emission of greenhouses gases where applicable, humus balance, phosphorus balance, nitrogen balance, intensity of chemical plant protection).
AF 4.2.3. All possible waste products (such as paper, cardboard, plastic, oil, etc) and sources of pollution (e.g. fertiliser excess, exhaust smoke, oil, fuel, noise, effluent, chemicals, sheep dip, feed waste, dead or diseased fish, algae produced during net cleaning, etc.) produced by the farm processes have been listed.
AF 4.1.2. Visual assessment that there is no evidence of breeding grounds in areas of waste/litter in the immediate vicinity of the production or storage buildings. Incidental and insignificant litter and waste on The designated areas are acceptable as well as the waste from the current day’s work. All other litter and waste has been cleared up. Areas where produce is handled indoors are cleaned at least once a day.
AF 5.1.1. There must be a written action plan which aims to enhance habitats and increase biodiversity on the farm. This can be either a regional activity or individual plan, if the farm is participating in or covered by it. This includes knowledge of IPM practices, of nutrient use of crops, conservation sites, etc.
NB: Control points and compliance criteria for all-farm integrated farm assurance. *Source:* GlobalGAP, 2009.

The UTZ standard contains a range of specific management criteria covering many important environmental aspects of coffee production (Table 2.32). Additional standards are available for cocoa, palm oil and tea production (UTZ, 2010b).

Table 2.32: An example of relevant environmental requirements contained in an improved environmental standard

Key environmental requirements from the UTZ standard
4.A.2. The producer uses practices to conserve and recuperate soil structure and fertility. There is visual and/or documented evidence that these practices are used.
4.A.3. The producer uses techniques to prevent soil erosion. There is visual and/or documented evidence that one of these techniques is used. Special attention is given after (re)planting.
5.A.2. The responsible person (producer, certificate holder or external advisor) has a documented fertiliser programme in place. This is to ensure that fertilisers are applied judiciously, preventing the amount applied from exceeding the needs of the crop and the storage capacity of the soil. The responsible person demonstrates that consideration has been given to nutritional needs of the crop and soil fertility.
6.B.1. The certificate holder has a water action plan to optimise irrigation water use and reduce loss and waste of water.
6.B.2. The certificate holder uses the most efficient and commercially practical water delivery system and/or methods to ensure the best utilisation of water resources. The certificate holder shows the efficiency of the irrigation system in terms of the amount of water used per Mt of coffee produced.
6.C.1. The certificate holder makes an annual risk assessment of phytosanitary, chemical or physical pollution or contamination of irrigation water sources. Irrigation water is analysed at a frequency according to the results of the risk assessment. In case of adverse results, records are kept of the actions taken.
6.D.1. Irrigation water is extracted from sustainable sources.
7.A.11. The producer applies recognised IPM techniques where they are technically feasible. The producer knows and is able to show evidence of implementing at least one of each of the following IPM activities: • prevention, reduction, monitoring and intervention • to reduce pest attacks • use low toxicity products • use biological products where possible.
11.A.1. The certificate holder conducts a risk assessment on environmental impacts. The assessment is regularly reviewed and kept up to date. The assessment can be done regionally and can be conducted by an external party.
11.A.2. Based on the risk assessment on environmental impacts (11.A.1), the certificate holder makes and implements an action plan how to address these environmental risks. Implemented actions are documented.
11.A.3. The certificate holder has a conservation plan or participates in a regional biodiversity or forest management plan.
11.B.1. The producer protects and conserves all the water streams and sources (incl. ground water) on the farm from contamination and pollution.
11.B.2. The producer allows a strip of native vegetation to grow along water streams to control erosion, filter out agrochemicals and protect the wildlife habitat.
11.C.1. Degradation and/or deforestation of primary forest is prohibited. The producer demonstrates that there has been no degradation and/or deforestation of primary forest in the 24 months prior to the date of first registration with UTZ CERTIFIED.
11.C.2. The producer does not plant new coffee on land that is not classified as agricultural land and/or approved for agricultural use.
11.C.3. Deforestation of secondary forest is only allowed if all of the following are complied with: legal land title is available; government permits are available (if required); there is compensation with at least equal ecological value, to be confirmed by an independent expert report.
11.C.4. When using wood for drying of coffee, the producer obtains this wood from managed forests or from the pruning of crops or shade trees, and not from native forests, unmanaged community forests, borders of waterways and other sources of water or protected areas.
11.C.5. The producer uses shade trees whenever this is compatible with the local coffee production practices and takes into consideration the productivity.
11.C.7. Coffee production does not take place in protected areas. Coffee production does not take place in the immediate vicinity (2 km) of these areas if this is not allowed in the official management plan for the area.
11.C.8. If coffee production is in the immediate vicinity (2 km) of a protected area or biological corridor, the certification holder is in contact with the park authorities.
11.D.1. The certification holder records and monitors the use of energy in production and processing.
11.D.4. The producer uses the by-products of coffee growing and processing (pulp, hulls, husk and parchment) as fertiliser, compost, mulch or energy source (for machine drying).
NB: Certified producers must implement all these requirements within four years of certification, but not all requirements are mandatory for initial certification. *Source:* UTZ, 2010. Code of conduct for coffee.

The FSC standard contains rigorous requirements for forestry operators that ensure sustainable forest harvest and management, for example requiring at least the preservation of existing ecological functions (Principle 6.3 in Table 2.33) and the avoidance of any loss of high conservation value forest area (Principle 6.10 in Table 2.33).

Table 2.33: An example of relevant environmental requirements contained in an exemplary environmental standard

Some key environmental requirements from the FSC Standard
Principle #6: Environmental impact. Forest management shall conserve biological diversity and its associated values, water resources, soils, and unique and fragile ecosystems and landscapes, and, by so doing, maintain the ecological functions and the integrity of the forest.
6.1. Assessment of environmental impacts shall be completed – appropriate to the scale, intensity of forest management and the uniqueness of the affected resources – and adequately integrated into management systems. Assessments shall include landscape level considerations as well as the impacts of on-site processing facilities. Environmental impacts shall be assessed prior to commencement of site-disturbing operations.
6.2. Safeguards shall exist which protect rare, threatened and endangered species and their habitats (e.g. nesting and feeding areas). Conservation zones and protection areas shall be established, appropriate to the scale and intensity of forest management and the uniqueness of the affected resources. Inappropriate hunting, fishing, trapping and collecting shall be controlled.
6.3. Ecological functions and values shall be maintained intact, enhanced, or restored, including: **a)** forest regeneration and succession **b)** genetic, species, and ecosystem diversity **c)** natural cycles that affect the productivity of the forest ecosystem.
6.4. Representative samples of existing ecosystems within the landscape shall be protected in their natural state and recorded on maps, appropriate to the scale and intensity of operations and the uniqueness of the affected resources.
6.5. Written guidelines shall be prepared and implemented to: control erosion; minimise forest damage during harvesting, road construction, and all other mechanical disturbances; and protect water resources.
6.6. Management systems shall promote the development and adoption of environmentally-friendly non-chemical methods of pest management and strive to avoid the use of chemical pesticides. World Health Organization Type 1A and 1B and chlorinated hydrocarbon pesticides; pesticides that are persistent, toxic or whose derivatives remain biologically active and accumulate in the food chain beyond their intended use; as well as any pesticides banned by international agreement, shall be prohibited. If chemicals are used, proper equipment and training shall be provided to minimise health and environmental risks.
6.7. Chemicals, containers, liquid and solid non-organic wastes including fuel and oil shall be disposed of in an environmentally appropriate manner at off-site locations.
6.8. Use of biological control agents shall be documented, minimised, monitored and strictly controlled in accordance with national laws and internationally accepted scientific protocols. Use of genetically modified organisms shall be prohibited.
6.9. The use of exotic species shall be carefully controlled and actively monitored to avoid adverse ecological impacts.
6.10. Forest conversion to plantations or non-forest land uses shall not occur, except in circumstances where conversion: **a)** entails a very limited portion of the forest management unit **b)** does not occur on high conservation value forest areas **c)** will enable clear, substantial, additional, secure, long term conservation benefits across the forest management unit.
Principle #7: Management plan A management plan – appropriate to the scale and intensity of the operations – shall be written, implemented, and kept up to date. The long term objectives of management, and the means of achieving them, shall be clearly stated. Four specific criteria listed under this principle.
Principle #8: Monitoring and assessment Monitoring shall be conducted -- appropriate to the scale and intensity of forest management -- to assess the condition of the forest, yields of forest products, chain of custody, management activities and their social and environmental impacts. Five specific criteria are listed under this principle.
Principle #9: Maintenance of high conservation value forests Management activities in high conservation value forests shall maintain or enhance the attributes which define such forests. Decisions regarding high conservation value forests shall always be considered in the context of a precautionary approach. Four specific criteria are listed under this principle.
Principle #10: Plantations. Plantations shall be planned and managed in accordance with Principles and Criteria 1 – 9, and Principle 10 and its Criteria. While plantations can provide an array of social and economic benefits, and can contribute to satisfying the world's needs for forest products, they should complement the management of, reduce pressures on, and promote the restoration and conservation of natural forests. Nine specific criteria listed under this principle.
Source: FSC, 2002. Principles and criteria for forest stewardship

Table 2.34 provides an overview of the most important product groups, according to their contribution to the eight environmental impacts considered in the EIPRO study (EC, 2006), and also their estimated contribution to biodiversity impacts (primarily through land use pressures

leading to natural habitat loss, and unsustainable harvesting of natural resources). The major processes and lifecycle stages contributing to impacts are indicated, along with relevant third party environmental standards available to control these processes and impacts. The environmental importance of food and drink products, especially animal-related, is apparent from Table 2.34.

In order to provide some more insight into the measurement and sources of environmental impacts over product lifecycles, some examples of environmental pressures and source processes are provided for a number of priority products in Section 2.2.5.3 to Section 2.2.5.9. These examples provide a background and reference point for particular standards and actions applied to the relevant product groups in subsequent sections of this chapter.

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Table 2.34: Summary of key stages and processes that contribute towards the environmental burden associated with supply chains for high environmental impact product groups, and relevant, widely-applied (or promising new, in brackets) third-party environmental standards

Product group	Key processes	Fert. appl.	Manure management	Animal husbandry	Irrigation	Pesticide appl.	Processing	Waste-water	Transport	Packaging	Animal feed	Habitat displacement	Resource consumption	Use phase	End-of-life
Cigarettes	Tobacco production, paper production														
Clothes	Cotton cultivation, flax cultivation, textile processing, polyester production, leather	**BCI , FT, OC**			**BCI , FT, OC**	**BCI , FT, OC**	**GOTS*, OX**	**GOTS*, OX**					**BCI , FT, OC**		
Coffee	Coffee cultivation, processing	**4C, FT, UTZ, OC**			**4C, FT, UTZ, OC**	**4C, FT, UTZ, OC**						**4C, FT, UTZ, OC**			
Dairy	Animal feed production, animal husbandry, manure management, land use	**GG, NPC, RA, OC**	**GG, NPC, RA, OC**	**GG, NPC, RA, OC**							**GG, RA, RTRS, OC**	**NPC, RA**			
Drugs	Manufacture, packaging, transport							**B-WW****							
Fruit and veg	Cultivation, greenhouse heating, transport (air freight)	**GG, FT, OC**			**GG, FT, OC**	**GG, FT, OC**									
Fats and oils	Cultivation, processing, land use	**NPC,RSPO,RTRS**			**NPC,RSPO,RTRS**	**NPC,RSPO,RTRS**						**NPC,RSPO,RTRS**			
Grain products	Cultivation, processing, land use	**NPC, GG, OC**			**NPC, GG, OC**	**NPC, GG, OC**									
Household Chemicals	Manufacture, packaging, transport, use, disposal						**EL**	**B-WW**, EL**		**EL**				**EL**	**EL**
Household goods (non-durable)	Harvest, manufacture, transport, resource use, disposal						**EL**	**B-WW**, EL**					**EL**	**EL**	**EL**
Household Furniture	Harvest, manufacture, transport,						**EL**	**B-WW**, EL**				**FSC, PEFC**	**FSC, PEFC**		
Poultry, eggs	Animal feed production, animal husbandry, manure management	**NPC, GG, OC**	**NPC, GG, OC**								**GG, RTRS, OC**				
Red meat	Animal feed production, animal husbandry, manure management, land use	**NPC, GG, OC**	**NPC, GG, OC**	**NPC, GG, OC**							**NPC, GG, RA, RTRS, OC**	**NPC, RA**			
Seafood	Harvesting, processing, transport (feed for fish-farms)										**(ASC), OC**	**(ASC), MSC, OC**	**(ASC), MSC**		
Soft drinks	Sugar production, processing, packaging, transport	**(BSI), FT, OC**			**(BSI), FT, OC**	**(BSI), FT, OC**		**(BSI), B-WW****				**(BSI), FT, OC**	**(BSI), FT, OC**		
Sugar	Cultivation (type of feedstock), processing, transport	**(BSI), FT, OC**			**(BSI), FT, OC**	**(BSI), FT, OC**		**(BSI), B-WW****				**(BSI), FT, OC**	**(BSI), FT, OC**		

(*) Other processes covered by GOTS are included under OC.
(**) B-WW is a specific waste water quality guideline, not a product standard.
4C, Common Code for the Coffee Community; (ASC) Aquaculture Stewardship Council (not finalised); BCI, Better Cotton Initiative; (BSI), Better Sugar Initiative (not finalised as standard); B-WW, BSR Waste Water Quality Guidelines; EL, Ecolabel; FSC, Forest Stewardship Council; FT Fairtrade; GG, Global Good Agricultural Practice; GOTS, Global Organic Textile Standard; MSC, Marine Stewardship Council; NPC, National (or regional or local) production Certification; OC, Organic; OX, Oekotex 1000; PEFC, Programme for the Endorsement of Forestry Certification schemes; RA, Rainforest Alliance; RSPO, Roundtable on Responsible Palm Oil; RTRS, Roundtable on Responsible Soy (alternative is Basel Criteria on Responsible Soy Production).

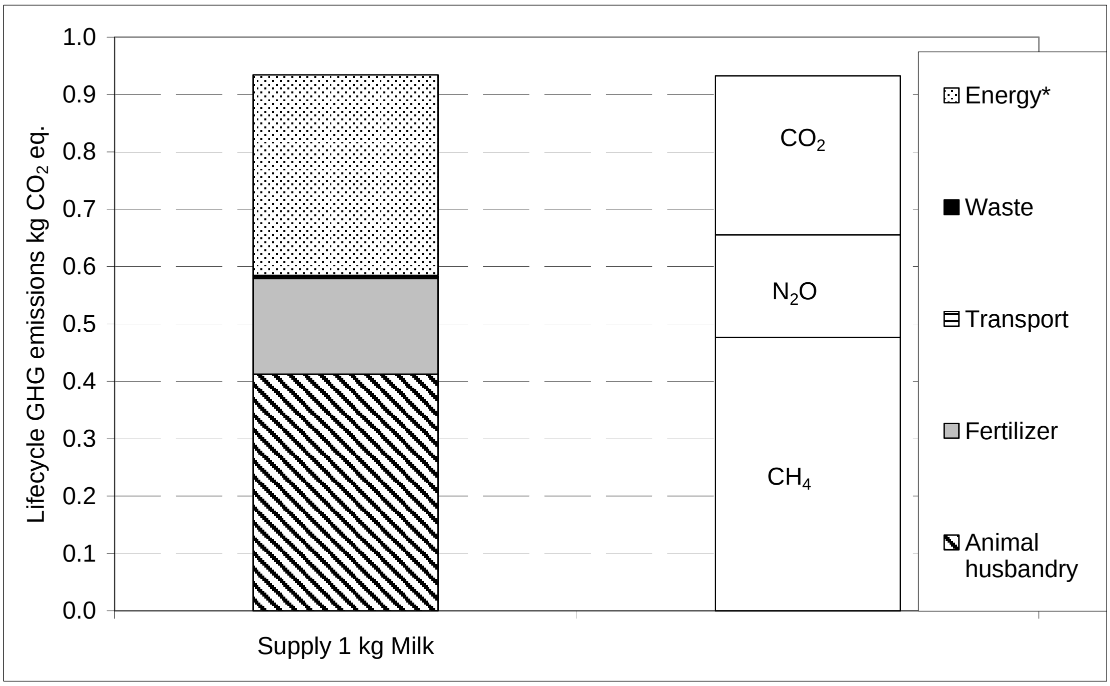
2.2.5.3 Product category example 1: meat and dairy production

Impacts

The importance of meat and dairy production in terms of environmental impact was highlighted in Section 2.2.5, in particular Figure 2.69. Specifically, it has been calculated that meat and dairy consumption contributes 24 % towards environmental impact from final consumption in the EU-27, whilst contributing 6 % towards economic activity (EC, 2008). For individual impact categories, meat and dairy production contribute between 6 % (mineral extraction) and 47 % (aquatic ecotoxicity). Aquatic and terrestrial eutrophication, nature occupation and acidification impacts are also high (25–39 %). Greenhouse gas emissions and other major environmental pressures are dominated by the following livestock system processes:

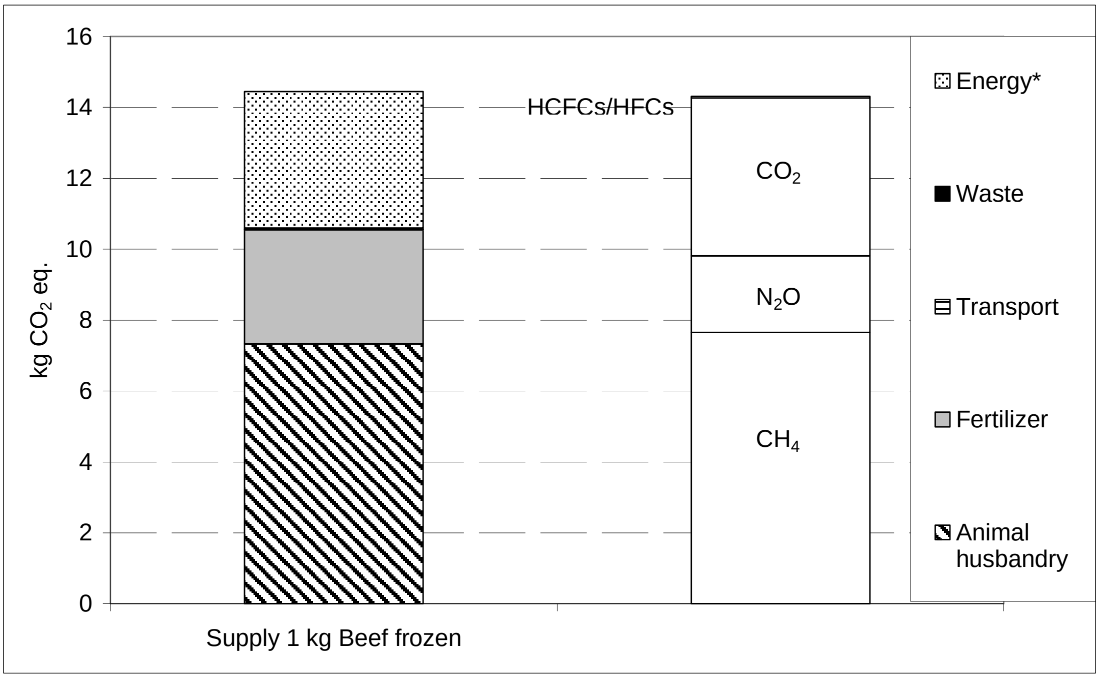
- animal husbandry
- feed production
- manure management
- fertiliser application
- fertiliser manufacture
- land occupation (expansion into (semi-)natural ecosystems).

To provide a brief example of global warming pressures attributable to milk and beef supply chains, the freely-available Global Emission Model of Integrated Systems (GEMIS) tool (Öko Institute, 2008) was used to assess the hundreds of individual processes that contribute to the lifecycle GHG emissions of these products. Processes were classified according to five main categories (Figure 2.70 and Figure 2.71), and highlight the importance of non-energy-related emissions of methane (primarily from enteric fermentation within cows' digestive systems, represented by animal husbandry) and nitrous oxide (primarily from manure management and fertiliser application). Transport and waste typically make minor contributions to the lifecycle GHG emission burdens (carbon footprints), and overall environmental footprints, of these products.



(*) Energy includes all direct and indirect energy associated with agricultural operations, excluding fertiliser manufacture and transport.

Figure 2.70: The origins and composition of GHG emissions arising during the production of 1 kg of milk, based on average German conditions, calculated using the GEMIS LCA tool



(*) Energy includes all direct and indirect energy associated with agricultural operations, excluding fertiliser manufacture and transport.

Figure 2.71: 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

Improvement options

The 2008 EC study on the environmental improvement potential of meat and dairy products recommended the following improvement potentials to reduce impacts associated with consumption by 20 %:

- plant catch crops during winter;
- improve growing practice and yields in low-yield areas;
- optimise protein feeding for pigs and dairy;
- reduce pH of liquid manure;
- tighten manure-application rules;
- reduce copper in pig and dairy cattle diets;
- introduce methane-reducing diets for dairy cattle;
- biogasification of manure from pigs and dairy cows;
- home-delivery of groceries;
- power saving across production-to-consumption chain;
- household meal planning.

In summary, the farming system (e.g. specialised versus integrated), animal husbandry, feed types and sources, and manure/fertiliser management are the processes with the greatest potential for modification to reduce GHG emissions and other impacts such as eutrophication. A number of no-regret efficiency options exist, such as ensuring good animal health and associated productivity, whilst the scope of management decisions can easily be expanded to consider lifecycle environmental pressures (e.g. when determining optimum slaughter age for beef-cattle).

Relevant basic environmental standards that avoid worst impacts, including expansion into (semi-)natural habitats, include:

- GlobalGAP
- National (or regional/local) Production Certification

The Rainforest Alliance standard may also be applied to meat from major source areas in central and South America, in particular to indicate that grazing land has not recently displaced forest or natural grassland habitats. Meanwhile, organic certification indicates lower resource use and guarantees minimal ecotoxicity pressures.

However, red meat and dairy production is not widely certified according to improved or exemplary standards, and there are various alternative approaches that farmers can adopt to reduce impacts – including intensification, extensification, or diversification into integrated systems. The most appropriate approach depends on local factors (e.g. the quality and availability of land, feed sources). Therefore, we propose that the most effective way to drive improvement in the short-term is to encourage monitoring and benchmarking of environmental performance across farmers, and disseminate best practice identified from front-runner farms. Some retailers are developing closer links with meat and dairy farmers to monitor performance and encourage environmental improvement in this manner: See Case study 2.8 in section 2.2.6.6.

2.2.5.4 Product category example 2: textiles (cotton production)

Impact

According to a report by MADE-BY (2010), textile production is dominated by polyester (40 % of the global fibre market) and cotton (35 % of the global fibre market). A separate report by MADE-BY (2009) classified the major textile fibres according to their overall environmental impact, based on six impact categories: global warming, human toxicity, ecotoxicity (each weighted 20 %), and energy input, water input, land use (each weighted 13.3 %). Polyester is rated as Class D, whilst cotton is rated as Class E (Table 2.35). Wool is another well known and high impact textile fibre, but is a considerably smaller constituent of global textile production. This section focuses on the fibre responsible for the largest share of the global environmental impact attributable to textile production: cotton.

Table 2.35: Ranking of different textile fibres according to environmental performance by MADE-BY

Class A	Class B	Class C	Class D	Class E	Unclassified
Recycled cotton Recycled nylon Recycled polyester Organic hemp Organic flax (linen)	Tencel (Lenzing lyocell product), **Organic cotton** In conversion cotton	Conventional hemp Ramie PLA Conventional flax (linen)	Virgin polyester Poly-acrylic Lenzing-modal (viscose product)	**Conventional cotton** Virgin nylon Rayon-cupram-monium Bamboo viscose Wool Generic viscose	Silk Organic wool Leather Elasthane (Spandex) Acetate Cashmere wool Alpaca wool Mohair wool Fiber-base bamboo
Source: (MADE-BY, 2009)					

Worldwide, 35 million ha of land are under cotton production (2.5 % of global arable land), mainly in India, US, China and Pakistan. The global average yield of 1670 kg seed cotton (584 kg lint) per ha varies considerably across regions, reaching 3837 kg seed cotton per ha in Israel (WWF, 2007). Cotton cultivation accounts for 8–10 % of world pesticide use, including 50 % of pesticide use in developing countries where handling practices are often poor (e.g. no protective clothing worn) and where worker exposure leads to a significant percentage of workers experiencing pesticide poisoning. On average globally, cultivation for one kg cotton lint requires 8 506 l of water, and up to 20 217 l in India (three quarters of cotton production is irrigation-fed). Flooding of cotton fields for irrigation can damage plant roots, increase weed invasion, result in high evaporative water losses and increase the risk/rate of soil salinisation. Further up the cotton value-chain, processing, dyeing and finishing of cotton in textile production can require a further 200 l per kg textile, and is associated with significant water pollution (e.g. COD loading).

India is the third largest cotton producer in the world, but productivity is low – on average 300 to 463 kg cotton lint per ha (CABI, 2009), reflecting poor seed supply, fibre contamination, and poor management practices. In Pakistan, another major cotton producer, yields have begun to decrease owing to poor seed quality (including supply of counterfeit hybrid seeds) and limited technical support. Similarly in West Africa, constraints to cotton production include poor seed supply, poor marketing structures, and lack of technical support (CABI, 2009).

Improvement options

There is considerable potential to improve the efficiency, and reduce the environmental impact, of cotton cultivation globally. Reducing resource use per unit output improves the financial security, and also the social conditions, on the many small family farms that produce cotton. Furrow irrigation methods can reduce water use by 50 %, and more advanced drip-feed irrigation systems can reduce water use by up to 70 % (WWF, 2007). The UN Food and Agricultural Organisation (FAO) promote an Integrated Pest Management (IPM) system – a practical approach to reduce chemical-pesticide use that includes the use of pheromones and natural pest predators, improved crop rotation practices, and highly targeted application of chemical pesticides (FAO, 2010). Implementation of IPM in a project involving 8 274 farmers in Punjab reduced pesticide use by 50 %, increased yields by 11 %, and increased profits by 46 % (CABI, 2009). IPM has therefore been recommended as Better Management Practice (BMP) for cotton farmers under the Better Cotton Initiative (Case study 2.7 in Section 2.2.6.5), and in Fairtrade standard criteria.

Organic cotton cultivation is another BMP option, particularly for smallholder farmers in isolated areas with poor access to agro-chemicals, and farmers who achieve low yields on marginal agricultural land, because it:

- allows inter-cropping with food crops
- reduces expenditure
- reduces the risk of pesticide poisoning (smallholders often lack protective clothing)
- improves soil quality
- enables farmers to obtain a price premium.

MADE-BY (2009) classifies organic cotton as Class B in terms of environmental impact, indicating considerably better environmental performance than conventional cotton which is ranked as Class E (Table 2.35).

Best practice for cotton farmers includes:

- use of furrow or drip irrigation, where irrigation is required
- Integrated Pest Management to minimise synthetic chemical applications
- nutrient management planning to optimise fertiliser use efficiency
- certified organic production.

Differing soil and climatic conditions necessitate regional-specific BMP research to optimise production. CABI (2009) suggest that the 29 % drop in cotton price in late 2008, coupled with decreasing global demand and subsidies given to cotton producers in developed countries, threatens the implementation of BMP in developing countries. Most improvement schemes have involved finance from foreign donors, and require long-term support to disseminate BMPs widely (e.g. through farmer field schools, training of facilitators, and resource centres (WWF, 2010).

Retailers can play an important role in driving environmental improvement across cotton supply chains, through:

- green procurement of recycled or certified cotton (e.g. BCI 'better cotton', Fairtrade cotton, or cotton from Oekotex-1000 certified suppliers, Section 2.2.6.4)
- providing funding and support for dissemination of more efficient cultivation (e.g. the BCI programme, Section 2.2.6.6)
- collaborating with suppliers to increase the availability of organic cotton (C&A, Case study 2.11 in section2.2.6.8; Coop Switzerland).

The textile supply chain comprises additional important processes with significant environmental impacts, including textile dying (and upstream dye production). Consequently, emissions to water and waste water treatment are also important in terms of environmental pressure and environmental protection within the textile supply chains.

2.2.5.5 Product category example 3: fish

Impact

According to a recent UN FAO study (FAO, 2009), over 75 % of the world's major fisheries are either fully or over-exploited, or already depleted. Catches in the western Central Pacific and in the western Indian Ocean continue to increase, but catches are declining in the western and eastern-central Atlantic Ocean. Most catches from inland waters occur in Asia, and are continuing to increase in part because of stock enhancement practices. Meanwhile, aquaculture continues to be the fastest growing animal food-producing sector, with per capita aquaculture fish supply increasing from 0.7 kg in 1970 to 7.8 kg in 2006 (FAO, 2009).

Relatively few LCA studies have been performed for wild catch fish supply chains. These few studies indicate that the fish harvesting stage accounts for 70–95 % of impact (Hospido and Tyedmers, 2005). Post harvest impacts associated with packaging, transport, cooling and cooking are typically relatively small compared with the harvest stage, though can be high for aluminium packaging of canned fish. For all the fisheries studied by Hospido and Tyedmers, the greatest relative (normalised) impacts were:

1. marine ecotoxicity
2. acidification
3. global warming
4. eutrophication.

Thrane et al. (2009) refer to Danish flatfish studies showing a 15-fold difference in fuel consumption per kg landed fish, depending on the fishing gear used. However, the most important impacts associated with wild catch fisheries, namely biotic renewable resource (i.e. fish) depletion and seabed damage, are poorly represented in LCA studies. Furthermore, options to reduce biotic depletion and seabed damage may conflict with options to reduce impacts such as marine ecotoxicity and global warming, indicated by LCA studies. For example, beam and bottom dredges are efficient in terms of fuel use, but cause extensive seafloor damage (Thrane et al., 2009).

The aggregate lifecycle environmental impact of fish farming can be lower or higher than wild-catch fisheries, per kg fish supplied, depending on the type of fish being farmed and the feed used. Fish farming often relies on wild-catch fisheries to supply feed, and is associated with localised eutrophication and toxicity impacts (d'Orbcastle et al., 2009). Shrimp farming is associated with significant negative impacts on coastal mangrove ecosystems.

Improvement options

The main improvement options for wild-catch fisheries are to avoid catching endangered species, and to manage (harvest) stocks sustainably based on the scientific monitoring of fish populations. In addition, fishing methods should minimise bycacth and seabed damage as much as possible without leading to large increases in fuel consumption. For retailers, the major best practice options to reduce the impacts of wild-catch seafood supply chains include:

- not stocking endangered species such as those on the WWF red list (section 2.2.6.4)
- green procurement of MSC-certified fish (section 2.2.6.4)
- implementation of tracking systems to ensure that fish do not come from unsustainable stocks (section 2.2.6.5)
- specification of efficient packaging and use of recycled aluminium for canning
- avoidance of air freight and optimisation of transport logistics.

Fish farms have considerable potential to provide fish sustainably if efficient feed inputs are used and pesticide use is minimised. They may be based on sustainable feed sources, including algae in turn fed by nutrients applied to the water – for some fish species such as tilapia. There is further scope for improvement of fish farming methods through the development of integrated systems that recycle nutrient-rich waste water from the fish farms for use in neighbouring cropping systems. This concept is implemented in its simplest form in integrated rice-fish systems (Berg, 2002). Best practice for fish farming systems includes:

- avoiding or reducing use of wild catch fish for feed
- minimising pesticide use
- avoiding nutrient sensitive areas
- implementation of integrated or organic systems.

Best practice options for retailers to reduce the impacts of farmed-fish supply chains include:

- stocking fish from integrated systems
- stocking organic-certified fish (e.g. KRAV label, section 2.2.6.8)
- encouraging the consumption of more sustainably produced species (e.g. tilapia)
- specification of efficient packaging and use of recycled aluminium for canning
- avoidance of air freight and optimisation of transport logistics.

In summary, the most important retailer action to improve the sustainability of wild-catch fish supply chains is to trace their fish supplies, and ensure that they originate from non-depleted and sustainably-managed stocks, using fishing methods that minimise damage to the seabed (e.g. MSC-certified, or Greenpeace Green-list fish species – see Section 2.2.6.4 and Section 2.2.6.5). For farmed fish, the most important retailer actions are to stock fish from low-input farms (organic and integrated systems) – see example of Coop Switzerland in Section 2.2.6.8.

During 2011, it is envisaged that a new comprehensive exemplary standard will become available for farmed fish, from the Aquaculture Stewardship Council (ASC). The ASC was founded in 2009 by WWF and the Dutch Sustainable Trade Initiative to establish global standards for sustainable aquaculture.

Once this standard and its associated label becomes available, best retailer practice for the sourcing of farmed fish will be green procurement of ASC certified fish.

2.2.5.6 Product category example 4: eggs

Impact

The German PCF Pilot project (PCF, 2009) published a detailed case study for Tengelmann quantifying the GHG emissions associated with the production of their Naturkind organic eggs.

The production of six eggs was calculated to cause the emission of 1.18 kg CO_2 eq. The major processes responsible for these emissions were:

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

The egg laying farm stage is responsible for the largest portion (59 %) of lifecycle GHG emissions for the production of six eggs (0.69 kg CO_2 eq.). Figure 2.72 demonstrates that emissions from the egg laying farm are dominated by manure management and feed production (responsible for approximately 79 % of egg laying farm emissions). Nitrous oxide is the largest component of GHG emissions from the egg laying farm stage, in terms of global warming potential. This arises from manure management, and fertilisation of feed crops. These processes are also hotspots for air emissions (ammonia) and eutrophication (nitrogen runoff).

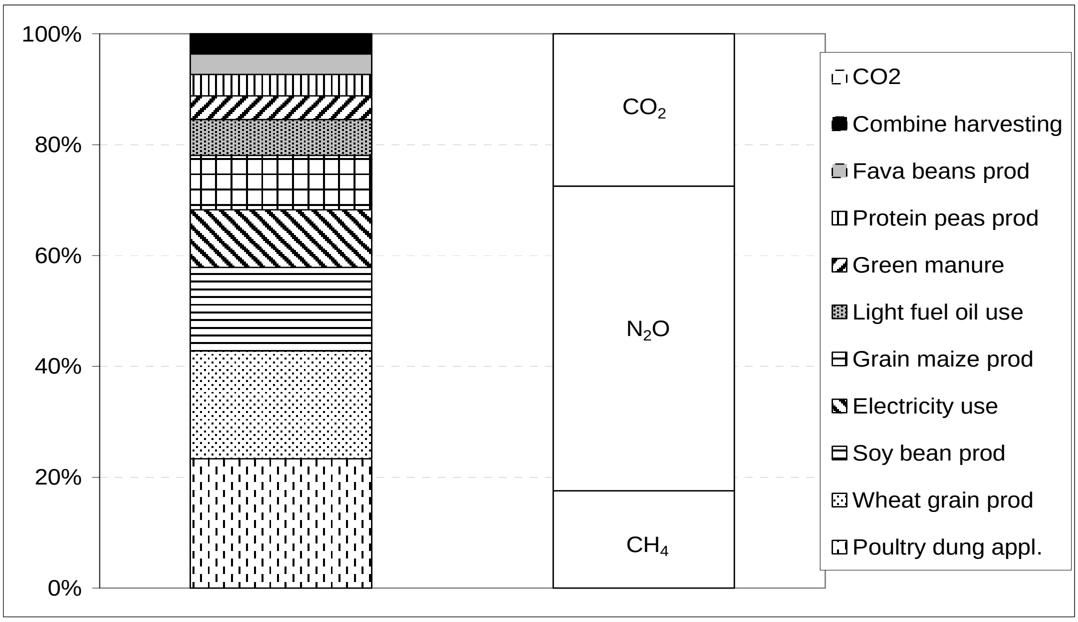


Figure 2.72: The contribution of processes and individual gases to GHG emissions on the egg laying farm

In additional to GHG emissions, major pressures associated with egg and poultry production include:

- eutrophication of water from nutrient runoff
- emissions of acidifying gases from fertiliser application, transport and farm machinery use
- displacement of natural habitat in tropical climates from soy feed production.

Improvement options

The following GHG reduction options were highlighted in the case study (reduction potentials are expressed as a percentage of the reference GHG footprint, 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 %).

Retailer options to reduce the environmental impact of egg supply chains include:

- green procurement of GlobalGAP or National Production Certified eggs
- benchmarking of farmers and encouraging adoption of BMPs (section 2.2.6.6)
- requiring farmers to use RTRS certified soy feed, or alternative sources of feed
- encouraging the consumption of certified organic eggs
- informing consumers of energy-efficient cooking methods (e.g. using an egg boiler).

2.2.5.7 Product category example 5: washing powder

Impact

Household chemicals represent an environmentally significant product group, and usually exhibit major environmental impacts at the use and disposal phases. In conjunction with the German PCF Pilot Project, Henkel performed a comprehensive LCA for one of their washing powders. This example also provides a best-practice case study for product assessment (Section 2.2.6.2). Data on manufacturing impacts were obtained from Henkel monitoring for ingredients manufactured on site, and from a lifecycle database (Ecoinvent v.2.01: http://www.ecoinvent.org/database/) for imported ingredients. The generation of domestic waste water and solid packaging waste were considered, and it was assumed that solid waste was incinerated to generate electricity. The recycling of packaging materials was not considered owing to an absence of data. For the use phase, an average scenario was applied, based on a wash temperature of 46 °C, a wash load of 3.9 kg, and an electricity demand of 0.68 kWh per wash (mean German values). The use phase was found to account for >70 % of the PCF (Figure 2.73), with extraction and supply of raw materials for powder production accounting for 20 %, and the production process itself accounting for just 2 %.

The range of likely use phase conditions was represented by low and high scenarios derived based on wash temperatures of 30 °C and 60 °C, loads of 5 and 2.5 kg, and light and heavy soiling, respectively (Table 2.36). The powder dose rate varied from 35 g for the light-soiling scenario to 116 g for the heavy-soiling scenario. The single most important factor for use-phase emissions was found to be the wash temperature.

Table 2.36: The effect of different usage characteristics on lifecycle GHG emissions per kg wash load, relative to the average scenario (first row)

Wash temp.	Load	Soiling	g CO_2 eq. / kg	Difference
46	3.9	Normal	180	0 %
30	3.9	Normal	115	-36 %
60	3.9	Normal	240	+33 %
46	**2.5**	Normal	280	+56 %
46	**5.0**	Normal	140	-22 %
30	3.9	**Light**	90	-50 %
90	3.9	**Heavy**	380	+111 %

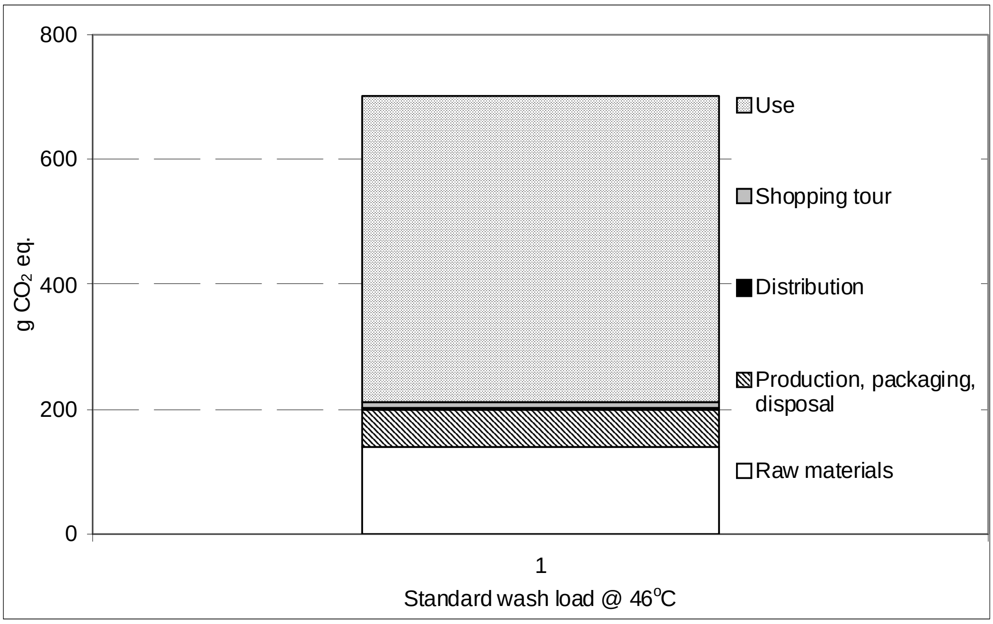


Figure 2.73: Breakdown of the major sources of GHG emissions over the product lifecycle of a single wash, under average use conditions (3.9 kg wash load at 46 °C)

In addition, a number of non-CO_2-related environmental impacts were found to be important at various stages of the washing lifecycle (Table 2.37). As with global warming potential, human toxicity, summer smog and resource depletion impacts mainly occurred during the use phase. However, eutrophication and BOD impacts mainly occurred at the disposal phase – in the final discharge from waste water treatment plants to the aquatic environment.

Table 2.37: The contribution of various lifecycle stages to the environmental impact associated with washing power use

Impact	Indicator	Raw mate-rials	Prod-uction	Pack-aging	Distri-bution	User Trans-port	Use phase	Disp-osal
GWP	kg CO_2 eq.	19.5	1.7	2.7	0.5	1.3	71.6	2.7
Eutrophication	kg PO_4 eq.	17.1	0.2	2.2	0.4	0.5	8.9	70.5
Human Toxicity.	kg 1.4-DCB	42.7	0.3	2.4	0.3	1.9	39.6	12.8
Summer smog	kg ethylene	43.9	0.5	4.2	0.8	3.9	41	5.6
BOD	kg	46.3	0.1	3.3	1.1	2.0	9.1	38.1
Resource depletion	kg antimony	26	1.8	2.9	0.5	1.1	66.2	1.6
Source: PCF Pilot Project (2009).								

Improvement options

From this LCA, Henkel concluded that the use phase represents the major opportunities for product lifecycle improvement. Higher GHG emissions during the production phase associated with enzyme production lead to considerably lower GHG emissions during the use phase by enabling low temperature washing. Henkel has targeted action at reducing the wash temperature required for their washing powders to work effectively, and conveys information on optimum dosing and temperature to consumers, on packaging and through a dedicated website (http://www.persil.com/thirtyDegreesWashing.aspx). In addition, Henkel has set a target to reduce the carbon footprint of production by 15 % between 2007 and 2012. Retailers can pursue similar ecodesign improvements for their private label washing powders, following the example of Carrefour applying ecodesign to reduce the ecotoxicity of their pesticide range (Carrefour, 2010).

Best environmental management practices by retailers to reduce the environmental impact of washing powder over its lifecycle:

- encouraging consumer shifts towards environmental labelled washing powders (marketing);
- green procurement of branded washing powders with lower self-declared (ISO Type-II label) or third party verified (ISO Type-III label) lifecycle impacts;
- ecodesign of private label washing powders to reduce lifecycle impact;
- informing consumers of economic savings from optimum dosing, loading and wash temperatures.

2.2.5.8 Product category example 6: sugar

Impact

The Migros 'CO_2 Champion' label is awarded to products with lifecycle GHG emissions at least 20 % lower than other products in the same category. Lifecycle GHG emissions are independently assessed by Climatop, and verified in a peer-review process. In late 2009 Migros had awarded the CO_2 Champion label to 104 products (Migros webpage, 2010). The results of Climatop's sugar LCA are summarised here (Climatop, 2008).

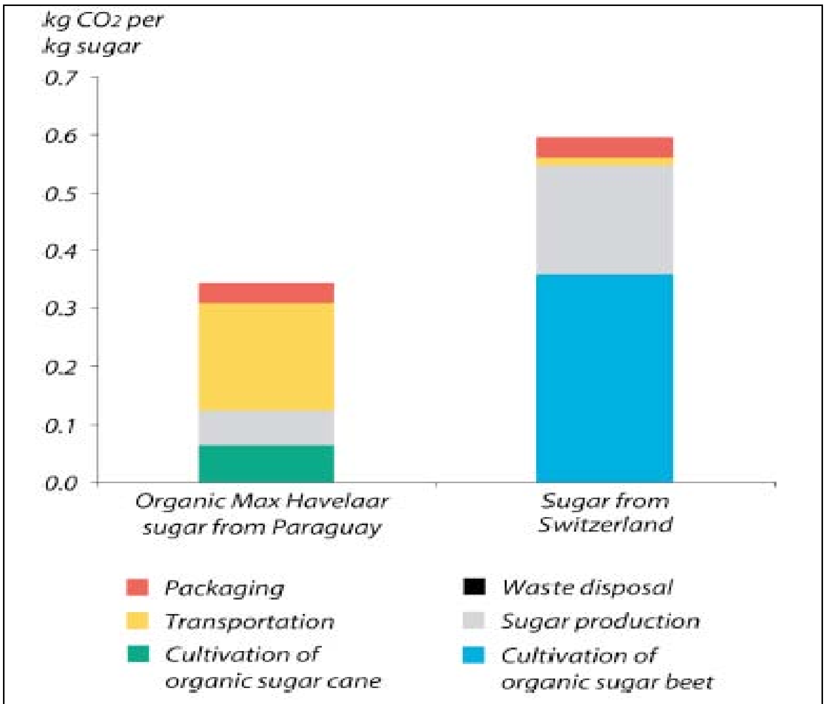
Total lifecycle GHG emissions were considered from sugar supply to the retailer, including all stages except the use phase. Six types of sugar were compared:

- sugar cubes and granulated sugar from Swiss/German sugar beet
- sugar cubes and granulated sugar from Columbian sugarcane
- organic granulated sugar from Swiss/German sugar beet
- organic granulated sugar from Paraguayan sugarcane.

The PCF per kg varied by a factor of two (see Table 2.38), primarily due to high cultivation emissions for sugar beet compared with sugarcane (see Figure 2.74). 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.

Table 2.38: Product carbon footprint values for different types of sugar

Sugar source and feedstock	kg CO_2 eq./ kg sugar
From Swiss/German sugar beet	0.6
From Columbian sugar cane	0.42
From organic Paraguayan sugar cane	0.32



Source: Climatop, 2008

Figure 2.74: Breakdown of GHG emission sources for different sugar products

In addition to GHG emissions, the sugar production contributes significantly to other environmental pressures, primarily:

- soil erosion
- depletion of water resources and salinisation where irrigation is used
- displacement of natural habitat in tropical climates
- eutrophication of water from nutrient runoff and sugar processing
- ecotoxicity effects from pesticide use
- emissions of acidifying gases from fertiliser application, sugar processing, transport and farm machinery use.

Improvement options

The conclusion for sugar is that lower cultivation and processing emissions for sugarcane in warmer climates more than offset emissions from sea-transport to Europe. The higher efficiency of sugarcane production should result in a lower environmental footprint across the range of environmental impacts, not just global warming. In particular, eutrophication, air emissions, and land use pressures should be reduced. Implementation of BMPs, as per cotton production (Section 2.2.5.4), can significantly reduce the range of environmental pressures associated with sugar cultivation.

Retailer best environmental management practices to reduce the environmental impacts of sugar supply chains include:

- sourcing private label sugar from sugarcane farmers (preferably with a certification to demonstrate that the sugarcane is not planted on recently deforested land);
- green procurement of Fairtrade certified sugar;
- encouraging a shift towards organic sugar consumption.

It is anticipated that the Better Sugarcane Initiative standard will be operational in 2011. Retailer best practice will then be represented by green procurement of sugar from Better Sugarcane Initiative certified suppliers.

2.2.5.9 Product category example 7: fresh fruit and vegetables (asparagus)

Impact

The results of the Climatop LCA for fresh green and white asparagus are presented in this section (Climatop, 2009). They present 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.

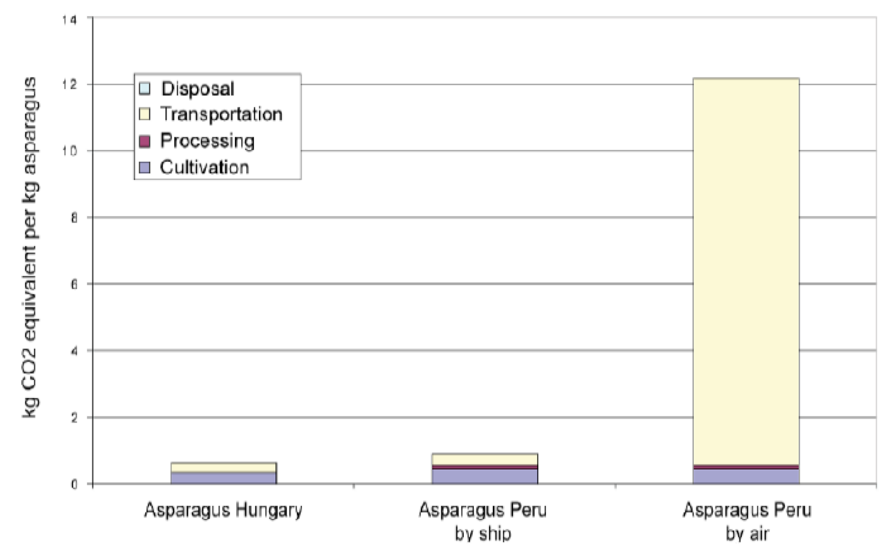
For asparagus, total life cycle GHG emissions were calculated up to the shop display stage, excluding emissions associated with consumption, as for sugar. Five types of asparagus were compared. In decreasing order of carbon footprint they were:

- white asparagus flown from Peru
- green asparagus flown from Mexico
- white asparagus shipped from Peru
- green and white asparagus transported by lorry from Germany
- white asparagus transported by lorry from Hungary.

The PCF for 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. As for sugar, cultivation emissions arise mainly from fertiliser application and manufacture, but also from manufacture of plastic sheeting, machinery fuel use, and soil carbon loss under tillage agriculture.

In addition to GHG emissions, the cultivation of fruit and vegetables contributes significantly to other environmental pressures, primarily:

- soil erosion
- depletion of water resources and salinisation where irrigation is used
- eutrophication of water from nutrient runoff
- eco toxicity effects from pesticide use
- emissions of acidifying gases from fertiliser application, machinery use and transport.



Source: (Climatop, 2009)

Figure 2.75: Breakdown of GHG emission sources for asparagus from different sources

Improvement options

The main conclusion for asparagus (and similar fresh products) is that air transport, but not ship transport, over long distances can massively increase PCFs, and should be avoided where possible. However, out-of-season production in greenhouses heated by fossil fuels can lead to even higher environmental burdens than long-distance transport, so should also be avoided. Some retailers are shifting their sourcing of short shelf-life fruit and vegetables to closer regions with warm climates, from where products may be transported using water- and land-based transport modes, such as Morocco (Coop Switzerland, 2010; M&S, 2010). Retailers are also encouraging seasonal consumption and/or working with regional suppliers to extend the growing season without relying on artificial heating (e.g. Sainsbury's, 2010).

Some retailers balance the environmental costs of long-distance transport against the social benefits of production in developing countries. Coop Switzerland does this with Fairtrade roses sourced from Kenya, and buys carbon credits to offset transport CO_2 emissions (Coop Switzerland, 2010).

However, it is crucial that retailers consider the range of major environmental pressures associated with fruit and vegetable cultivation when taking action to reduce GHG emissions. In particular, retailers can require growers to implement BMPs as per cotton production (Section 2.2.5.4). These include use of efficient drip irrigation techniques, application of IPM, and implementation of a nutrient management plan based on periodic soil testing.

Best environmental management practices for retailers to reduce the environmental impacts of fresh fruit and vegetable supply chains include:

- green procurement of GlobalGAP or Fairtrade certified fruit and vegetables (section 2.2.6.4);
- encouraging a shift towards organic consumption (section 2.2.6.8);
- performing environmental assessment to identify efficient improvement options specific for each type of fruit and vegetable (section 2.2.6.2);
- encouraging seasonal consumption;
- not stocking air-freighted products, subject to sustainability assessment (section 2.2.6.4);
- developing supplier capacity for short shelf-life products in warm regions within a range of water- and land-based transport modes (section 2.3.4.3).

2.2.5.10 Agricultural improvement option 1: continuous improvement of conventional production

Synthetic nitrogen application has been a key factor driving large increases in global food productivity, and supports 50 % of global food production. Continuing yield improvements and synthetic fertiliser application are regarded as essential to satisfy the growing demand for food driven by: (i) a global population that is forecast to peak at around 9 billion people in 2050, from 6 billion people today; (ii) a shift towards more protein (dairy and meat)-rich diets in developing countries. In particular, it is argued that agricultural intensification is key to reducing further encroachment of agricultural land into natural habitats, and the array of environmental impacts associated with this. For example, it is estimated that land use change for agriculture accounts for 12 % of global GHG emissions, almost half of agriculture's total contribution of 26 % (Bellarby et al. 2008).

The fertiliser industry has used LCA to demonstrate that the land appropriation and global warming consequences of lower production associated with no synthetic fertiliser-N application exceed the acidification, eutrophication and global warming consequences of moderate (96 kg ha^{-1} yr^{-1}) and high (192 kg N ha^{-1} yr^{-1}) but not very high (288 kg N ha^{-1} yr^{-1}) fertiliser-N application rates for grain production (Brentrup, 2010). Burney et al. (2010) estimate that agricultural intensification (increased fertiliser and pesticide application, but also crop breeding, increased mechanisation and irrigation) has prevented between 1.9 and 2.3 Gt C per year globally on average between 1961 and 2005 (equivalent to between approximately 14 % and 16 % of current annual global emissions). Synthetic fertiliser application can also contribute to long-term soil organic matter accumulation in non-tilled grassland soils (Byrne et al., 2007).

So, on the one hand, fertiliser-N application requires energy-intensive fertiliser production (accounting for 0.8 % of global GHG emissions), and results in emissions of N_2O (1.3 % of global GHG emissions: Bellarby, 2008), NH_3 and NO_x – contributing to global warming, acidification and eutrophication. On the other hand, fertiliser application enables higher yields that can help prevent further loss of ecologically-valuable natural habitats. There is considerable scope to increase the efficiency of intensive agricultural production (i.e. reduce the inputs and impacts per unit of output), and doing this is a route to widespread environmental improvement (e.g. as demonstrated by the Better Cotton Initiative: Case study 2.7 in Section 2.2.6.6).

2.2.5.11 Agricultural improvement option 2: organic production

Whilst improving the efficiency of conventional intensive agricultural production is widely regarded as a necessity to meet expected increases in food demand in the medium term, there remain some serious questions regarding the long-term sustainability of intensive production in many areas. A recent review of soil erosion rates in relation to soil formation rates across Europe estimated that actual soil erosion rates for tilled arable land range from three to 40 times above sustainable erosion rates (Verheijen et al., 2009). There is growing concern about the quality of agricultural soils (EU Soil Framework Directive), especially the depletion of organic matter associated with long-term tillage agriculture, salinisation associated with irrigation in hot climates, and physical (structural) degradation (e.g. IAASTD, 2009). Meanwhile, reserves of phosphorus mined for fertiliser production are rapidly depleting, and supply is expected to peak in 2030 against projected increases in demand from conventional agricultural practices (Cordell et al., 2009).

Organic agriculture can contribute considerably towards improving agricultural sustainability through the maintenance of soil quality (especially by increasing organic matter content), and by supporting sustainable biological nutrient cycles – through the utilisation of the large quantities of organic nutrients currently diffused to the environment in waste streams. The UN FAO regards soil improvement associated with organic agriculture as an effective adaptation option for a changing climate (Niggli et al., 2009), whilst IFOAM claim that organic agriculture could sequester enough carbon in soil and vegetation to offset one third of human GHG emissions (up to 2.3 t C ha^{-1} yr^{-1} in a long-term arable crop field trial in the US). Compared with conventional intensive agricultural production, yield increases have been lower for organic production, and yields are typically around 30 % lower per ha of land farmed (IFOAM, 2009). Nonetheless, crop development and investment have so far focused on conventional production: further investment in, and crop development for, organic methods could increase yields substantially. Meanwhile, organic production develops knowledge on sustainable soil, nutrient and pest management practices that can be transferred to improve non-organic production.

In summary, there is a clear need for widespread continuous improvement of conventional farming systems, in particular to reduce pesticide, water and fertiliser input per unit of product output. Such improvement will be central to improved supply chain sustainability. Meanwhile, development of alternative farming systems, such as organic, develops the knowledge required to achieve genuine sustainability in the longer-term (Figure 2.76). Therefore, retailer actions to improve supply chain sustainability should focus on **both:**

(i) driving widespread continuous improvement of intensive agricultural production through green procurement (Section 2.2.6.4), product environmental specifications (Section 2.2.6.5) and intervention (Section 2.2.6.6);

(ii) stimulating alternative production systems, such as organic and integrated systems, by encouraging a shift towards the consumption of certified front-runner (e.g. organic) products (Section 2.2.6.8).

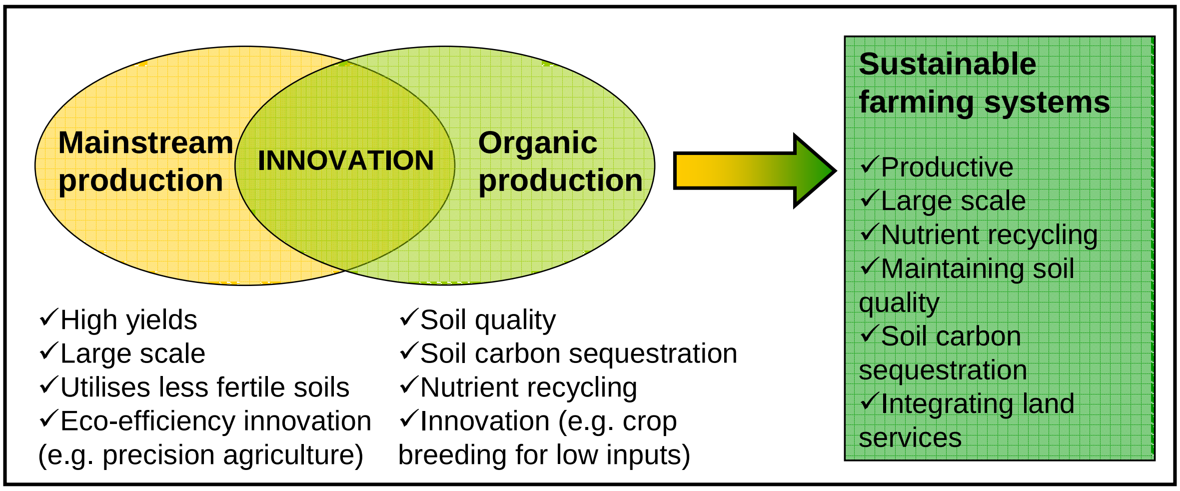


Figure 2.76: The complementary roles of mainstream production and organic production in driving the innovation required to achieve sustainable farming systems

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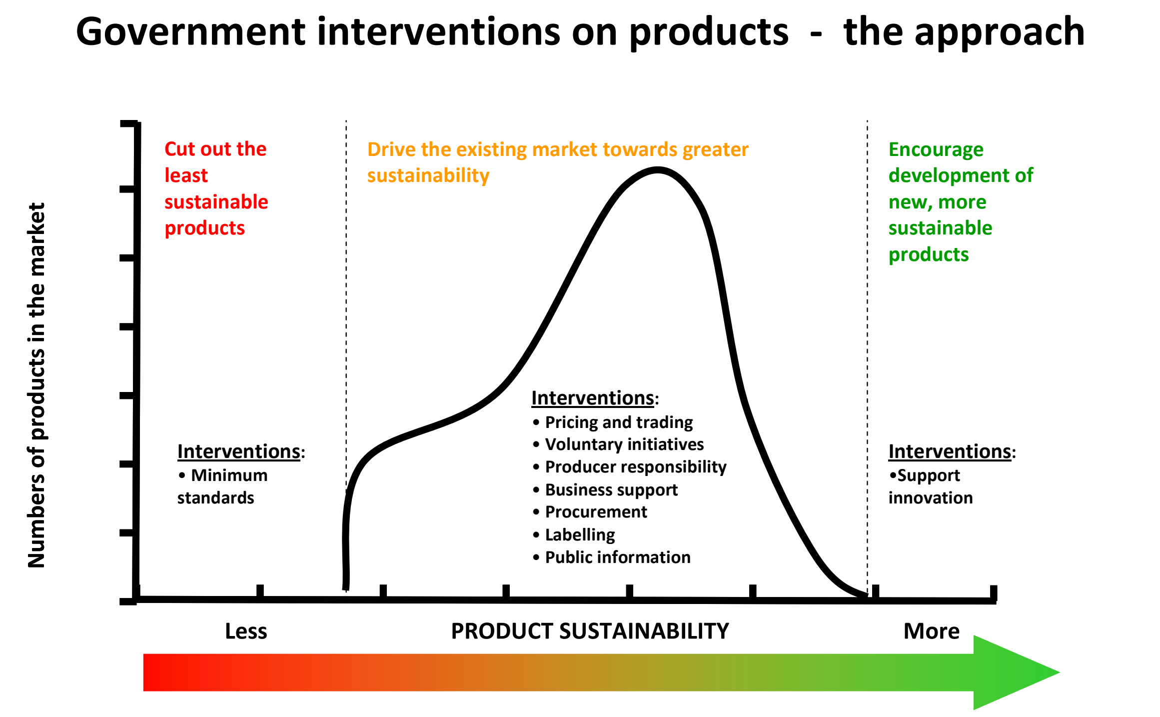
2.2.6 Best environmental management practices for supply chain improvement: techniques overview

Product improvement options

Figure 2.77 provides an overview of interventions that can be employed by governments to drive environmental performance improvement of products (Ryder, 2008). All these interventions are pursued to varying degrees for different product groups through existing EU or member state policies, and provide a useful context for the role of the retail sector in driving product supply chain improvement. In fact, many of the improvement options in Figure 2.77 can also be implemented by retailers, perhaps more effectively than by national governments for globalised supply chains.



Source: DEFRA, 2008.

Figure 2.77: Options to drive product improvement through 'push' and 'pull' effects

Retailer influence over suppliers and consumers

Retailers have strong direct and indirect influence over the supply chains of their private label (own brand) products (Section 2.2.3). By establishing environmental performance criteria for private label products through third party certification and contract agreements, or supporting suppliers to address environmental hotspots, retailers can have a powerful influence over the performance of their supply chains through a 'push' effect (Figure 2.78). Retailers may also use choice editing ('push') and green procurement ('push' or 'pull' depending on whether environmental certification is mandatory for a product group) to influence the supply chains of branded products.

Retailers have significant direct influence over consumer choice, through the provision of environmental information and the marketing (pricing and positioning) of front-runner products. Front-runner ecological products should be identified to the consumer with rigorous Type-1 environmental labels (Figure 2.78). The decision to obtain Type I environmental label certification is usually taken by suppliers for marketing purposes, but may be encouraged by retailers (Section2.2.6.8). Front-runner products are often associated with a price premium which consumers must be willing to pay to create demand and thus pull supplier improvement

(Figure 2.78). The main role of retailers with respect to environmental labelled products is to encourage this consumer pull effect through environmental awareness campaigns and marketing of front-runner products (e.g. by inclusion in an umbrella ecorange). In this role, retailers act as an intermediary between front-runner ecological producers and consumers, and their net influence is regarded as smaller than for push effects (Figure 2.78), as reflected in priotirisation below (Table 2.39).

Fundamental shifts and overall reductions in consumption will be important to achieve sustainability, but conflict with retail business objectives and are outside the scope of this chapter. Targeted application of best practice techniques represents an opportunity for retailers to leverage their influence over the entire value chain, and drive widespread environmental improvement.

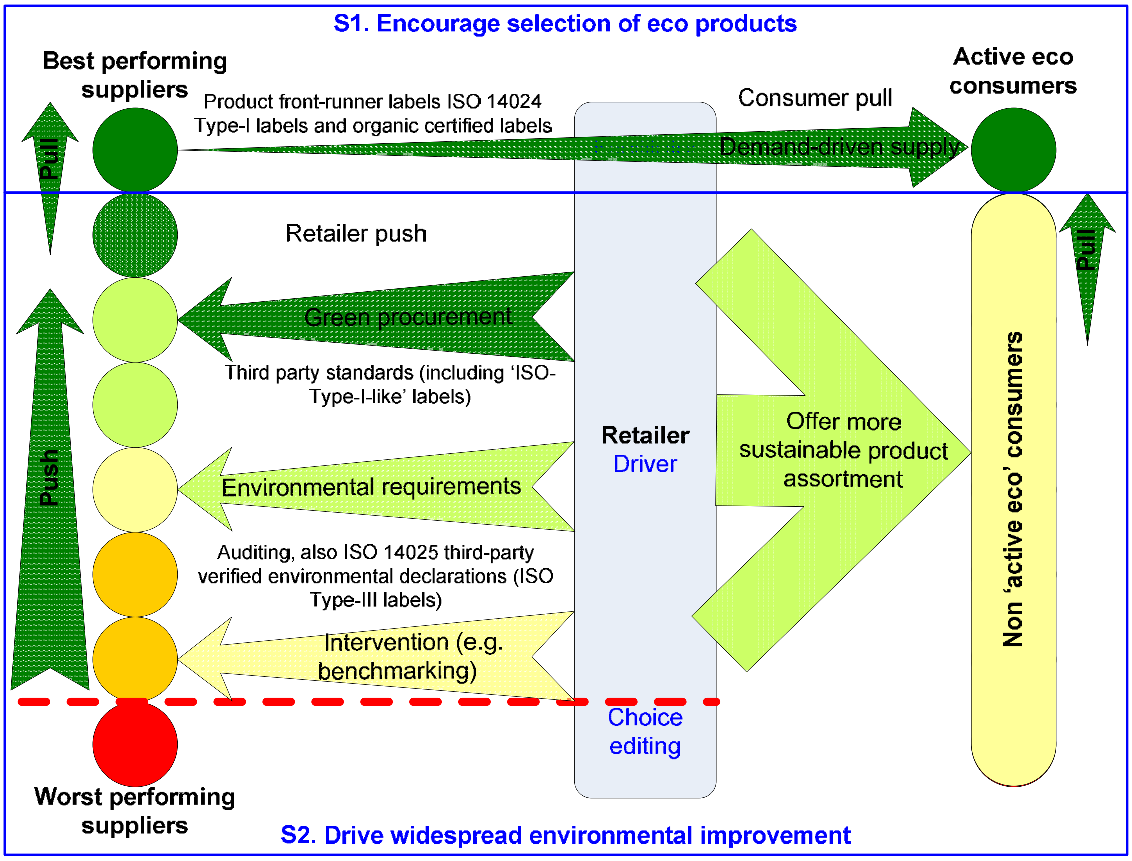


Figure 2.78: Key mechanisms by which retailers may improve the sustainability of supply chains, and the roles of standards and relevant ISO-classified environmental labels

Identification of core priority products

The range of products, environmental impacts and suppliers involved in retail supply chains is vast (e.g. Figure 2.64 in Section 2.2.2 and Figure 2.69 in section 2.2.5.1). It is critical that retailers target supply chain monitoring and improvement to maximise environmental improvement potential, in particular:

- focus on the most important environmental impacts, processes and products as indicated in Section 2.2.5;
- focus on high sales volume (by value) products – subsequently referred to as 'core products' in this document.

There is much scope for improvement in supply locations where regulations are weak and production processes are less developed, although the ability of retailers to influence environmental performance in such locations may be lower compared with geographically closer supplier locations.

Overview of retail approaches and techniques

Table 2.39 provides a simplified categorisation of the major strategies and associated actions (techniques) being employed by retailers to improve the environmental performance of their supply chains. Some techniques are more relevant to some sizes and formats of retailer (e.g. grocery versus specialist) than others, depending on the range of products they sell and the degree of influence they have over their supply chains. A number of techniques are critical prerequisites for the effective supply chain environmental improvement, and apply to all retailers.

- **Technique 1** in Table 2.39: top-level management must prioritise the improvement of supply chain sustainability, demonstrated through (i) reported quantifiable targets set at the corporate and operational (e.g. procurement) level, and (ii) communication of supply chain sustainability actions to stakeholders, including shareholders and customers (e.g. embedded in marketing). Supply chain sustainability needs to be integrated into the retail organisation through establishment of a top-level-management steering committee to drive and coordinate necessary actions across all relevant business units and departments.
- **Technique 2** in Table 2.39: assessment of product supply chain environmental impacts (using published scientific reports, advice from experts, and in-house assessment) to identify priority products, processes and impacts for intervention.
- **Technique 3** in Table 2.39: identify effective supply chain improvement mechanisms, based on identification of hotspots and appropriate certified environmental standards. Where such standards are not available, transparency and traceability must be introduced throughout the supply chain through communication with suppliers and collaboration with other retailers (e.g. via supplier data exchange systems such as Sedex: http://www.sedex.org.uk/sedex/go.asp?u=/WebSite/home&pm=6&location=Home).

The first strategy defined in Table 2.39 is for retailers to drive widespread environmental improvement across products and suppliers. It is based on:

- **Technique 4** in Table 2.39: choice editing to exclude the most environmentally-damaging products, and green procurement of products complying with basic, improved or exemplary level standards (Table 2.29), applied to priority product groups.
- **Technique 5** in Table 2.39: establishment of environmental requirements (criteria) for core product groups, enforced alongside routine product quality criteria in quality assurance systems.
- **Technique 6** in Table 2.39: retailer intervention in the supply chain to measure and benchmark environmental performance, and to disseminate better management practices.
- **Technique 7** in Table 2.39: participate in strategic collaboration between retailers, branded-product manufacturers, suppliers, research institutes and NGOs to develop new product standards and drive innovation.

The second strategy defined in Table 2.39 can complement the first, and is defined as retailers encouraging consumers to select ecological products. It is comprised of one technique:

- **Technique 8** in Table 2.39: encouraging ecological consumption through awareness campaigns and marketing of front-runner ecological products (defined by third-party certified exemplary standards, in particular ISO Type I environmental labels).

A framework for systematic improvement of retail product assortments

Techniques displayed in Table 2.39 are listed in order of priority, according to their potential to improve the overall sustainability of retail supply chains (for entire product assortments). Figure 2.79 presents a sequence of questions and actions that retailers can apply across priority product groups (identified in Section 2.2.6.2) to effectively implement the first strategy in Table 2.39, and systematically improve the environmental sustainability of their product assortments.

Clearly, implementing prerequisite techniques is the first priority for retailers who want to improve their supply chains, including assessing product groups (Figure 2.79). Subsequently, the greatest improvement potential exists in requiring suppliers to comply with widely-recognised third-party-certified environmental standards (Technique 4). A number of high impact product groups remain poorly represented by such standards at the basic and improved level (Table 2.29 and Table 2.34) – for example dairy and red meat. In such cases, front-runner retailers are either developing their own environmental requirements (Technique 5) or engaging with suppliers to define and drive environmental improvement (Technique 6). Front-runner retailers also engage with the development of third party standards that can be applied to products in the future, and participate in research to drive product innovation (Technique 7).

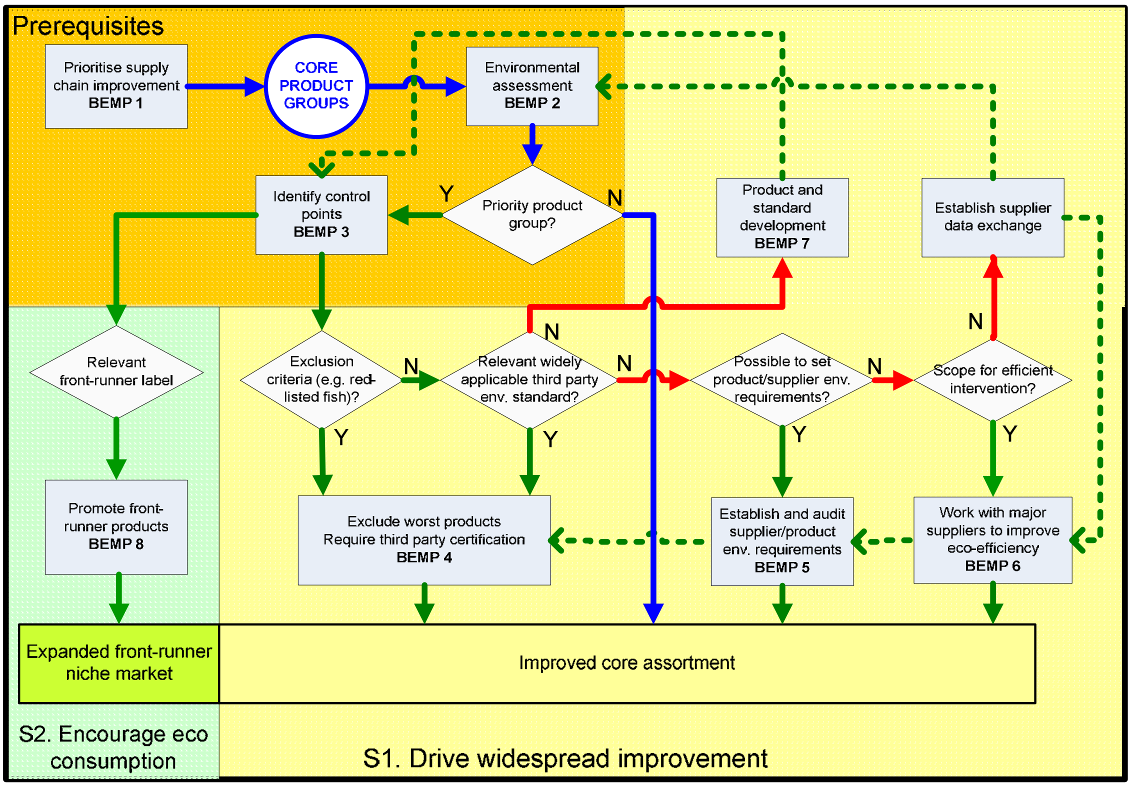


Figure 2.79: Proposed sequence of key questions and actions (shaded rectangular boxes) representing best practice for systematic supply chain improvement, divided into prerequisites or one of two strategies (S1 and S2)

Environmental labelled products typically demand a significant price premium, and are therefore bought by a minority of ecologically-aware consumers. The direct environmental improvement potential of the second strategy (Technique 8) in Table 2.39 is therefore limited by the extent to which retailers can expand this share of consumers, and/or further shift the purchasing decisions of these consumers towards environmental labelled products. However, a small but commercially-viable market in exemplary ecological products may drive sufficient front-runner innovation to significantly improve wider environmental performance. Technique 8 may therefore be associated with significant indirect environmental improvement potential, and is an important complement to the other techniques, but is a lower priority in terms of maximising retailer leverage over supply chains.

Note that product labelling of environmental performance (ISO Type III labels) can be used as a basis for retailers to select products and suppliers (i.e. green procurement), but does not represent best practice in communicating ecological products to consumers. Two key defining characteristics of front-runner retailers are:

- front-runner retailers take responsibility for improving their supply chains, and do not abdicate this responsibility to consumers who cannot reasonably be expected to have a strategic overview of complex supply chain sustainability challenges;
- front-runner retailers work with their suppliers to systematically improve the environmental performance of their core supply chains, using independent standards where possible.

Demonstration by example

Developing sustainable supply chains is a massive and complex task that is difficult to quantitatively measure in its entirety, and that retailers are just beginning to address. Consequently, this chapter:

- proposes technique implementation in a step-wise manner across priority (high sales value, high environmental impact) product groups, and presents indicators and benchmarks of excellence **expressed at the level of individual priority product groups**;
- uses case studies on best practice technique implementation by specific retailers to elucidate individual techniques and demonstrate their commercial viability (see examples listed in Table 2.39).

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Table 2.39: Portfolio of approaches and techniques employed by retailers to improve supply chain sustainability

Strategy	Best practice techniques	Examples	Applicability	Section
Prerequisites: integrate sustainable sourcing into business strategy and operations	**1. Integrate sustainable sourcing into business strategy and operations.** Develop supply chain environmental improvement objectives and specific targets that are communicated to stakeholders and integrated into the retail organisation through a high-level unit with responsibility for implementation.	Coop Switzerland (Case study 2.2); M&S's Plan A (Case study 2.1)	All retailers	2.2.6.1 (p. 159)
	2. Product supply chain assessment. Collate scientific information on product environmental hotspots, and identify priority improvement options.	Coop Switzerland (Case study 2.3); M&S and WWF; Sustainability Consortium (Albert Heijn, Asda, M&S, Safeway)	All retailers All core products	2.2.6.2 (p. 165)
	3. Identify effective supply chain improvement mechanisms. Identify chains of custody and control points to influence the environmental performance of priority product groups and suppliers.	H&M (Case study 2.4); Migros (RSPO, Case study 2.5)	All retailers All core products	2.2.6.3 (p. 173)
1. Drive widespread product and supplier environmental improvement	**4. Choice editing and green procurement.** Exclude worst performing products, and require widespread certification according to 'basic', 'improved' or 'exemplary' environmental standards for priority product groups.	Sainsburys, M&S (RSPO); Coop Switz, Migros, Rewe (GlobalGAP); IKEA, M&S, Migros (BCI); M&S, Waitrose (MSC fish); B&Q (FSC)	All retailers All core products	2.2.6.4 (p. 173)
	5. Establish environmental criteria for products and suppliers. Define and enforce 'basic', 'improved' or 'exemplary' environmental standards for suppliers of priority product groups, targeting environmental hotspots, and work with suppliers to improve performance.	H&M (CoC, CR, BSR-WWQG); IKEA (IWAY CoC and Wood Sourcing: Case study 2.6); Migros (Terra Suisse)	Larger retailers Private-label core products	2.2.6.5 (p. 181)
	6. Intervene to encourage supplier improvement. Assist supplier certification according to third party standards, disseminate best practice, benchmark performance.	BCI (Case study 2.7); H&M (CPP: Case study 2.9); Sainsburys (DDG: Case study 2.8)	Larger retailers Private-label core products	2.2.6.6 (p. 203)
	7. Strategic collaboration on product and standard development. Participate in research to drive supply chain innovation, including collaboration to develop product standards and supplier data exchange.	Coop Switzerland (FiBL research: Case study 2.10); Tesco (Sustainable Consumption Institute)	Larger retailers All core products	0 (p. 213)
2. Encourage ecological purchasing	**8. Promote front-runner ecological products.** Use awareness campaigns, positioning, pricing and own-brand ecological ranges to promote **third-party-certified** ecoproducts. Expand availability of these products.	Albert Heijn (Pure and Honest); B&Q (One Planet Home); C&A (organic cotton: Case study 2.11); Colruyt (Bio Planet stores); Coop Switz (Naturaplan/Naturaline); Migros (Bio)	All retailers All core products	(2.2.6.8 p.219)

NB: BCI, Better Cotton Initiative; BSR WWQG, Business for Social Responsibility Wastewater Quality Guidelines; FSC, Forest Sustainability Council; GAP, Good Agricultural Practice; MSC, Marine Sustainability Council; RSPO, Roundtable on Responsible Palm Oil; RTRS, Roundtable on Responsible Soy .

2.2.6.1 Integrate supply chain sustainability into business strategy and operations

Description
The transformation of existing supply chains into sustainable supply chains is a massive and long-term challenge faced by retailers and other key stakeholders, including consumers. The scale and long-term nature of this challenge require that supply chain environmental improvement be given explicit recognition and prioritisation by top-level retail management if it is to be effectively addressed (through a systematic and strategic plan). Coordination is required across the many business units typically involved in aspects of the supply chain, including those responsible for procurement, manufacturing, quality assurance, transport and logistics, and marketing. This in turn requires strategic management of supply chain issues, best achieved through a high-level business unit with overarching responsibility for them.

Integrating management of supply chain sustainability into retail organisations can improve long-term economic performance, both through creating a strong value-added brand identity, and by securing efficient and sustainable product supplies into the future. A recent report published by the global management consulting company Accenture (Accenture, 2009) found that businesses with greater control over their supply chains exhibited stronger economic performance than businesses with less control over their supply chains. The establishment of quantitative sustainability targets that are widely communicated and highly weighted in the corporate decision-making process is particularly important, both as an indicator and driver of actions to improve supply chain sustainability.

It is important that the full range of environmental impacts attributable to product supply chains are considered (air pollution, biodiversity, climate change, ecotoxicity, resource depletion, water quality and availability, etc.) in order to effectively prioritise particular supply chains and target improvement actions. These should be considered alongside social and economic aspects so that the overall sustainability of supply chains can be optimised. It appears that this is not yet the case for many retailers. Whilst most sustainability reports from major retailers refer to the carbon footprint of supply chains, only a few retailers demonstrate comprehensive awareness of wider environmental impacts. Even fewer demonstrate an integrated understanding of environmental, social and economic aspects, or implement strategic programmes for comprehensive and systematic supply chain improvement.

Achieved environmental benefits
Front-runner retailers who have successfully integrated supply chain sustainability objectives into their operations demonstrate best practice across a range of techniques, and achieve environmental benefits detailed in Section 2.2.6.4 to Section 2.2.6.8. The overall environmental impact attributable to these retailers' product assortments is being systematically reduced.

Appropriate environmental indicator
Integration of sustainable supply chain management into retailer organisations necessitates a number of features that can be categorically defined, including:

- public reporting of quantitative corporate targets specifically related to improving the sustainability of priority product supply chains (e.g. in annual reports);
- presence of a high-level business unit with responsibility for driving and coordinating supply chain sustainability actions (e.g. 'How we do business committee' in Figure 2.28);
- quantitative internal performance targets (e.g. for individual employees) specifically related to supply chain sustainability.

The scope and comprehensiveness of targets can be used to indicate best practice, with leading retailers demonstrating a comprehensive understanding of environmental challenges throughout the supply chains of many core products (e.g. in sustainability reports). Meanwhile, the main indicators of successful integration of supply chain environmental improvement are based on achieved improvements, and can be assessed from retailer performance across key techniques, according to quantitative targets proposed for Techniques 4, 5, 6 and 8. These indicators can be summarised as:

- percentage of products in core product groups that are certified according to third party standards of varying stringency (Section 2.2.6.4 and Section 2.2.6.8);
- percentage of products in core product groups that comply with environmental criteria specified by the retailer (Section 2.2.6.5);
- percentage of products in core product groups that originate from suppliers participating in retailer-driven eco-efficiency improvement programmes (Section 2.2.6.6).

A **proposed benchmark of excellence** is the systematic implementation of supply chain improvement programmes across priority product groups, as indicated in schematic Figure 2.78 (section 2.2.6).

Cross-media effects

Best practice integration of supply chain sustainability objectives reduces the overall environmental impact of product assortments by targeting priority products and considering all major environmental impacts (air pollution, biodiversity loss, climate change, ecotoxicity, resource depletion, etc.). This is informed by comprehensive environmental assessment of core product supply chains using tools such as LCA (Section 2.2.6.2). Any cross-media effects should be identified and considered within the design of optimized improvement options.

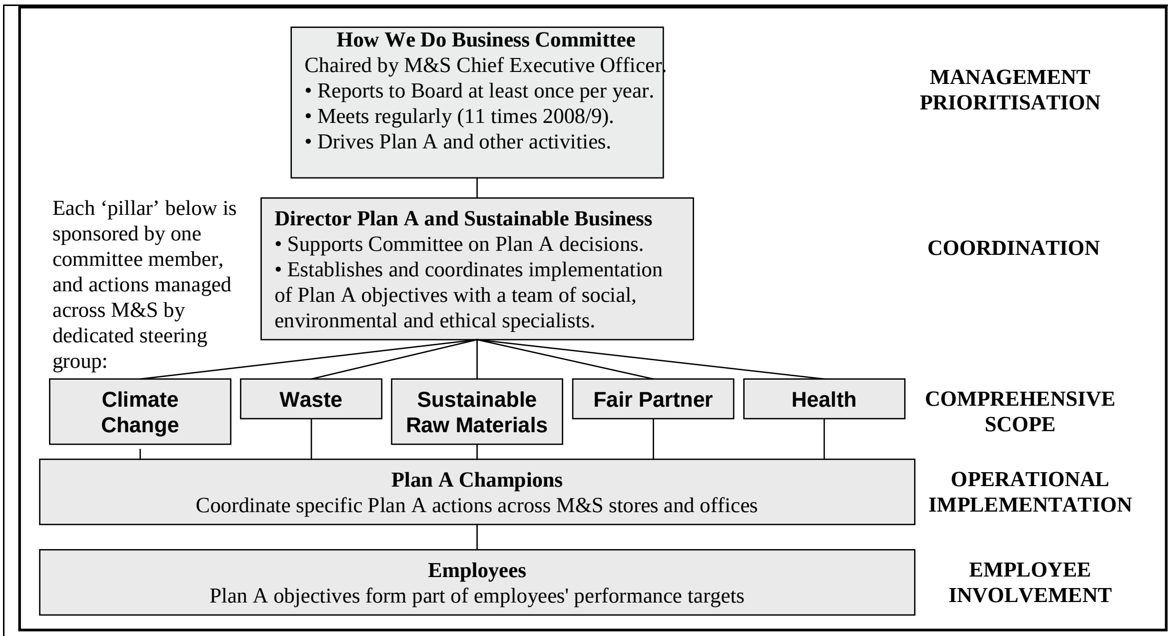
Retail managers at the corporate and operational levels may need to decide how to balance trade-offs between various aspects of sustainability. Examples of this include:

- social benefits of providing employment in developing countries versus the impact of long-distance transport for perishable products such as flowers;
- animal welfare benefits of free-range production versus higher per-unit GHG and air-pollution emissions.

Some retailers use balanced scorecards to help decide such trade-offs, and front-runner retailers explicitly communicate trade-offs to stakeholders (e.g. Coop Switzerland, 2009).

Operational data

Best practice is illustrated through case studies for two front-runner retailers, below. Figure 2.28 shows the management hierarchy for M&S's comprehensive Plan A (Case study 2.1), and provides an example of how sustainability objectives can be integrated into a retailer's management structure and operations (based on top-level prioritisation, and a high-level committee to integrate sustainability objectives).



Source: based on information from M&S, 2009

Figure 2.80: The management and implementation of sustainability objectives in M&S

Case study 2.1: M&S's comprehensive Plan A sustainability strategy

Management

In 2007, M&S launched their 'Plan A' ('there is no Plan B') – a five-year plan comprised of 100 commitments on the key social, environmental and ethical challenges facing M&S (many with measureable targets), supported by a EUR 240 million investment commitment. Figure 2.80 shows how Plan A is integrated into M&S management structure. In March 2010, Plan A was updated to include 180 commitments to be achieved by 2015, alongside an overarching ambitious target for M&S to become the world's most sustainable major retailer by 2015 (M&S, 2010). Plan A contains five short-term (2011) commitments specifically intended to integrate sustainability into M&S systems and processes. M&S works in partnership with suppliers and organisations such as WWF, MSC, FSC and RSPO to establish supply chain sustainability targets.

Communication

Progress on achieving sustainability objectives is clearly communicated to all stakeholders via annual reporting (compliant with Global Reporting Initiative G3 level C) that includes progress on all Plan A commitments (M&S, 2010). As of 2010, 62 of the original 100 Plan A commitments were achieved, 30 commitments were on schedule, and 8 commitments were behind schedule. Some key commitments to supply chain environmental improvement are listed in Appendix A2. Plan A is part of the M&S 'way of business' (Figure 2.80), and is regarded as an integral part of a business strategy intended to differentiate M&S from other retailers.

Product requirements

Two thirds of Plan A's 180 commitments are relevant to supply chain environmental performance. Forty-three commitments are strongly related to techniques for supply chain environmental improvement referred to in this chapter, and 14 of these have already been achieved (M&S, 2010). To monitor and encourage compliance with product quality and sustainability standards, M&S have 17 regional compliance managers in seven countries (including Turkey, India, Bangladesh, Thailand, Vietnam, Sri Lanka and China). M&S demonstrates good performance with respect to product standards (Section 2.2.6.4 and Section 2.2.6.8), and is a front-runner in terms of ambitious targets to drive supply-chain improvement through benchmarking (Section 2.2.6.6).

Plan A generated a net profit of EUR 60 million in 2009-10 through efficiency improvements and new income streams.

Another exemplary retailer in terms of integrating sustainability considerations into supply chain management is Coop Switzerland, as outlined in Case study 2.2, below. Two additional front-runner retailers are referred to in Table 2.40.

Case study 2.2: Integration of sustainable supply chain objectives in Coop Switzerland's management structure and operations

Management In 2008, Coop Switzerland established a single high-level Sustainability Steering Committee, reporting directly to the CEO, containing representatives from all business units, and responsible for sustainability and quality assurance along the entire supply chain (Coop Switzerland, 2009). Coop Switzerland regards sustainability as an integral component of business strategy, not a separate strategy, and has a comparatively long history of supply chain environmental improvement. The proof of this is in Coop's position as a front-runner retailer for many best practice techniques referred to in this document. Comprehensive supply chain sustainability targets (Appendix A1) indicate a commitment to systematic environmental improvement of supply chains, whilst close collaboration with environmental organisations and research institutes to develop long-term solutions to supply chain challenges (Section 2.2.6.7) demonstrates a strategic approach. This is reinforced by Coop's contributions to the policy debate on environmental sustainability in Switzerland. Coop's 2010 Sustainability Report (Coop Switzerland, 2010) identifies five specific measures taken in 2009 to integrate sustainability into strategy and management. **Communication** Environmental objectives are prioritised within Coop's mission statement, and comprehensive targets related to environmental improvement of supply chains are listed in sustainability reports (see Appendix A1). In Coop's 2010 Sustainability Report, progress towards achieving 15 goals relevant to supply chain environmental improvement is summarised, and 48 associated measures taken in 2009 are listed. Priorities stated in Coop's 2009 Sustainability Report are: climate change, water shortage, over-fishing, destruction of woodland, dwindling biodiversity and fair working conditions. Communication of these priorities suggests that Coop has a comprehensive understanding of supply chain environmental impacts. **Product requirements** 'Sustainable products' is one of three pillars of Coop Switzerland's sustainability strategy, and sustainable labelled products account for 12 % of total sales (Section 2.2.6.8). Environmental criteria are considered alongside social and commercial criteria when selecting suppliers, using a balanced score-card approach. Coop Switzerland is a front-runner retailer with respect to product standards (Section 2.2.6.4), and is responsible for almost half of all organic food sales in Switzerland (Section 2.2.6.8).

Table 2.40: Other front-runner retailers who have integrated supply chain sustainability considerations into their business strategy and operations

H&M explicitly acknowledges the centrality of its supply chain to overall sustainability performance, and has CSR team of over 80 people working in 13 countries. Each department must identify potential for environmental improvement, and the CSR department employs a range of key performance indicators.
Migros compete with Coop Switzerland on sustainability issues and have a track record pursuing a wide range of supply chain improvement actions. Migros management take a comprehensive and long-term view, as reflected in numerous case study examples within this document. Migros sells EUR 1.5 billion of sustainable labelled products annually (14 % retail sales in 2009).

Applicability

Integration of a sustainable supply chain strategy into the management structure and operations is possible for any retailer.

Economics

Full integration of supply chain management into retailer business structure, enabling greater supply chain control, has been shown to improve business performance (Accenture, 2009). In the medium term, the retail sector is critically dependent upon improving supply chain sustainability. Marketing advantages have been identified for front-runner retailers (Deloitte, 2009).

Driving force for implementation

Major driving forces for retailers to integrate supply chain sustainability improvement into their operations and management structure include:

- corporate responsibility: retail directors/governance responding to increasingly evident environmental problems;
- resource price volatility: response to large increases in commodity prices, and insurance against future price volatility;
- risk management: realisation that fundamentally unsustainable rates of resource consumption in supply chains pose a major risk to future business viability;
- image and public relations: stakeholder (notably customer and shareholder) concern over environmental issues such as climate change;
- demand and marketing: increasing customer demand for 'ecological' products, and retailer positioning to market these more profitable value-added products;
- regulation: the prospect of regulation imposing restrictions or costs on environmentally-damaging activities/products (e.g. a carbon tax).

Reference retailers

Coop Switzerland, H&M, M&S, Migros.

Reference literature

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2.2.6.2 Assess core product supply chains to identify priority products, suppliers and improvement options

Description

In order to target action effectively towards improving supply chain sustainability, it is first necessary for retailers to understand the supply chains of their products. This technique should be applied to core (high sales volume) products that retailers suspect have a high environmental impact. There is a considerable body of available evidence identifying environmental hotspots for various product groups, some of which is identified in Section 2.2.5. In addition, many resources are available to retailers to help them quantify the environmental pressures associated with product supply chains, including LCA databases such as CML, Eco-Invent and the European platform on LCA, and various software tools (e.g. Gemis and SimaPro) and consultancy companies. The European Commission provides guidance and links to these tools at: http://lca.jrc.ec.europa.eu/lcainfohub/index.vm.

Recently, a number of retailers have concentrated on quantifying the Product Carbon Footprint (PCF) of their products, in some cases for the purpose of providing consumer information. However, best practice in supply chain assessment is to take an approach that is both quantitative and comprehensive with respect to major environmental pressures. The range of environmental pressures that occur throughout product value chains, from production through to end-of-life, must be considered, and can be compared using lifecycle impact assessment methodologies (normalisation and weighting of impact categories).

Some environmental pressures are not well accounted for in LCA databases and associated modelling methodologies. Particular attention is required when assessing impacts that are highly dependent on the local context (e.g. biodiversity loss and water use) and indirect effects (e.g. displacing global agricultural production into areas of high conservation value). Alternative approaches are required to supplement LCA methodologies. Guidance on water footprint methodologies is provided by the Alliance for Water Stewardship (http://www.allianceforwaterstewardship.org/) and the Water Footprint Network (http://www.waterfootprint.org/?page=files/home)

Full assessment of supply chains using LCA can be time consuming, although time and cost requirements are declining considerably with experience (Carbon Trust, personal communication). The primary objective of supply chain assessment is to identify priority improvement options, and it is neither feasible nor necessary for retailers to perform full LCAs for all products. Retailers should select the most efficient methods of assessment (lowest effort required) to enable the effective implementation of supply chain improvement according to subsequent techniques (Figure 2.81 and Table 2.41).

- Method 1 in Table 2.41. In many cases, critical processes contributing to environmental impacts are sufficiently well known that retailers can identify them, and associated improvement options, through reference to existing scientific literature (see Table 2.34). This method is relevant for all improvement techniques, but particularly for choice editing and green procurement (Technique 4) – it provides sufficient information for retailers to select appropriate certification schemes for different product groups.
- Method 2 in Table 2.41. The environmental impacts of some product supply chains are not well documented, or may vary considerably depending on factors such as source region. For such supply chains, basic LCA using region-specific data may be used to identify improvement options. In addition, performing detailed LCA on a small subset of product groups may offer useful insight into typical 'hotspot' processes for different types of product. This method is particularly relevant to inform the establishment of priority environmental criteria for products and suppliers (Technique 5).
- Method 3 in Table 2.41. Where supply chain impacts are highly dependent on the source region and/or fall outside the scope of LCA, expert knowledge on region-specific pressures is required (e.g. cumulative water demand relative to availability). Retailers can effectively identify region-specific improvement options by working closely with

independent environmental experts (e.g. WWF). This method is particularly useful to target regional clusters of suppliers to whom environmental specifications should be addressed (Technique 5), and supplier who should be benchmarked and targeted for better management practice dissemination (Technique 6).

- Method 4 in Table 2.41. For a number of important product groups the environmental performance of individual suppliers can vary greatly depending on specific management practices. For example, environmental performance across the hundreds of dairy farmers that supply large retailers strongly depends on factors such as the type of animal-feed used and manure management (Section 2.2.5.3 and Case study 2.8). Where it is not possible to use third-party standards or mandate environmental criteria for products and suppliers, environmental performance improvement requires intervention by retailers to benchmark the performance of individual suppliers and facilitate the implementation of better management practice (Technique 6). Such action requires supplier-specific data, and is therefore resource intensive to initiate, but represents best practice where other actions are not applicable.

Knowledge gained during initial supply chain assessment will provide retailers with the insight necessary to develop systematic, risk-based impact assessment and supply chain improvement across their assortments (Method 5 in Table 2.41).

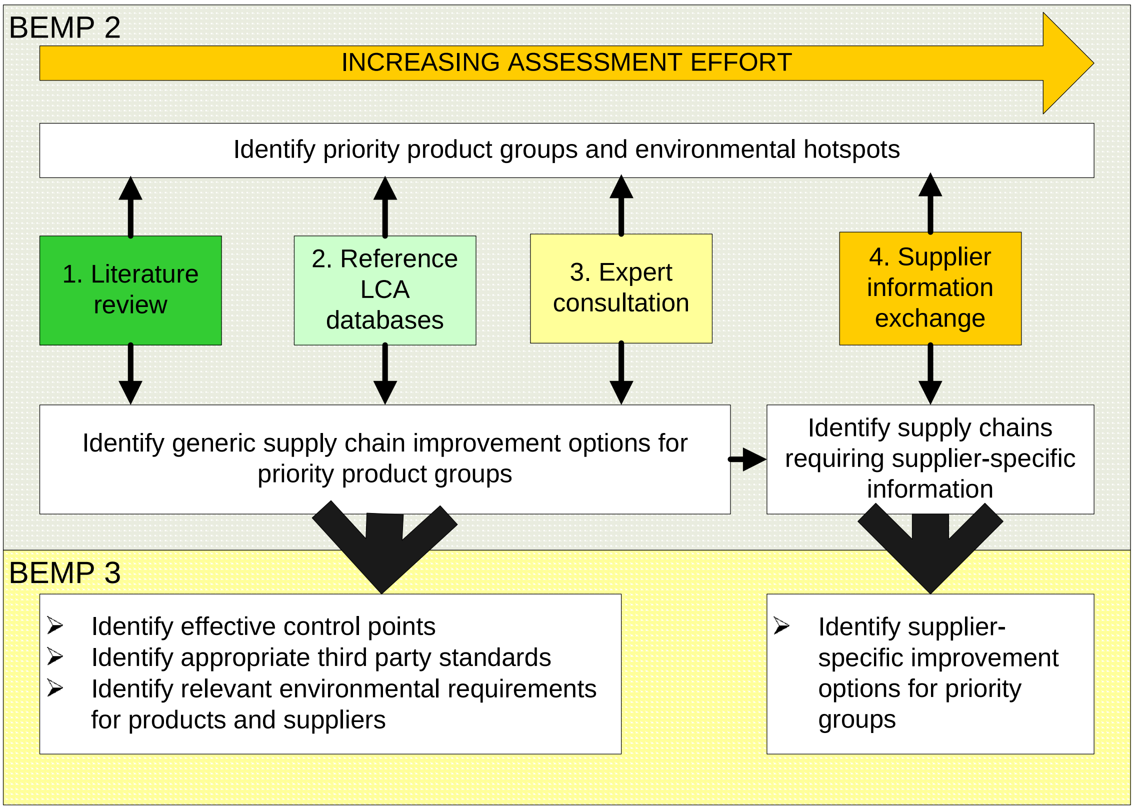

Figure 2.81: Proposed method of prioritisation to efficiently identify supply chain improvement options, depending on the level of detail required to implement different improvement options

Table 2.41: Description and best practice examples of supply chain environmental impact assessment methods, ranked in sequence of implementation priority (easiest first)

Method	Description	Best practice examples
1. Use available data to identify obvious 'hot spots'	Refer to published scientific evidence on environmental 'hotspots' for various product groups (e.g. Section 2.2.5) to select priority product groups and priority improvement options	Migros established the RSPO with WWF to address tropical deforestation for palm oil production; IKEA and Kingfisher identified unsustainable logging as a priority impact; H&M introduced chemical and waste water restrictions across apparel supply chains
2. Refer to reference LCA databases and perform detailed LCA for example product groups	Work with consultants, experts, or independently using available support tools, to identify typical 'hotspot' processes in supply chains. Performing detailed LCA for a few priority product groups can be used to inform a wider understanding of supply chain impacts.	Tengelmann organic egg PCF (section 2.2.5.6), Henkel case study (below)
3. Work with independent experts to identify 'hotspots'	Work with independent experts, including environmental consultants and NGOs, to identify key environmental impacts and improvement options	Coop Switzerland, IKEA, Migros and M&S work with WWF to identify priority impacts and improvement options (e.g. for sustainable wood and fish sourcing)
4. Collate supplier data to assess performance across suppliers	Collaborate with suppliers to collect relevant data for performance assessment and benchmarking across individual suppliers	Sainsburys DDG (Case study 2.8), H&M collated water use data from 296 suppliers and their sub-contractors in 2009 to benchmark water-use efficiency. M&S plan to benchmark farmers in their Sustainable Agricultural Programme
5. Develop risk-based screening of supply chains for major environmental impacts	Based on knowledge gained from environmental impact assessments, develop a screening method to highlight high-risk supply chains for various environmental impacts	M&S and WWF have produced a guidance document for water use that includes guidance on how agricultural suppliers can assess water availability and pollution risks (M&S-WWF, 2010)

Achieved environmental benefits

Environmental impact assessment is a prerequisite for improving the environmental performance of supply chains, and directs retailers' efforts towards achieving maximum environmental benefits by identifying priority product groups, processes, and suppliers. Environmental benefits attributable to all the techniques described in this chapter are informed and measured using environmental assessment methods. Environmental benefits are described in Section 2.2.6.4 to Section 2.2.6.8.

Appropriate environmental indicators

Some common indicators used to express environmental impacts in LCA are listed in Table 2.42 (and Table 2.37 in Section 2.2.5.7). Average default data may be obtained from LCA databases such as CML, Eco-Invent and the European platform on LCA. For detailed data specific to particular supply chains, retailers must ask suppliers to provide relevant data. Some possible types and sources of relevant data are referred to in Table 2.42. Product impacts should be expressed per functional unit as described in formal LCA guidance (ISO 14040). For many food products, impacts may be expressed per unit weight (e.g. per kg beef), but for other products such as washing powder and light bulbs, careful definition of functional units is essential (e.g. kg clothes washed or luxes of light produced).

An indicator of retailer best practice for this technique is:

- implementation of systematic assessment (independently or through consortia) of core product supply chains.

Table 2.42: Common indicators and potential data sources for product environmental impact assessment

Impact	LCA indicators	Data sources
Air pollution	kg air emissions of NO_x, SO_x, NH_3, PM, VOCs, expressed as acid or VOC or ethylene equivalent	Process technology emission factors, exhaust gas concentrations
Biodiversity loss	ha high-conservation-value land area lost	Land-use records and Geographic Information Systems (GIS)
Climate change	kg GHG emissions, expressed as CO_2 equivalent	Mass balance accounting, process emission factors (IPCC)
Ecotoxicity	kg toxic substance released to environmental compartments, expressed as 1,4-dichlorobenzene (DCB) equivalent	Mass balance accounting of substances used in processes, chemical analysis to identify toxic substances used
Resource depletion	kg of finite or over-harvested renewable resource extraction, expressed as kg antimony equivalent	Mass balance accounting
Water use	m^3 water used	Farm records, estimates based on cropping system and climate. See Water Footprint Network (2010) and Alliance for Water Stewardship (2010)
Water quality	kg water pollutants (COD, N, P expressed as PO_4 eq., toxic substances expressed as 1,4-DCB eq.)	Mass balance accounting of substances used in processes, chemical analysis of waste water concentrations

Cross-media effects

It is important for retailers to consider the full range of major environmental impacts. The current retailer focus on calculating product carbon footprints should provide an opportunity to screen for other important impacts with little additional effort (e.g. water footprints in Case study 2.3 and the range of impacts presented in Table 2.37 for the washing power LCA example in Section 2.2.5.7).

Operational data

Best practice is most readily conveyed through comprehensive case studies of product LCA, but retailers are reluctant to provide such case studies owing to concerns over confidentiality with respect to their own operational procedures and information provided by suppliers (Tesco, personal communication, 2010). The washing powder LCA performed by the brand manufacturer Henkel, presented in Section 2.2.5.7, represents a best practice example of product assessment. In this example, considering the entire product lifecycle was necessary to demonstrate that increasing the impact of production (by including enzymes) resulted in a considerable lifecycle impact reduction owing to lower wash temperatures during the use phase. Data provided by Coop Switzerland also demonstrates how relatively simple LCA-based eco-audits, using existing data sets, can be used to inform environmentally-responsible product sourcing (Case study 2.3).

Minimising the environmental impacts of products over their entire lifecycle (value chain) may sometimes conflict with minimising impacts over the lifecycle phases that occur within the supply chain. For products where the use phase dominates environmental impact, such as for washing powder (Section 2.2.5.7), it is especially important that retailers consider improvement options from a lifecycle perspective. A number of observations were made by Henkel in relation to their washing power LCA.

- It can be difficult for retailers to obtain primary data (e.g. energy use) from suppliers who are often reluctant to divulge information on operational parameters.
- Logistics processes can be difficult to trace and assess owing to complex business structures (contractors and sub-contractors). Transport assessment often involves assumptions about the EURO standard compliance of transport vehicles.
- Consequently, assessment procedures may rely heavily on secondary data from sources such as the Ecoinvent database.
- Product Category Rules (PCR) need to be developed to standardize scope, boundary and allocation procedures for product groups in LCA.
- Communication of LCA results to consumers will require internationally consolidated methodologies to be developed for products, and should focus on key messages, such as recommendations to reduce use-phase impacts (NB: standardised methodologies are not required for retailers to identify hotspots and improve supply chains).
- LCA calculation is too time and resource intensive to pursue for all products.

When contracting third parties (primarily consultants) to assess product lifecycle impacts, it is important that retailers define the product functional unit, process boundaries, and expected outputs (Carrefour, 2010).

Case study 2.3: Coop Switzerland assessment of fruit and vegetables

Approach

Coop Switzerland assessed 28 different fruits and vegetables, from 29 countries of origin. A range of production methods were compared, including integrated and organic production, and field-grown and glass-house production. Data were obtained from the Ecoinvent database (http://www.ecoinvent.org/database/), and SimaPro 7 software was used to model different supply chains. The functional unit was defined as 1 kg of fruit or vegetable. There was a focus on GHG emissions (Figure 2.82), water use (Figure 2.83), land use and biodiversity.

Results

The carbon footprints of regionally-supplied apples and kiwis increase with time from harvest owing to storage energy requirements (Figure 2.82). However, GHG emissions attributable to storage are lower than GHG emissions attributable to transport from New Zealand at all times of the year. Water requirements vary considerably across fruits and countries (Figure 2.83). In some cases low water and carbon footprints coincide (e.g. apples from Switzerland), in other cases there may be conflicts requiring trade-offs (e.g. avocados from Mexico). Coop demonstrates that relatively simple ecoaudits are often sufficient to inform environmentally-responsible purchasing decisions.

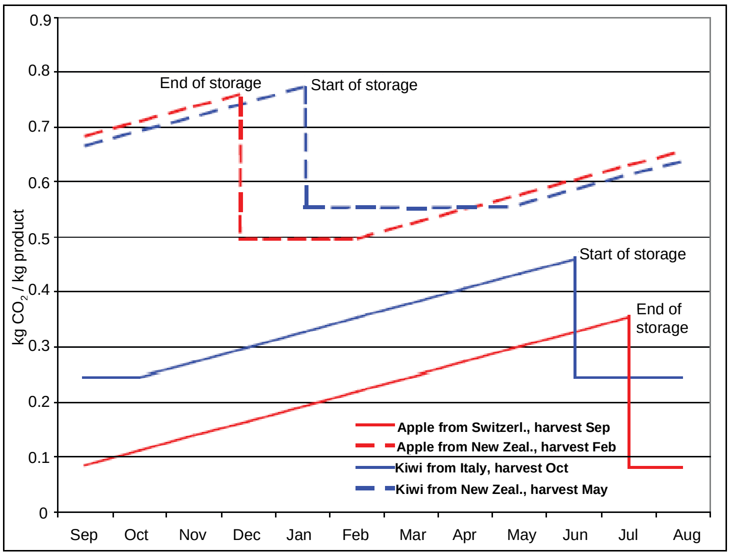

Figure 2.82: Carbon footprint of apples and kiwis from regional (European) and distant (New Zealand)

Source: Hofer, 2009.

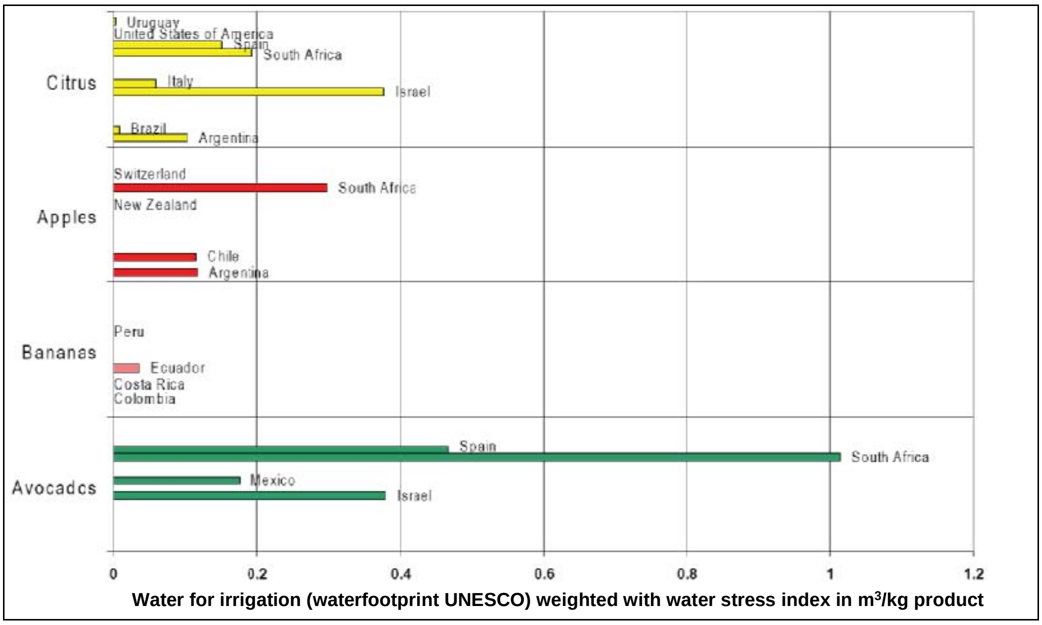

Figure 2.83: Water footprint of fruits from different source countries

Source: Hofer, 2009.

Applicability
In order to make most efficient use of resources, high volume (sales value) and anticipated high impact product categories should be prioritised for initial assessment. Basic environmental assessment methods are relevant to all retailers and all products, to select the most appropriate product groups for choice editing and green procurement (Section 2.2.6.4) and for promotion of front-runners (Section 2.2.6.8).

More data intensive assessment methods are applicable to private label products sold by larger retailers, to inform the implementation of supply chain improvement through environmental requirements (Section 2.2.6.5) and supplier environmental performance benchmarking (Section 2.2.6.6).

Economics
No specific economic data were provided, but it is estimated that the cost of product LCA assessment will decline by an order of magnitude as experience is gained and more products are assessed (Carbon Trust, pers. com.).

Time and cost burdens may be compensated by the implementation of new process efficiencies identified during the assessment, and by revenue increases associated with value-added products, marketing and reputational benefits.

Driving force for implementation
Retailers need to assess supply chain environmental impacts in order to begin reducing them, and thus improve the sustainability of their supply chains (see driving forces listed in Section 0). Specific retailer objectives for supply chain environmental impact assessment are to:

- identify opportunities to leverage efficient environmental impact reduction
- identify opportunities to improve the efficiency of supply chains
- identify major supply chain risk factors and mitigation options.

Reference retailers
Coop Switzerland, H&M, IKEA, Kingfisher, Migros, M&S, Tengelmann.

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2.2.6.3 Identify effective product supply chain improvement mechanisms

Description

Reliance on external auditing of suppliers for compliance with the third-party standards is an important approach to supply chain improvement, and can be relied upon where retailers implement green procurement (Section 2.2.6.4 and Section 2.2.6.8). However, the availability and coverage of widely recognised environmental standards is currently insufficient to form the basis of supply chain improvement across all priority product groups. For longer supply chains, important processes and impacts may fall outside the scope of certified standards. Therefore, in order to drive widespread environmental improvement of private label supply chains, it is necessary for retailers to identify chains of custody and control points that can be used to verify compliance with their own standards or requirements. This technique is therefore a critical prerequisite for retailer intervention to drive supply chain improvement (Section 2.2.6.5 and Section 2.2.6.6).

It can be particularly challenging for retailers to establish effective improvement mechanisms for supply chains where these chains:

- have many levels of supplier or subcontractors (see Case study 2.4);
- have a broad base of many hundreds, or thousands, of raw material suppliers (e.g. milk and cotton);
- originate in developing regions where regulatory requirements and/or enforcement are weak.

These features are increasingly common for globalised product supply chains, and the latter two features are associated with high improvement potential. Small scale farmers are often associated with under-developed farming practices. Meanwhile, retailers and branded product manufacturers are often the only entities in a position to effectively influence the social and environmental performance of suppliers in regions where regulatory control is weak. Despite the challenges of doing so, retailers are wise to exert more supply chain control in such regions, to protect their reputation from supply chain 'scandals'.

Many retailers have established mechanisms to control social conditions (employment, health and safety) throughout important supply chains – in particular for apparel supply chains following heightened public awareness of poor working conditions in apparel factories since the early 1990s. Retailer codes of conduct and contractual agreements for suppliers typically focus on social conditions (see Table 2.28 in Section 2.2.3), but are increasingly including environmental criteria. However, few retailers demonstrate a level of control over supply chain environmental performance equivalent to the best third-party certification schemes indicated in Table 2.29, and at best such control is effectively exerted over a small number of priority supply chains.

Figure 2.84 provides an overview of the main control options available to retailers. If retailers do not delegate supply chain control to third party certification, they may need to establish collaboration with first tier suppliers to obtain information about their operations, and the operations of second-tier suppliers and sub-contractors. It may be necessary to approach second tier suppliers for further information, but this is complicated in the absence of contractual agreements between the retailer and these suppliers. Tracking down entire supply networks is often not feasible, and it is therefore important that critical control points are identified in relation to:

- influence over relevant processes driving environmental impact (section 2.2.6.2)
- potential for control through specification of verifiable requirement criteria

Two principal mechanisms can be used by retailers to influence the environmental performance of suppliers beyond the first-tier, the first a form of control, the second a form of influence:

- contractual agreements with first-tier suppliers that place responsibility for ensuring second-tier supplier performance with them
- targeted intervention directed at key lower-tier suppliers to encourage them to implement better management practices.

Figure 2.84 indicates a hierarchy of the main control options available to retailers, in order of the level of control they exert over supply chains (highest first).

1. Delegation of environmental performance regulation to certification organisations (i.e. exclusively purchasing certified products – see Section 2.2.6.4 and Section 2.2.6.8).
2. Mandatory environmental requirements for first tier suppliers (e.g. IKEA's IWAY Code of Conduct (Case study 2.6). These may be enforced by retailer or independent auditing.
3. Mandatory environmental requirements for second tier suppliers (e.g. H&M's restricted chemical list in Case study 2.4; IKEA's Forestry Standard in Case study 2.6). These can be enforced through product testing (e.g. for chemical residues) and requirements for detailed record keeping.
4. Intervention to encourage better practices by benchmarking suppliers against best performers and disseminating best practice techniques (e.g. H&M's Cleaner Production Programme in Case study 2.4 or Sainsbury's DDG in Case study 2.8). This may be applied to any tier of the supply chain.

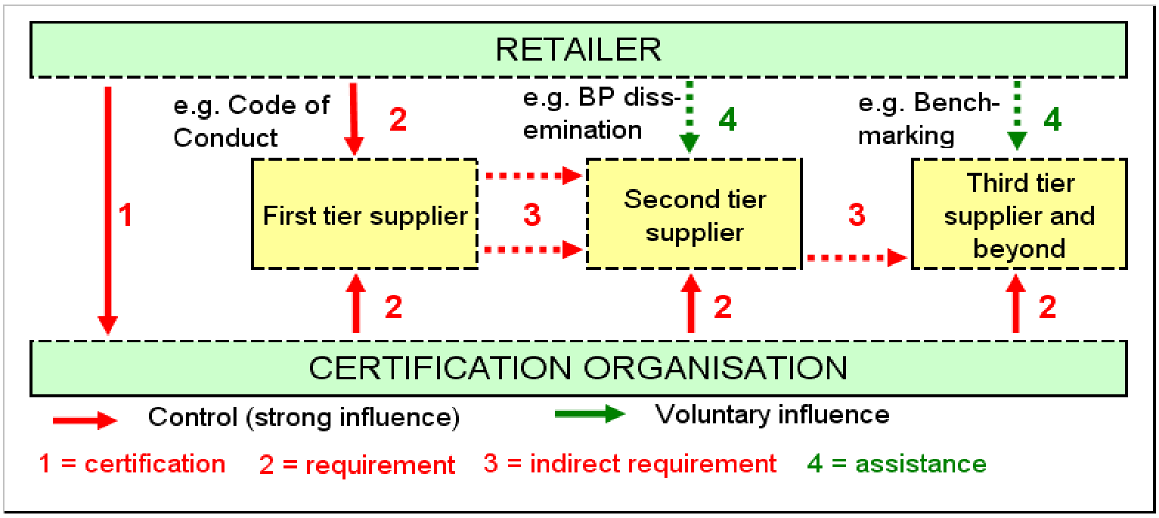

Figure 2.84: The major control options available to retailers to exert influence over their supply chains

The level of control does not necessarily correlate with environmental improvement potential. A large portion of supply chain improvement potential is located at the supply chain base, where retailer control is often lowest. For these suppliers, including farmers, well-targeted intervention to improve the performance through the dissemination of BMPs can be more effective than indirect requirements expressed in contracts with first-tier suppliers. Examples of this include the Better Cotton Initiative (Case study 2.7), H&M's Cleaner Production Programme (Case study 2.8), and Sainsbury's Dairy Development Group (Case study 2.8) in Section 2.2.6.6.

Front-runner retailers employ a number of methods simultaneously to effectively drive improvement across different supply chains, or different levels of supplier within the same supply chains. Two Swedish retailers, H&M and IKEA, publish their approaches to the identification of chains of custody and the establishment of control points for key supply chains (Case study 2.4, and Case study 2.6 in Section 2.2.6.5). In addition, C&A intervenes at different levels in the apparel supply chain to increase organic certification (Case study 2.11 in Section 2.2.6.8).

Achieved environmental benefits

As with environmental impact assessment (Section 2.2.6.2), identifying chains of custody and establishing control points is a prerequisite for improving the environmental performance of supply chains. This technique enables retailers to address supply chain hotspots, and is a direct prerequisite for retailers working with suppliers to improve their environmental performance (Section 2.2.6.5 and Section 2.2.6.6). The environmental benefits listed in those sections are therefore attributable to the identification of supply chain improvement mechanisms as described in this technique.

Appropriate environmental indicator

Retailer performance in this technique is ultimately reflected in indicators for Techniques 4 to 6, and Technique 8 (Section 2.2.6.4 to Section 2.2.6.6, and Section 2.2.6.8). The ideal summary indicator for retailer performance in this technique is:

- the percentage of total sales represented by products from supply chains that are environmentally improved through use of certification, or retailer standards, or intervention.

An easier to calculate alternative is:

- the number of priority product supply chains that have been extensively environmentally improved (improved products represent at least 50 % of sales value within the group) through application of best practice techniques.

Cross-media effects

There are no significant direct cross-media effects associated with this technique. Retailers need to balance environmental and social impacts when deciding on priority stages, processes and criteria to influence within supply chains, as referred to in Section 2.2.6.2.

Operational data

Environmental criteria can be integrated into existing mechanisms of supply chain control for social standards, for example by being added to existing lists of social criteria that suppliers are expected to comply with, as defined in contractual agreements or codes of conduct (Section 2.2.6.5). For specialist retailers, systematic and regular auditing of all major suppliers is possible (H&M and IKEA: Case study 2.4 and Case study 2.6 in Section 2.2.6.5), whilst for grocery retailers it is important to target high-risk supply chains based on environmental assessment (Technique 2 in Section 2.2.6.2), and further to target high-risk suppliers for auditing according to criteria such as location – for example, IKEA's approach to targeted wood supplier auditing outlined in Case study 2.6. The WWF's Global Forest and Trade Network provides an online guide to the responsible sourcing of forest products that may be of use for other products: http://sourcing.gftn.panda.org/index.php?id=1

Owing to diverse supply chains containing large numbers of suppliers, and practicalities of compliance assessment, environmental criteria contained in general supplier agreements of large retailers are often basic, and do not adequately address environmental hotspots. To drive significant environmental improvement, product- and supplier- specific criteria are required (e.g. H&M's requirement for wet-process suppliers to comply with BSR Water Quality Guidelines, and IKEA's Forestry Standard).

Retailers can exchange compliance information regarding specific suppliers through systems such as the UK-based Sedex supplier ethical data exchange system (over 400 members, of which M&S, Tesco and Waitrose are founding members: http://www.sedex.org.uk/sedex/go.asp?u=/WebSite/home&pm=6&location=Home) in order to optimise supplier selection and auditing processes. The scope of Sedex is being expanded to consider some basic environmental criteria, and this should assist retailers to select suppliers' based on such criteria in the future.

Figure 2.85 indicates how front-runner retailers can use a combination of control mechanisms, targeted for specific product groups and product ranges, to comprehensively improve their product assortment. This includes use of third party certification, retailer-defined requirements, and collaboration with other retailers to enable more efficient auditing of common requirements.

Applicability

Any retailer can identify the most effective supply chain improvement mechanisms:

- for large retailers with private label products, all aspects of this technique can be implemented.
- for small retailers, this technique is restricted to identification of priority products for choice editing or green procurement based on third-party certification.

Economics

No economic data were provided, but supply chain control and auditing costs are small in relation to the potential costs associated with reputational damage from product or supply chain 'scandals'.

When comparing the cost of third party certification (Technique 4) with the implementation of retailer-defined criteria (Technique 5), retailers should carefully consider the effectiveness and value-added of the control mechanisms, both in terms of environmental effectiveness and consumer perception (see Section 2.2.6.5).

Case study 2.4: H&M's comprehensive approach to management of a complex supply chain

Code of Conduct
In 2009, H&M had 700 suppliers operating 1900 apparel factories (H&M, 2010). In 1997, H&M drew up a Code of Conduct (CoC), last updated in 2009, containing eight sections: Legal requirements; Child labour; Safety; Workers' rights; Factory conditions; Housing conditions; Environment; Monitoring and compliance. The last section includes standards on waste and chemical management procedures. A five point grading system is used to measure supplier compliance with the CoC: Permanently rejected; Rejected; Temporary; Insufficient; Satisfactory. All new suppliers must meet 'Temporary Grade', and are allowed six months to achieve the 'Insufficient' grade. Suppliers are rejected if they move down to 'Temporary' grade.

Compliance is monitored by 70 auditors who implement H&M's Full Audit Programme (FAP) across all apparel factories (direct suppliers and subcontractors). In 2008, 2509 CoC compliance audits were performed (1145 in the Far East, 615 in Asia, 749 in Europe, the Middle East and Africa), taking up to six person-days each. 254 production units were graded 'Rejected' (contracts suspended) and one supplier was permanently rejected. In 2008, 515 audits on potential new production units resulted in 138 graded 'Rejected' (H&M, 2009).

Restricted Chemicals
A wide range of chemicals are used in textile production. H&M's suppliers are contractually bound to comply with a list of banned substances which must not be used, or used only in limited quantities. The list was composed in 1995, and was most recently updated in 2008 (Appendix A4) to include over 180 substances. Sensitive analytical methods such as gas chromatography high-resolution mass spectrometry are used to detect ultra-trace quantities in tens of thousands of compliance tests carried out every year. Suppliers are trained to enforce chemical restrictions compliance among sub-contractors.

Waste water limits
Since 2006, H&M have required all suppliers to comply with BSR Waste Water Quality Guidelines (Appendix A3). All suppliers with wet processes (textile finishers) are requested to submit results from standard water quality tests conducted by H&M-approved laboratories. Where limits are exceeded, suppliers are requested to devise draft action plans. Suspicious (e.g. very low) reported values are investigated with unannounced visits. The FAP also checks waste water plant management and sludge handling. In 2009, waste water quality was assessed for 198 wet-process production units: 78.8 % suppliers reported BOD_5 within the lowest threshold (30 mg/l); 93.3 % suppliers reported COD within the lowest threshold (200 mg/l); and 76.3 % suppliers reported TSS within the lowest threshold (30 mg/l).

Reaching beyond first-tier suppliers
Much of the lifecycle environmental impacts of H&M products arise lower down on the production chain, beyond first-tier suppliers directly contracted by H&M. In addition to placing responsibility for sub-contractor requirements with first-tier suppliers (above), H&M implement a Cleaner Production Programme aimed to improve the environmental performance of fabric dyeing mills (Case study 2.9 in Section 2.2.6.5 and participate in the Better Cotton Initiative (Case study 2.7 in Section 2.2.6.5).

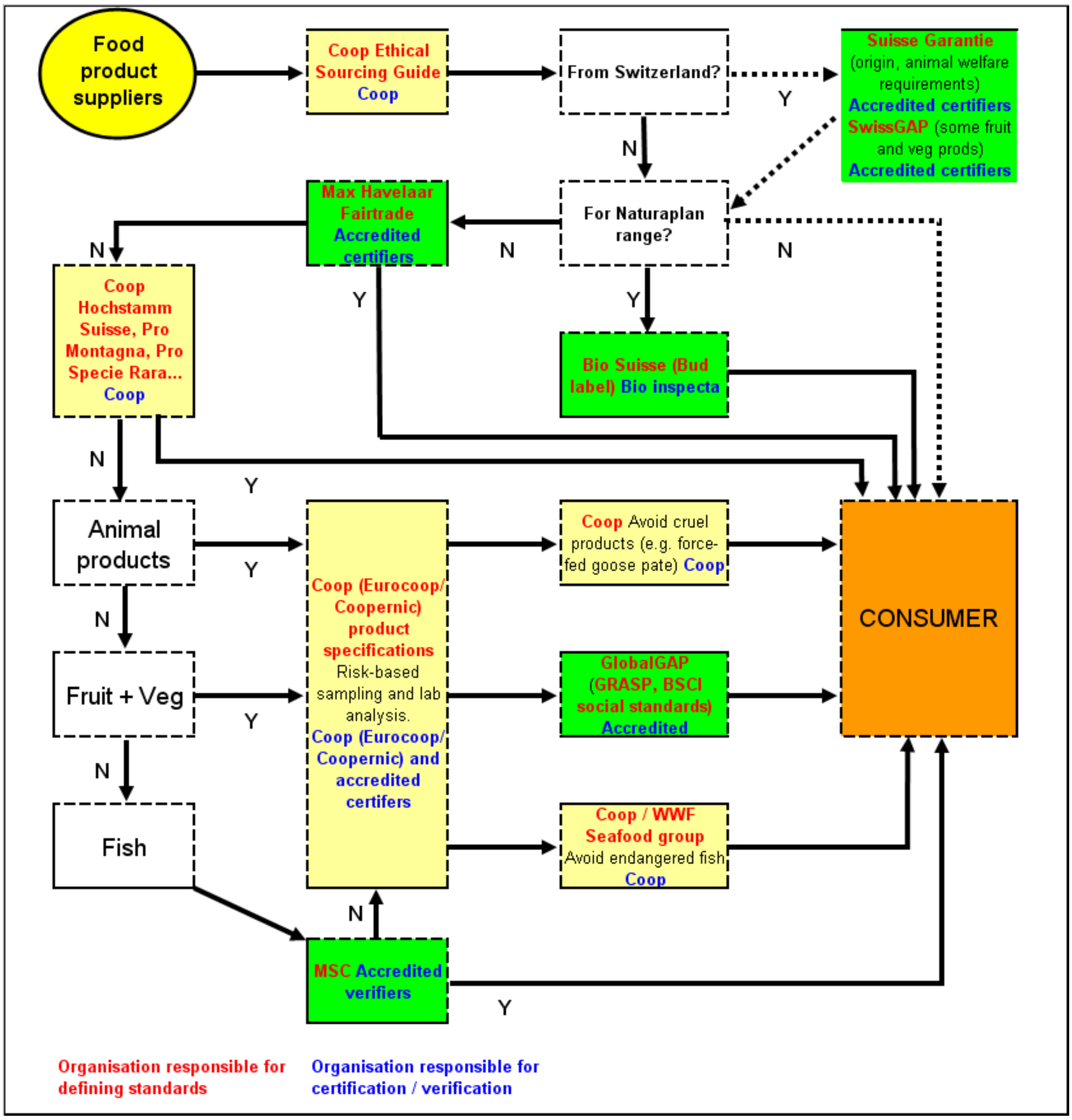

Figure 2.85: **Flow chart representing the comprehensive control Coop Switzerland exerts over food product suppliers, including third party certification and auditing by Coop Switzerland and collaborating retailers**

Source: Information from Coop Switzerland (2010) and own elaboration

Driving force for implementation

Greater control over supply chains has been shown to improve business performance in general (Accenture, 2009), and can add value to product assortments. In the medium term, the most successful retailers will be those that ensure their supply chains are sustainable in the context of increasing resource scarcity and environmental carrying capacity (see Section 0).

Reference retailers

C&A, Coop Switzerland, H&M, IKEA, M&S, Sainsbury's.

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2.2.6.4 Choice editing and green procurement of priority product groups based on third party certification

Description

This technique describes how retailers can demand widespread certification (i.e. target of 100 % within priority product groups) according to third party environmental standards. These standards are broadly classified as basic (Table 2.43), improved (Table 2.44), or exemplary (Table 2.45) – according to the rigour and comprehensiveness of environmental requirements, as outlined in Section 2.2.5.2, and apply to the product or to the supplier. Retailers may require 100 % certification according to exemplary standards where these standards relate to sustainable harvest rates (i.e. FSC and MSC), but universal certification is not regarded as best practice for **front-runner** ecological standards such as official environmental labels (e.g. EU Ecolabel) and organic (see Section 2.2.6.8). Retailer performance is indicated by the highest achieved (or target) certification rate, for the highest classification of standard. Performance is assessed, and best practice is identified, at the level of individual product groups.

Consumers are often overwhelmed with information about products. Horne (2009) reports that 97 % of consumers think there is too much information on products, and consumers do not trust retailers' environmental claims about their products (in contrast, NGO claims are widely trusted). This may partially explain the considerable deficit between the high proportion of consumers who claim that environmental considerations are important to them when buying products and the proportion of consumers who actually select products based on environmental criteria (IBM, 2008; EC, 2009). In fact, many consumers may implicitly assume that products available to them are sustainably produced and sourced. Ensuring that products comply with minimum environmental standards is regarded by front-runner retailers as a 'gate-keeper' duty to their customers (Hofer, 2009), and is an effective way for retailers to mitigate against reputational damage that can arise from product 'scandals'.

The most robust method for retailers to ensure that their supply chains comply with defined environmental performance criteria is to require third party certification according to relevant and widely-recognised environmental standards. This technique is implemented through choice editing and green procurement. For large retailers, widespread green procurement necessitates a plan to require existing suppliers to become certified according to appropriate third party standards. Where appropriate third party standards are available for a particular product group, as determined through the application of Technique 2 (Section 2.2.6.2) and Technique 3 (Section 2.2.6.3); requiring suppliers to become certified according to these standards is preferable to the requirement for compliance with retailer-defined standards (Technique 5 in Section 2.2.6.5), as indicated in Figure 2.78 (Section 2.2.6), because:

- third party certified standards are usually the strongest and most comprehensive form of supply chain control available to retailers (section 2.2.6.3);
- coordinated use of common widely-recognised standards across retailers and branded-product manufacturers represents the most efficient approach to widespread supply chain improvement;
- third party standards are the most transparent and **credible** indicators of environmental value-added for the consumer;
- coordinated use of common widely-recognised standards reduces label proliferation and enhances consumer recognition of environmental value-added.

Choice editing may involve the complete removal of particular products from retail assortments in response to strong environmental concerns. For example, a number of retailers do not stock acutely endangered fish species (e.g. those on the red lists of Greenpeace, IUCN or MSC). A recently published report highlights the role that choice editing by retailers could play in promoting diet changes associated with health and environmental improvements in Europe (EC, 2009). Buying products certified as locally or regionally produced (i.e. within Europe) is a way to ensure that the worst practices in global supply chains are avoided (Table 2.43). However, it is preferable that retailers require certification beyond basic standards, and require improved

(Table 2.44) or exemplary (Table 2.45) standards that can be applied to products and suppliers from across the globe.

There is overlap between the application of this technique and Technique 8 – encouraging consumers to buy front-runner ecological products (Section 2.2.6.8). Technique 8 focuses on ISO Type-I labelling for consumers, whilst this technique emphasises retailer use of business-to-business certification to screen products before they are offered to consumers. Nonetheless, it is important for retailers to communicate their choice editing and green procurement actions, and the consequent supply chain improvement, to consumers through advertising, information displays, and product labelling.

Leading retailers contribute to the development of third party product standards, along with stakeholders from NGOs and industry. Migros was largely responsible for initiating the Roundtable on Sustainable palm Oil (RSPO) that has developed a palm oil certification standard. It is important that retailers keep track of the evolution of existing standards, and the introduction of new ones. One important new standard close to completion is the Aquaculture Stewardship Council standard: http://www.ascworldwide.org/. Where it involves coordinated development of widely recognised international standards, participation in standard development by retailers can reduce the risk of 'standard proliferation', and thus represents best practice (see Section 2.2.6.7).

Achieved environmental benefits

The environmental benefit achieved by requiring products to be certified according to third party standards is a function of:

- the difference in environmental performance between suppliers of certified and non-certified products (i.e. the additionality of environmental requirements beyond prevailing environmental performance)
- the volume of conventional products replaced by certified products (approximate to additional sales of certified products).

This cannot be calculated precisely, but can be estimated for particular impacts.

The environmental improvement potential associated with implementation of BMPs across small farms in developing countries is considerable. Case study 2.7 in Section 2.2.6.6 summarises the substantial improvements in the environmental efficiency of cotton production achieved by farmers participating in the BCI scheme. Three year data for trial farms in India indicate that water use has been reduced by 49 %, pesticide use by 81 % and fertiliser use by 18 %, on average. For trial farms in Pakistan, the equivalent reductions are: 32 % for water use, 32 % for pesticide use, 38 % for fertiliser use (WWF, 2010). Meanwhile yields and gross margins increased.

To provide an indication of environmental benefits associated with the implementation of this technique, the main features and environmental benefits associated with widely used standards are displayed in Table 2.43, Table 2.44 and Table 2.45 – for standards classified as basic, improved and exemplary, respectively.

Table 2.43: Widely-used third party basic environmental standards applicable to product groups

Standard	Features	Main environmental benefits
GG: 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' (see Table 2.31 in section 2.2.5.2) and various 'recommended' measures to reduce erosion and water use (GlobalGAP, 2009)	Avoids excessive use of resources and bad environmental practices
RLF: Red-listed fish	Greenpeace, the IUCN and MSC have listed fish species from particular regions that are likely to come from unsustainable fisheries (Greenpeace, 2010; IUCN, 2010; MSC, 2010).	Preserves acutely endangered fish species
NPC: National (or regional) Product Certification	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
OT: Oeko-Tex 1000	The Oeko-Tex 100 standard precludes the use of a range of banned and harmful substances in textile products, enforced through analysis of products for residues. In addition to these requirements, the Oeko-Tex 1000 standard requires textile processing facilities to comply with basic environmental management criteria, including emission limits for waste water and air emissions (Oeko-Tex, 2010).	Avoids worst ecotoxicity impacts Safeguards air and water from intense pollution

Table 2.44: Widely-used third party improved environmental standards applicable to product groups

Standard	Features	Main environmental benefits
BCI: Better Cotton Initiative	Farmers must comply with basic minimum environmental principles and criteria for initial certification, and demonstrate continuous improvement through compliance with additional environmental criteria in subsequent years – see Case study 2.7 (BCI, 2010)	Reduces resource consumption Reduces soil erosion Reduces water and air pollution
BCRSP: 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 and minimization of chemical inputs.	Avoids agricultural encroachment into high conservation areas Reduces resource consumption Reduces soil erosion Reduces water and air pollution
BSI: Better Sugarcane Initiative	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 – see Table 2.46 (BSI, 2010)	Avoids agricultural encroachment into high conservation areas Reduces resource consumption Reduces soil erosion Reduces water and air pollution
4C: Common Code for the Coffee Community Association	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
FT: Fairtrade	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
PEFC: Programme for the Endorsement of Forest Certification	The PEFC endorses national certification systems and requires compliance with more than 200 criteria for sustainable forest management, including environmental requirements aimed at maintaining and enhancing forest resources and biodiversity	Avoids encroachment into high-conservation-value areas Reduces resource consumption Reduces soil erosion Reduces water and air pollution
RA: Rainforest Alliance	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
RSPO: Round Table on Sustainable Palm Oil	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. RSPO certification and trading is outlined in Case study 2.5.	Avoids agricultural encroachment into high conservation areas Reduces resource consumption Reduces soil erosion Reduces water and air pollution

Standard	Features	Main environmental benefits
RTRS: Round Table on Responsible Soy	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 (see Table 2.32 in Section 2.2.5.2). 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

Table 2.45: Widely-used third party exemplary environmental standards applicable to product groups that are relevant for green procurement

Standard	Features	Main environmental benefits
Forest Stewardship Council (FSC)	FSC certification requires evidence of long-term tenure and chain of custody documentation for forests and forest products. Ten principles and 56 criteria cover traceability, social and environmental aspects. The overriding environmental requirement is to achieve sustainable harvesting that maintains or enhances forest value, ecosystem integrity and biodiversity, enforced through requirements for monitoring and management plans – see Table 2.33 in Section 2.2.5.2 (FSC, 2002)	Avoids encroachment into high-conservation-value areas Maintains and enhances biodiversity and ecosystem functions Reduces resource consumption Reduces soil erosion Reduces water and air pollution
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
NB: Other important exemplary standards denote front-runner products that represent a small portion of the market, and whose production is more appropriately stimulated by labelling and consumer demand (Section 2.2.6.8) rather than green procurement		

Appropriate environmental indicator

Indicators for this technique are divided into product supply chain indicators, and retailer performance indicators.

For product supply chains, there are many relevant indicators of environmental performance, as indicated in Section 2.2.6.2, that are used to assess compliance with third party environmental standards. Environmental standards should contain specific environmental management requirements (e.g. Table 2.32 in Section 2.2.5.2) or quantitative minimum benchmarks (Table

2.46 and Appendix A3), and possibly requirements for continuous improvement (e.g. the BCI: Case study 2.7 in Section 2.2.6.5).

Table 2.46 contains some relevant environmental performance benchmarks contained within the BSI certification standard launched in 2010. Compliance with the benchmarks is mandatory to receive certification, along with a demonstrated commitment to continuous improvement.

Table 2.46: Some environmental performance benchmarks required by the Better Sugarcane Initiative

Environmental impact	Indicator	Benchmark
Acidification	SO_2 eq.	< 5 kg/kg sugar
Ecotoxicity	Pesticide use (active ingredient)	< 5 kg/ha/yr
Energy use	kJ	< 2500 kJ/kg sugar
Eutrophication	PO_4 eq.	< 120 kg/ha/yr
General	Environmental Management Plan	Implemented
Global warming burden	CO_2 eq.	< 0.4 t/t sugar
Material use	kg	< 11 kg/kg sugar
Natural habitat loss	% legally-protected or high conservation value areas used	0
Water consumption	l	Farm: < 50 l/kg cane Mill: <20 l/kg sugar
Water pollution	Chemical oxygen demand (COD)	< 1 kg/t sugar
Source: BSI, 2010		

Retailer performance with respect to product supply chain certification can be measured quantitatively according to the following indicators:

- the percentage of products sold within a particular product group that are certified according to a particular third party environmental standard, according to sales value;
- the environmental rigour and completeness of the third party standard, as broadly indicated by categorisation according to basic, improved or exemplary.

Retailers may express certified percentages in relation to private label sales for particular product groups, or to all sales for particular product groups in cases where branded products are also certified. This should be clearly specified in reporting. A retailer may express 100 % compliance with a basic environmental standard based on exclusion (e.g. Red List Fish) only where all red-listed products (e.g. fish species) have been removed from the product group (e.g. wild-catch seafood).

Where a portion of sales within a product group is certified to a higher standard than the standard being reported (e.g. front-runner standards), this portion is included as certified to the level of standard reported in this technique, but will also be reported separately in Section 2.2.6.8.

Table 2.47 displays current best practice in terms of third party standard certification of priority product groups. Amongst food products, coffee, fats and oils, fruit and vegetables, seafood and sugar are the products for which widespread or universal certification is most often required. Many retailers have stopped selling critically endangered fish species such as eel and sturgeon (Table 2.47) and many retailers plan to achieve 100 % RSPO certified palm oil by 2015 (Table 2.47). In addition, Coop Switzerland (personal communication) claims that approximately 1% of overall food sales are Fairtrade certified, the highest apparent certification rate for Fairtrade.

Amongst non-food products, a number of retailers have minimum energy-efficiency requirements for electronic goods based on energy ratings, with front-runner retailers only selling appliances rated at least an A+. A number of retailers buy BCI-certified 'better cotton'.

IKEA currently sources around 10 % of its cotton from BCI farmers, and has a target to source 100 % 'better cotton' by 2015 (IKEA, 2010). Meanwhile, 50 % of the wood sold in the Kingfisher group was FSC certified in 2010, including 76 % of wood sold in the B&Q UK division (Kingfisher, personal communication) (Table 2.47). The Kingfisher group is aiming for 100 % 'well-managed' (FSC or PEFC certified, or Global Forest Network or WWF approved) or recycled wood. B&Q UK achieved this target in February 2011 (Kingfisher, personal communication).

Front-runner retailers are rapidly increasing the rate of third party certification across product groups. Therefore, 'benchmarks of excellence' proposed in Table 2.47 are based on targets, and should be interpreted as such. It is proposed that retailers and verifiers interpret excellent retailer performance for a specific product group thus:

- the retailer demonstrates on-track progress within the context of a detailed plan to achieve the proposed benchmark.

Although this technique targets **widespread** certification of product groups, it may be appropriate to express performance for more disaggregated product groups than the summary product groups presented in Table 2.47. For example, red meat could be divided into beef, lamb, pork products. Performance could be reported for specific fruit and vegetables. The following indicator may be used to represent the extent of certification across entire product assortments:

- the number of product groups where more than half of sales are certified according to a third party environmental standard.

Table 2.47: Performance of leading retailers and proposed benchmarks of excellence, with respect to independent certification of priority product groups (expressed as percentage of product group certified)

	Product group	Standard classification	Applicable standards	Best performers: 2010	Best performers: Target (year)	Proposed benchmark
FOOD PRODUCTS	Coffee, tea	Improved	4C, FT, UTZ	100 % FT[SS]; 20 % 4C[CS]	100 % 4C (2012)[CS]	100 % improved
	Dairy	Basic	GG	No data	No data	100 % basic
		Improved	See retailer-defined standards (Technique 5) and improvement schemes (Technique 6)			
	Fruit and veg	Basic	GG	100 % GG [CS,ICA,MG,RW]		100 % basic
		Improved	FT	13 % FT[CS];100 % FT (bananas)[SS]		
		Improved	See retailer-defined standards (Technique 5) and improvement schemes (Technique 6)			
	Fats and oils	Improved	RSPO (Green Palm certificates), RTRS	100 % Green Palm certificates[M&S,MG]	100 % RSPO (2012)[WE]; (2015)[CR,CS,M&S,MG,SS,TO]; 100 % RTRS (2014)[CS,MG]	100 % improved
	Grain products	Basic	GG	NA	NA	100 % basic
		Improved	See retailer improvement schemes (Technique 6)			
	Poultry, eggs	Basic	GG	NA	NA	100 % basic
		Improved	See retailer-defined standards (Technique 5) and improvement schemes (Technique 6)			
	Red meat	Basic	GG	NA	NA	100 % basic
		Improved	See retailer-defined standards (Technique 5) and improvement schemes (Technique 6)			
	Seafood (wild catch)	Basic	RLF (avoidance)	100 %[AD,CS,ICA,MG,M&S,SS,WE]		100 % exemplary
		Improved	See retailer-defined standards (Technique 5)			
		Exemplary	MSC	62 % MSC[M&S]	100 % MSC (2012)[M&S]	
	Sugar	Basic	GG	NA		100 % improved
		Improved	Fairtrade	100 % FT[M&S;SS] (bagged sugar)		
NON-FOOD	Household	Exemplary	See environmental labelled product sales (Technique 8)			
	Electronic goods	Basic	NA	NA	NA	100 % improved
		Improved	A+ ER	100 %A+[CS,MG]	100 %	
	Textiles	Basic	OT	100 % OT[OT]		100 % improved
		Improved	BCI	3 % FT[M&S]; 12 % BCI[IA]	100 % (2015)[IA]	
	Wood and paper products	Improved	See retailer-defined standards (Technique 5)			100 % exemplary
		Improved	See retailer-defined standards (Technique 5)			
		Exemplary	FSC	22 % FSC[IA]; 76 % FSC[B&Q]; 88 % FSC[SS]	90 % FSC (2012)[SS]; 100 % FSC[IA]	

NB: Applicable standard abbreviations as described in Table 2.43, Table 2.44 and Table 2.44.
AD = Axfood, CR = Carrefour, CS = Coop Switzerland, IA = IKEA, KR = Kingfisher, MG = Migros, RW = REWE, SS = Sainsburys, TO = Tesco, WE = Waitrose

Cross-media effects

Where standards appropriate to particular product groups and their impacts are selected, there should be no significant cross-media effects. However, for some product groups, retailers may need to balance environmental requirements with requirements across different aspects of sustainability (social conditions, animal welfare, health, etc.) when selecting appropriate product standards.

Cross-media effects may be avoided by selecting standards that comprehensively cover social and environmental aspects, such as Fairtrade, or by requiring certification according to multiple standards.

Operational data

Selection of appropriate environmental standards for product certification should be assessed on a product-by-product basis. Table 2.34 in Section 2.2.5.1 indicates the product groups, processes and environmental impacts addressed by some widely recognised independent standards. Table 2.48 lists questions that can be used to determine the appropriateness of a particular standard for a particular product group.

Table 2.48: Questions to assess the appropriateness of a product standard for a particular product group

Question	Answer required for selection
Is choice editing or certification the most effective improvement option, for this product group, as identified in Technique 3 (Section 2.2.6.3)?	Yes
Does this standard address product supply chain hotspots identified in Technique 2 (Section 2.2.6.2)?	Yes
Do certification requirements represent significant environmental improvement (see classification in Section 2.2.5.2)?	Yes
Is there a more widely recognised standard with similar environmental requirements?	No
Does the standard contain sufficient social requirements, or is it compatible with another social standard?	Yes
Are there a sufficient number of accessible suppliers already certified according to this standard, or can existing suppliers be asked to achieve certification?	Yes
Is the net retailer cost of widespread certification proportionate to medium-term benefits (considering pricing and marketing opportunities, public relations, medium-term business sustainability, etc.)?	Yes

Retailers can improve the efficiency of green procurement by forming alliances, such as the Coopernic Alliance comprised of Coop Switzerland, Colruyt, Conard, E.Leclerc, and Rewe Group. Such alliances can facilitate the exchanges of know-how and best practice, and lower costs through pooled purchasing and efficient delegation of responsibilities. They assist the establishment of standards so that they become widely-recognised, and the implementation of retailer-defined environmental requirements (Section 2.2.6.5).

The number of suppliers certified according to any particular standard is limited, and it is unlikely that large retailers can simply shift to certified suppliers. Existing suppliers may be reluctant or unable to incur certification costs. In such cases, retailers may be required to take a more proactive approach than green procurement, and assist supplier certification. As referred to in Section 2.2.6.5, Coop Switzerland, Migros and the Rewe are helping fruit and vegetable suppliers in Italy, Morocco and Spain to comply with GAP standards by offering free advice and training. Retailers including C&A, Coop Switzerland, IKEA and Rewe are working with Indian cotton farmers to help them supply more sustainable cotton.

Where products are commonly used as ingredients in final products (e.g. palm oil in soap and food), universal certification of private label products may require extensive collaboration with suppliers to ensure that they use only certified ingredients. In such cases, full implementation of minimum standard certification goes beyond green procurement, and requires the establishment of an additional chain of custody and control points (Technique 3 in Section 2.2.6.3).

It is important that retailers keep track of the evolution of existing standards, and the introduction of new ones. One important new standard close to completion is the Aquaculture Stewardship Council standard (http://www.ascworldwide.org/index.cfm?act=tekst.item&iid=4&lng=1).

Case study 2.5. Roundtable for Sustainable Palm Oil certification for more sustainable palm oil

Standard initiation

The RSPO initiative was established in 2002 by the WWF and industry representatives aimed at developing sustainably-cultivated palm oil that does not involve the destruction of rainforests or wetland. The initiative now has more than 340 members, including oil palm growers, product manufacturers, retailers, banks, investors and non-governmental organisations (NGOs). RSPO headquarters are located in Zürich, and the secretariat is based in Kuala Lumpur.

Palm oil certification

To become RSPO certified, palm oil growers must comply with specific criteria, including the avoidance of recent encroachment into natural habitats and implementation of good environmental management practices (RSPO, 2007). However, owing to the difficulties of physically separating RSPO-certified palm oil throughout the supply chain, a trading scheme for sustainable palm oil was established so that purchasers can stimulate sustainable production through the purchase of credits (RSPO, 2010). This is based on certification according to four models:

1. identity preserved: RSPO-certified palm oil or derivative products are traceable to a specific mill supplied by certified plantations;
2. segregation: RSPO-certified palm oil or derivative products are traceable to a number of certified plantations and mills;
3. mass balance: matches the quantity of sustainable palm oil demand from end-users with RSPO-certified palm oil production within specific (but not RSPO-exclusive) supply chains;
4. book and claim: provides tradable certificates (e.g. 'Green palm' certificates) for RSPO-certified palm oil to the supply base who can then sell these certificates to end-users who would like specific volumes of sustainable palm oil.

These models offer progressively lower levels of traceability and 'level of claim' for the end-users (from 1 through to 4), and also progressively lower green procurement costs.

Retail contribution to standard development

Migros initiated the process of devising a palm oil standard through collaboration with WWF. A number of retailers were involved with establishing the RSPO standard in 2002: Aarhus United UK Ltd, Migros, Sainsbury's and Unilever. Currently, 23 retailers are active members of the RSPO, and many retailers buy RSPO-certified palm-oil (Table 2.47).

Applicability

Any retailers can implement choice editing and green procurement, although only larger retailers can influence suppliers to become certified according to third party standards (including by providing assistance: e.g. Section 2.2.6.5).

This technique is applicable to all product groups for which appropriate and widely applicable third party environmental standards are available. Third party standards may not cover all relevant environmental aspects and processes along the supply chain, and widely applicable improved level standards are not available for all product groups (see Table 2.34 in Section 2.2.5.1). These product groups may be targeted for supply chain improvement through intervention by front-runner retailers, as described in subsequent techniques.

Economics
No specific economic data were provided. Compliance and certification costs are directly borne by suppliers, but may be shared between suppliers and retailers. Leading retailers provide financial assistance to suppliers to meet certification costs (e.g. Coop Switzerland for GlobalGAP compliance).

For suppliers, compliance costs should be balanced against maximising the market available for their products, and any price premiums they may consequently demand.

For retailers, costs should be balanced against reputational and medium-term business supply chain risks associated with unsustainable practices, and against price and marketing premiums they may consequently realise.

Driving forces for implementation
Retail demand, and the realisation of product price premiums, motivates suppliers to invest in certification according to third party standards. For retailers, all of the driving forces listed in Section 0 are relevant, but the following are particularly important for implementing widespread compliance with independent minimum standards:

- environmental awareness and responsibility
- consumer demands
- developing potentially more profitable value-added product ranges
- enhancing image and reputation
- reducing the reputational risk from 'product scandals'
- future-proofing supply chains.

Reference retailers
See Table 2.47. Overall front-runner retailers include Coop Switzerland, Migros, M&S and Sainsbury's.

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2.2.6.5 Enforce environmental requirements for suppliers of priority product groups

Description

When improving the environmental performance of priority product groups identified following product supply chain environmental assessment (Section 2.2.6.2), it is preferable that retailers use certification according to widely recognised third party standards (Technique 4 in Section 2.2.6.4). However, as indicated in Table 2.34 in Section 2.2.5.1, some core product groups are not well represented by third party standards, particularly standards associated with an improved level of environmental performance as classified in Section 2.2.5.2. Where it is not possible to use third party standards to drive improvement of priority product groups, retailers can drive product improvement by establishing and enforcing their own environmental requirements across private label suppliers. This technique refers to the **widespread** application of environmental requirements across the suppliers of priority product groups.

In some cases, product specifications enforced through the quality assurance process may indicate that suppliers have complied with basic environmental management requirements. Enforcing restricted chemical lists through product testing for residues and supplier auditing is an integral part of product quality assurance that can reduce the risk of toxic spills and diffuse ecotoxicity impacts (and worker poisoning) during the production process. Retailers may implement such product specifications simply to ensure compliance with legislation in all countries where they operate (e.g. H&M's restricted chemical list: Appendix A2). Consumer concern over exposure to substances potentially harmful to health([19]) is another strong driving force for implementing such requirements. Whilst it is basic good practice to integrate chemical restrictions into quality assurance systems, best practice in this technique goes considerably beyond such requirements to include auditing of suppliers against specific criteria based on well-defined control points (Technique 3 in Section 2.2.6.3). Best practice includes:

- universal application across all suppliers of the target product group(s)
- establishment of specific and enforceable environmental requirements
- enforcement of supplier compliance using a systematic auditing and sanctions.

To be enforceable, retailer environmental requirements must be written into supplier contracts or binding codes of conduct. As referred to in Section 2.2.6.3, H&M and IKEA enforce specific basic environmental requirements in their respective codes of conduct (IKEA, 2008, H&M, 2010). Both of these retailers extend environmental requirements beyond first tier suppliers, and target relevant suppliers with specific additional requirements to address environmental hotspots (see Section 2.2.6.3). In particular, H&M requires all suppliers with wet processes (textile finishers) to comply with the BSR Water Quality Guidelines (Case study 2.4), whilst IKEA requires all wood suppliers without FSC certification to comply with their Forestry Standard (Case study 2.6). In the UK, B&Q are publishing a series of procurement standards for various product groups (B&Q, 2010). The Paint Buying Standard (B&Q, 2010a) requires transparent accounting and labelling of paint VOC content, but also **precludes** procurement of products with **misleading environmental labelling** such as 'environmentally friendly', 'environmentally safe' and 'ozone friendly'.

Front-runner retailers use supplier requirements to complement and assist widespread certification according to third party standards. IKEA have a long term target to source all the wood used in their products from FSC-certified suppliers (Table 2.47 in Section 2.2.6.4). However, most IKEA suppliers are from regions where low-cost forestry operations are associated with poor environmental management and where few suppliers are FSC certified. IKEA argue that implementing their Forestry Standard (Case study 2.6) in these supply regions

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([19]) E.g. pentachlorophenol in leather goods, carcinogenic aromatic amines in textiles, tributyl tin compounds in textiles, assorted pesticides in food products.

accelerates the diffusion of more sustainable practices, and can encourage certification according to third party standards. Similarly, many retailers are aiming for 100 % MSC certification of wild catch fish sales, but this will take a number of years to achieve based on current certification rates. In the meantime, retailers can work with seafood experts to select fish from more sustainable sources. Both Greenpeace and WWF provide lists of endangered fish species from particular stocks that should be avoided (avoidance represents a basic standard), and sustainable alternatives (widespread stocking of which represents an improved standard). The process of shifting procurement towards sustainable supplies that are likely to become MSC certified also improves the security and long-term trading potential of fish supply chains.

Achieved environmental benefits

The environmental benefits associated with retailer environmental requirements for suppliers can be similar to environmental benefits associated with third party certification (Section 2.2.6.4), but depend on both the specific requirements, and the rigour of enforcement. Typically, retailer requirements are less specific and comprehensive than the requirements of third party standards, and compliance verification is less transparent. Consequently, retailer requirements are primarily classified as equivalent to basic or improved third party standards outlined in Section 2.2.5.2. Table 2.49 summarises the most widely applied environmental requirements relevant to this technique, indicates their equivalence with third party standards, and list the associated environmental benefits.

Table 2.49: A summary of the main requirements enforced by retailers across all suppliers of specific priority product groups, and associated environmental benefits

Requirement	Features	Environmental benefits
AFA: Air-Freight Avoidance	Front-runner retailers are minimising transport of seasonal perishable goods by airfreight through regional (*) sourcing. In some cases, air freight may be preferred over local production in heated greenhouses, particularly where employment is created in developing countries. Front-runner retailers offset 'residual' air freight CO_2 emissions (Coop Switzerland, 2010). Equivalent to basic third party standard.	Avoids high specific emissions of GHG, NO_x and hydrocarbons at high-altitudes where they are most damaging
BS: Buying Standards	B&Q has published a list of buying standards for product groups including chemicals, energy-using products, invasive plant species, lighting, paint, peat, timber, water-using products (B&Q, 2010).	Avoids particularly harmful substances and obvious environmental hotspots, improves resource efficiency
CR: Chemical Restrictions	Many retailers have lists of restricted chemicals that suppliers must not use, or can use only with justification and permission. Restricted chemical criteria usually apply to fruit and vegetables (e.g. Rewe, 2010), and textiles (e.g. H&M, 2010), and are enforced through systematic or random chemical analyses Equivalent to basic third party standard.	Avoids use of, and contamination from, particularly harmful substances. Can reduce local air, water and soil pollution
CoC: Codes of Conduct	Many retailers have some form of code of conduct that suppliers are required to sign. Front-runner retailers ensure compliance with specific criteria through extensive auditing combined with compliance training and enforcement mechanisms such as contract suspension or termination (e.g. H&M, 2010; IKEA, 2008). Equivalent to basic third party standard.	Avoids worst practices, especially with respect to hazardous chemical management and disposal. Avoids acute local air, water and soil pollution.
DFA: Deforestation Avoidance	M&S has a target to ensure that no agricultural product suppliers use land that was recently cleared of forest to make way for agriculture (M&S, 2010).	Avoids deforestation and associated ecosystem damage, biodiversity loss and GHG emissions

Requirement	Features	Environmental benefits
RSP: Regionally Sourced Products	Many retailers pursue a policy of regional or local sourcing for fresh products such as milk, fruit and vegetables when in season, and meat. Sourcing from within Europe ensures that suppliers are subject to basic regulatory environmental requirements. Sourcing products from nearby suppliers can reduce transport emissions, and improve traceability (e.g. Sainsbury's, 2010). Equivalent to basic third party standard.	Avoids worst environmental practices in less regulated regions
SFS: Sustainable Fish Sourcing	A number of retailers use information from independent experts, such as Greenpeace and MSC, to identify sustainable (but not necessarily certified) fish sources (e.g. Waitrose, 2009). Equivalent to improved third party standard.	Preservation of endangered fish species Maintenance of marine fishery ecosystem integrity and biodiversity
WQG: Compliance with BSR Water Quality Standard	Some retailers require textile suppliers with wet processes to comply with BSR Water Quality Guidelines (BSR, 2010), comprising a set of waste water chemical parameters (see Appendix A3). Equivalent to basic third party standard.	Reduced water pollution (ecotoxicity and eutrophication)
IFS: IKEA Forestry Standard	The IKEA Forestry Standard includes requirements to implement wood traceability, to avoid illegal deforestation, and to protect virgin and high nature value forests. 10 % of wood was audited in 2009 (IKEA, 2010). Equivalent to improved third party standard.	Maintenance of forest ecosystem integrity and biodiversity Avoidance of net forest loss
(*) In this instance, 'regional' refers to a geographic area within range for rail, road or water-based transport (rather than necessitating air transport). Many retailers are pursuing this by increasing sourcing from within the countries of sale.		

Environmental indicators

Relevant environmental indicators to assess supplier environmental performance are referred to in Table 2.46 of Section 2.2.6.4 and Case study 2.7.

The most relevant indicators of retailer performance with respect to implementing retailer-defined minimum environmental requirements for products and suppliers are:

- the percentage of private label products sold that comply with particular retailer-defined environmental requirements, expressed in relation to total sales value within the relevant product group;
- the environmental rigour and completeness of the particular retailer-defined requirements, as broadly indicated by categorization according to basic, improved or exemplary.

Where a portion of sales within a product group is certified by a third party to an equivalent or higher standard than the requirements being reported, this portion is included as compliant with the requirements reported in this technique, but will also be reported separately in Section 2.2.6.4 or Section 2.2.6.8.

Table 2.50 provides an overview of the performance of front-runner retailers with respect to implementing retailer-defined requirements. The most common requirements are basic code of conduct requirements and chemical restrictions – targeted at fresh fruit and vegetables and textile products in particular. Table 2.50 explicitly refers to codes of conduct only where they are demonstrably based on specific and enforced criteria of relevance to the product group.

Benchmarks of excellence proposed in Table 2.50 are mainly based on targets, and retailer compliance should be interpreted for each product group as per Technique 4 (Section 2.2.6.4):

- the retailer demonstrates on-track progress within the context of a detailed plan to achieve the proposed benchmark.

Although this technique targets **widespread** implementation of product requirements, it may be appropriate to express performance for more disaggregated product groups than the summary product groups presented in Table 2.50. The following indicator may be used to represent the extent of influence of retailer requirements across entire product assortments:

- the number of product groups where more than half of sales comply with retailer-defined environmental requirements.

Cross-media effects

Retailer requirements should focus on reducing the most important environmental impacts for particular product groups, without shifting impacts to other areas. There may be trade-offs between different aspects of sustainability – for example between environmental and animal-welfare standards with respect to free-range farming, and between environmental and social standards with respect to sourcing perishable products from geographically distant developing countries.

Table 2.50: Performance of leading retailers and proposed benchmarks of excellence, with respect to application of retailer-defined standards for priority product groups (expressed as percentage of product group certified)

Product group		Standard classification	Best performers		Proposed benchmark
			2010	Target (year)	
FOOD PRODUCTS	Dairy	Basic	76 % RSP[CR]; 100 % RSP[SS] (milk)	100 % DFA (2015)[M&S]	100 % basic
FOOD PRODUCTS	Fruit and veg	Basic	100 % CR[,CS,ICA,MG,RW, UKC,WE]; 100 % AFA[cs;] 76 % RSP[CR]		100 % basic
FOOD PRODUCTS	Fruit and veg	improved	12 % CQL[CR]		
FOOD PRODUCTS	Grain products	Basic	76 % RSP[CR]	100 % RSP[CR]	100 % basic
FOOD PRODUCTS	Poultry, eggs	Basic	76 % RSP[CR]; 100 % RSP[SS]		100 % basic
FOOD PRODUCTS	Poultry, eggs	Improved	30 % CQL[CR]		
FOOD PRODUCTS	Red meat	Basic	30 % CQL[CR]; 76 % LPS[CR]…	100 % DFA (2015)[M&S]	100 % basic
FOOD PRODUCTS	Seafood	Improved	12 % CQL[CR]; 80 % SFS [SS] 100 % SFS[ICA,MG,M&S,WE]		100 % improved
NON FOOD	Household	Basic	97 % CoC[IA]	B&Q-BS 100 %[B&Q]	100 % improved
NON FOOD	Textiles	Basic	57 % CoC[H&M]; 100 % CR[H&M]		100 % improved
NON FOOD	Textiles	Improved	100 % WQG[H&M]		
NON FOOD	Wood	Improved	97 % IFS[IA]		100 % exemplary

NB: Retailer defined standard abbreviations as described in Table 2.49.
CR = Carrefour, CS = Coop Switzerland, IA = IKEA, MG = Migros, RW = REWE, SS = Sainsburys, UKC = UK Coop, WE = Waitrose

Operational data

Examples from front-runner retailers in this technique offer useful guidance on operational aspects of implementation. IKEA's work to ensure that wood complies with their Forestry Standard is described in Case study 2.6. Waitrose provides an example of best practice in actively ensuring that all the fish they sell are sustainably sourced (see Table 2.50), based on collaboration with an NGOs to obtain best available data (Waitrose, 2009, Waitrose personal communication). Waitrose require all fish sold to comply with the following criteria:

- full traceability to the fishery
- non-threatened or endangered species
- caught from a well managed fishery with scientifically-based quotas
- caught using responsible fishing methods.

Choice editing by Waitrose ensures that consumers are not offered threatened species, or fish from poorly managed or unsustainable fisheries. For example, North Sea cod was replaced with Icelandic Cod. Pressure on the most popular fish species is alleviated through the stocking of alternative species such as pollock, coley and tilapia. Fisheries supplying Waitrose are required to demonstrate sustainable management (e.g. stock regeneration through zone closure when necessary) based on scientific stock assessment and appropriate quotas. Waitrose sourcing criteria require fish to be caught according to the least environmentally-damaging methods for each species (considering sea bed damage, by-catch, fuel use, etc.).

Best practice in supplier auditing is for retailers to systematically audit suppliers for compliance with environmental requirements, and verify the performance of their auditing system using third party verification audits (Case study 2.6). For grocery retailers with a large number of products and suppliers, systematic auditing of supply chains to ensure compliance with environmental requirements, as performed by specialist retailers such as H&M and IKEA, may not be possible. In these cases, a risk-based auditing strategy should be employed, targeting higher risk suppliers for more frequent inspections. Sainsbury's conduct risk assessments on their suppliers, and allow lower risk suppliers to self assess against their code of conduct whilst higher risk suppliers are required to have an independent third party audit (Sainsbury's, 2010).

A number of retailers define environmental requirements only for limited product ranges. These are not referred to in Table 2.50 as they do not target entire product groups. An exception is Carrefour's Quality Line, which comprises 464 products sold in 15 countries (Carrefour, 2010), because this range represents a high proportion of sales in some product groups: accounting for 30 % of meat sales, 12 % of fish sales, 6 % fruit and vegetable sales (Table 2.50) (Carrefour, personal communication). Risk based audits are used to ensure compliance with good environmental management.

Case study 2.6: IKEA supply chain control through IWAY wood sourcing standards

IWAY

IKEA defines minimum ethical and sustainability standards for suppliers in their IWAY code of conduct (IKEA, 2008). Suppliers are responsible for ensuring that the many thousands of IKEA sub-suppliers also comply with this code of conduct. In 2009, IKEA auditors performed 1050 supplier audits, of which 523 were unannounced, to check on IWAY compliance (IKEA, 2010). During the same year, 43 audits were performed by the IKEA Compliance and Monitoring Group, to check that procedures and standards are applied consistently across regions, and an additional 45 verification audits were performed by independent third parties (e.g. KPMG, PWC). Audits are focused on high-risk regions: on average, Chinese suppliers are audited at least once per year, compared with once every two years for all suppliers. Compliance statistics for different regions and criteria are published in annual sustainability reports (Table 1).

Table 2.51: Percentage of suppliers from different regions who fulfil various IWAY criteria

IWAY criteria	Europe	Americas	Asia	Total
Overall	79.0 %	83.0 %	22.0 % (China 7.0 %)	52.0 %
Environment	98.1 %	96.2 %	95.1 %	97.1 %
Chemicals	98.5 %	98.9 %	96.4 %	97.8 %
Waste	98.6 %	98.3 %	97.5 %	98.2 %

Source: IKEA, 2010

Wood sourcing

In addition to IWAY, suppliers must demonstrate compliance with IKEA's wood sourcing standards contained in the IKEA Forestry Standard (IKEA, 2010) by providing relevant documentation on wood origin every four months to IKEA's Forest Tracing System. IKEA standards require that wood is: (i) not illegally harvested; (ii) not from forestry operations engaged in forest-related social conflicts; (iii) not harvested from uncertified Intact Natural Forests (INF) or High Conservation Value Forests (HCVF); (iv) not harvested from natural forests in the (sub) tropical regions being converted to plantations or non-forest use; (v) not from genetically-modified tree plantations. In 2009, 9 % of the 5 686 000 m^3 wood used in IKEA products was audited, and 92 % of audited supply complied with these minimum requirements.

Auditing of preferred, FSC-compliant suppliers (accounting for 22 % of wood used) is left to third parties. Most of IKEA's wood is sourced in China and Russia, where unsustainable forestry practices are relatively common, and where supply chains can be obscure. IKEA argues that encouraging transparent and sustainable supply chain practice in these low-cost source countries can achieve widespread sustainability improvements in forestry. IKEA employs nine forestry specialists in these countries, who assist trade service audits by tracing supplier wood back to specific forests, and also disseminate knowledge across the forestry industry. Risk maps developed by Global Forest Watch and the World Resources Institute are used, along with supplier responses to wood-origin questionnaires, to target auditing in high-risk areas. IKEA is working with WWF and others to address illegal logging, to encourage sustainable forestry practices, and to promote FSC-certification in Russia and China (target for 1 million ha FSC forest in China). Currently, all wood used by Swedwood (IKEA's industrial division) is FSC certified, and IKEA's long-term aim is to ensure that all the wood it uses is from forests certified as responsibly managed.

Applicability

Any large retailer with significant sales of private label products and leverage over suppliers can stipulate minimum environmental standards for production. The most easily verifiable standards relate to restricted chemical use and basic code of conduct requirements. Best practice for large retailers extends considerably beyond these basic standards.

Retailer requirements should be applied to product groups for which appropriate third party environmental standards are not available.

Economics

No specific economic data were provided. Compliance costs are directly borne by suppliers, whilst auditing costs are borne by retailers. For suppliers, compliance costs should be balanced against improved security of demand and enhanced marketability for their products, and any price premiums they may consequently realise.

For retailers, costs should be balanced against reduced reputational and medium-term business supply chain risks associated with unsustainable practices, and against price and marketing premiums they may consequently realise.

Driving forces for implementation

Maintaining business contracts with large retailers, and in some cases product price premiums offered by retailers, motivates suppliers to comply with retailer defined standards. For retailers, all of the driving forces listed in Section 0 are relevant, but the following are particularly important for implementing widespread compliance with independent minimum standards:

- environmental awareness and responsibility
- consumer demands
- developing potentially more profitable value-added product ranges
- enhancing image and reputation
- reducing the reputational risk from 'product scandals'
- future-proofing supply chains.

Enforcement of environmental requirements enables retailers to make environmental claims for their products that can be very useful for marketing. For example, implementation of their Forestry Standard across the 78 % of wood supply that is not yet FSC certified enables IKEA to claim that almost all of the wood used in their products is from sustainable sources (IKEA, 2010).

Reference retailers

H&M, IKEA, M&S, Sainsbury's.

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2.2.6.6 Drive supplier performance improvement through benchmarking and best practice dissemination

Description

For some priority product groups where appropriate third party environmental standards are not available or widely applicable, it may not be possible to effectively target environmental hotspots in the supply chain using environmental requirements contained in contracts and codes of conduct with first tier suppliers as described in Section 2.2.6.5. This is most likely to be the case for product supply chains based on a large number of small producers, such as those for dairy and cotton products. Proactive retailers are beginning to collaborate with (indirect) suppliers in order to drive continuous improvement, where this has been identified as an effective method to improve environmental performance for priority product groups (Section 2.1.6.2 and Section 2.2.6.3). This technique describes such collaboration, which is usually based on performance benchmarking and the dissemination of better management practices (BMPs). The BMP dissemination element of this technique is also important where retailers are assisting suppliers to comply with environmental requirements contained in codes of conduct or third party standards.

Introducing constructive intervention into competitive business relationships with suppliers can drive continuous improvement in supply chain sustainability, but may require changes to procurement policy for some retailers. Whilst competition across suppliers provides a strong incentive for efficiency, establishing long-term business relationships with suppliers offers suppliers the necessary motivation and stability to engage with long-term environmental improvement projects, in particular to make investments that would be seen as too risky in the absence of retailer commitment. In addition, collaboration between retailers and suppliers enables the implementation of strategic efficiencies throughout supply chains, and can provide insurance against product supply fluctuations and price volatility. Evidence of extremely wide variations in ecoefficiency across individual suppliers (e.g. a four-fold difference in the carbon intensity of milk production amongst Sainsbury's milk suppliers: Case study 2.8) highlights the environmental improvement potential that can be achieved through performance monitoring and BMP dissemination – often associated with economic efficiency benefits.

There are two fundamental elements of successful retailer cooperation with suppliers to drive product supply chain improvement:

- quantitative benchmarking of supplier environmental performance
- dissemination of BMP.

Benchmarking requires the collation of relevant environmental performance data from suppliers. This represents a considerable challenge as suppliers must be persuaded to monitor and report on relevant environmental performance parameters. A number of retailers are beginning to collate supplier environmental performance information with the intention to benchmark performance (Carrefour, personal communication; Colruyt, personal communication; H&M, 2010; M&S personal communication; Sainsbury's, 2010).

Another common focus of supply chain improvement is the provision of necessary tools, training and advice, especially to small scale farmers where productivity can be improved, use of water and chemical inputs reduced, and soil erosion minimised through the implementation of BMPs. The BCI provides a useful reference template for BMP dissemination (Case study 2.7). In some cases, retailers are also intervening in the supply chain to achieve widespread supplier certification according to third party standards (e.g. Case study 2.11 in Section 2.2.6.8). According to the hierarchy of supplier improvement outlined in Section 2.2.6, providing a basis for widespread third party certification is an important secondary objective for this technique.

Many large retailers are involved with projects to improve supplier performance in pilot projects. Depending on the specific objectives and degree of retailer involvement, such projects may constitute best practice in terms of research and development (Section 2.2.6.2). Best practice for this technique requires extensive improvement programmes aimed at the majority of suppliers for a particular priority product group. Currently, there are few well documented examples of this technique. Aside from the multi-stakeholder BCI, the most extensive current example of technique implementation appears to be Sainsbury's Dairy Development Group (SDDG) programme, described in Case study 2.8 (the original objective of this programme was to improve agronomic efficiency, but it has become an important driver of environmental improvement through a focus on ecoefficiency).

H&M has begun benchmarking supplier carbon and water footprints, has introduced a Management System Scorecard that aims to encourage supplier development of management systems to drive continuous improvement, and encourages voluntary environmental improvement deep in the supply chain (for tertiary suppliers) with their Cleaner Production Programme (Case study 2.9). In addition, Coop Switzerland and Rewe are working with RemeiAG to improve growing conditions for 10 300 organic cotton farmers and their families in India and Tanzania (Coop Switzerland, 2010; Rewe, 2010).

Achieved environmental benefit

Sainsbury's reports that GHG emissions from dairy farmers participating in their DDG have declined at a rate of 5000 t C per year up to 2009 (Sainsbury's, personal communication). Farmers participating in the BCI have achieved a substantial reduction in pesticide, water and fertiliser inputs per unit output (Case study 2.7). Specifically for Indian farmers participating in BCI trials, pesticide use was reduced by 81 %, water use by 49 % and fertiliser use by 18 %, on average. Table 2.52 provides an overview of the main features and associated environmental benefits of major widespread supplier improvement programmes implemented by retailers.

Table 2.52: Main continuous improvement programmes implemented by retailers

Programme	Features	Environmental benefits
BCI: Better Cotton Initiative	Whilst minimum production criteria necessary to sell 'better cotton' may be regarded as a third party standard (Section 2.2.6.4), the main goal of the BCI is to drive widespread continuous improvement across cotton farmers (Case study 2.7). It is equivalent to improved third party standards	Reduced resource use Reduced soil erosion Reduced air and water pollution
SAP: M&S Sustainable Agriculture Programme	M&S has trialled the use of environmental indicators with selected supplier farmers, and plans to roll out these indicators as part of a benchmarking scheme (farmers rated bronze, silver and gold) to be fully operational by 2015. Drives continuous performance improvement, and is equivalent to improved third party standards	Reduced resource use Reduced soil erosion Reduced air and water pollution
SDG: Sainsbury's Development Groups	Sainsbury's have spent three years working with independent consultants and dairy farmers to benchmark and improve the efficiency of dairy production (Case study 2.8). This approach has been rolled out to livestock farmers, and is planned for cereal farmers (Table 2.50). Drives continuous performance improvement, and is equivalent to improved third party standards	Reduced resource use Reduced soil erosion Reduced air and water pollution
TPI: H&M Textile Processor Improvement	H&M is implementing a number of initiatives to benchmark the environmental performance of textile processors within their supply chain. These include benchmarking carbon and water footprints, the implementation of a management system scorecard, and the Cleaner Production Programme (H&M, 2010). Here, these are collectively referred to as the TPI. The TPI aims to drive continuous improvement, and is equivalent to improved third party standards	Reduced resource use Reduced air and water pollution

Appropriate environmental indicator

Relevant environmental indicators to assess supplier environmental performance are referred to in Section 2.2.6.2, Case study 2.6, Case study 2.7 and Case study 2.8. The most relevant indicator to reflect retailer performance for this technique is:

- the percentage of private label products sold that originate from suppliers participating in retail programmes to improve environmental performance, expressed in relation to total sales value within the relevant product group

Where a portion of sales within a product group is certified by a third party to an equivalent or higher standard than the improvement programme being reported, this portion is included as compliant with the improvement programme, but will also be reported separately in Section 2.2.6.4 or Section 2.2.6.8.

Table 2.53 provides an overview of the performance of front-runner retailers with respect to the implementation of supply chain improvement through collaboration with suppliers. Sainsbury’s is a front-runner retailer for this technique, having implemented their SDDG programme across dairy suppliers. Sainsbury's and M&S have targets to roll out farmer improvement programmes to all suppliers of agricultural products over the next few years (Table 2.53). Coop Switzerland

and C&A work with cotton farmers to encourage organic production through the multi-stakeholder Textile Exchange (formerly Organic Exchange) programme. Organic textile sales for these retailers are included in Table 2.53 as an example of the positive influence of best practice dissemination, but as organic certification is a front-runner ecological standard, these examples represent best practice in Section 2.2.6.8.

Implementing widespread supplier improvement programmes takes a number of years. As with Techniques 4 and 5 (Section 2.2.6.4 and Section 2.2.6.5), retailer performance in relation to benchmarks of excellence should be interpreted in terms of demonstrable progress towards targets:

- the retailer demonstrates on-track progress within the context of a detailed plan to achieve the proposed benchmark.

Although this technique targets **widespread** implementation of product requirements, it may be appropriate to express performance for more disaggregated product groups than the summary product groups presented in Table 2.53. The following indicator may be used to represent the extent of improvement programme implementation across entire product assortments:

the number of product groups where more than half of sales are from suppliers participating in retail programmes to improve environmental performance.

The first 'better cotton' from BCI farmers became available in 2010. Consequently, few retailers have quantitative data or targets for better cotton sales (Table 2.47 in Section 2.2.6.4). All retailers involved in the BCI initiative may be regarded as reference retailers for this technique.

Table 2.53: Performance of leading retailers and proposed benchmarks of excellence, with respect to product groups improved through retailer collaboration with suppliers (expressed as percentage of product group certified)

Product group		Standard classification	Best performers		Proposed benchmark
			2010	Target (year)	
FOOD	Dairy	Improved	100 % SDDG[SS]	100 % SAP (2015)[M&S]	100 % improved
	Fruit & vegetables	Improved		100 % SAP (2015)[M&S]	100 % improved
	Grain products	Improved		100 % SDG[SS], 100 % SAP (2015)[M&S]	100 % improved
	Poultry, eggs	Improved		100 % SDG[SS], 100 % SAP (2015)[M&]	100 % improved
	Red meat	Improved		100 % SAP (2015)[M&S], 100 % SDG[SS]	100 % improved
NON-FOOD	Household	Improved			
	Textiles	Improved		TPI 100 %[H&M]	100 % improved
		Exemplary	TE 10 %[C&A]; TE 60 %[CS]	TE 100 %[C&A]	50 % exemplary
	Wood	Improved			100 % exemplary

NB: improvement programme abbreviations as per Table 2.52, TE = Textile Exchange (formerly known as Organic Exchange), SS = Sainsbury's.

Cross-media effects

Ecoefficiency improvements promoted by supplier improvement programmes such as the BCI are usually not associated with significant cross-media effects. However, there may be trade-offs between some agricultural management practices with respect to different environmental objectives. With respect to their SDDG programme, Sainsbury's claim that slurry spreading restrictions in nitrate-vulnerable-zones, intended to reduce water pollution, conflict with the frequent small slurry applications regarded as best practice to minimise GHG emissions (Sainsbury's, personal communication).

Operational data

Supplier performance should be compared using quantitative environmental performance indicators where possible (Section 2.2.6.2), expressed per unit of output. H&M is measuring carbon and water footprints expressed per kg of garment produced, but translates water footprint data into environmental pressure according to local water scarcity for individual factories. The BCI uses quantitative indicators of pesticide, water and fertiliser use (Case study 2.7), whilst Sainsbury's SDDG programme uses a specifically developed GHG calculator, certified by the UK Carbon Trust, to monitor GHG emissions of participating farms based on farm input data (Case study 2.8).

Often it may difficult to obtain the level of input data necessary from suppliers to calculate quantitative environmental performance indicators, owing to both confidentiality concerns and monitoring effort on the part of suppliers. These issues may be addressed through the hiring of independent consultants to undertake data collation and benchmarking (see Case study 2.8). Economic incentives may also be necessary to encourage widespread supplier participation in the initial stages.

Environmental management or process-based indicators (e.g. type of feed fed to animals, type of energy source, etc.) may also be used to estimate and compare the environmental performance of suppliers. For example, the SDDG uses an environmental scorecard approach to compare operational practices on participating farms. This is used to estimate GHG emissions, and provides a basis for recommending BMPs to farmers (Sainsbury's, personal communication).

A number of retailers are developing online self-reporting systems for suppliers, which may be used to benchmark environmental performance. Questionnaires should be designed to extract non-biased information, for example by formulating balanced questions that do not encourage a particular answer, and should be verified by periodic auditing. Carrefour is encouraging suppliers to report on their sustainability performance via an online self-assessment tool based on 49 criteria rated basic to excellent (four levels). In 2009, over 1000 suppliers used the tool, although information is not being used to define minimum standards (Carrefour, personal communication). In the UK, Tesco is working with the Carbon Trust to obtain supplier data in order to calculate PCFs (Tesco, 2010), whilst in the US, Walmart and the Sustainability Consortium (USSC, 2010) are working on the development of supplier data exchange systems. Such data collation systems could provide an important basis for supplier improvement programmes, and thus represent an important component of this technique (or similar techniques developed by retailers in the future).

Case study 2.7: The Better Cotton Initiative as an example of intervention to improve agricultural supply chains

The cotton problem
Cotton is one of most widely grown and important crops in the world: almost 35 million ha are under cultivation (WWF, 2007). Ninety percent of cotton farmers are in developing countries and manage small farm holdings (<2 hectares). Inefficient irrigation methods, poor cultivation practices, improper use of pesticides and fertilisers exacerbate the impacts of this intensive crop, and threaten water quality, soil fertility, human health and biodiversity. See Section 2.2.5.4.

BCI training
The BCI aims to make farming practices more sustainable, by improving: (i) environmental performance; (ii) socio-economic conditions; (iii) resilience to future resource scarcity and climate change. The BCI works with farmer organisations and farmers directly to disseminate knowledge and guidance on Better Management Practices (BMPs), including the implementation of FAO Integrated Pest Management practices that minimise the need for pesticide inputs. Central to the BCI is the practical training provided to farmers through Farmer Field Schools, administered by local facilitators who are trained by experts under the BCI programme (Appendix A5). In addition, Resource Centres provide information, advice and equipment to farmers who could not otherwise afford it. A participatory approach to basic agronomic and ecological education and training empowers farmers to organise themselves in order to continue developing and sharing BMPs.

BCI requirements
Benchmarks and minimum production criteria have been established, and are included in separate benchmarking guidelines for three categories of farmer (i) Family smallholdings; (ii) Smallholder employers; (iii) Large farm employers. Within the BCI progress framework of Understand > Plan > Do > Learn > Improve, farmers must achieve the 'Do' benchmark for each minimum production criteria in order to sell 'better cotton'. To continue selling better cotton, farmers must demonstrate continuous improvement by completing a minimum number of additional benchmarks over the following three growing seasons.

Quantitative monitoring
Farmer assessment within the BCI is based on quantitative indicators for economic, environmental and social performance. Key environmental indicators are:

- pesticide use and type (kg or l/ha per year and per pesticide)
- water use for irrigation (m3/season)
- fertiliser use and type (kg/ha per year and per type).

These are combined with productivity indicators, including production area, production quantity, and production quality, to generate quantitative environmental performance indicators.

BCI achievements
A focus on productivity and fibre quality alongside environmental and social issues has increased gross margins on farms participating in the pilot phase by 15–20 % on average (WWF, 2010). Better Cotton is no more expensive than standard cotton.
On trial farms in India, three year trial data indicate that, on average, water use has been reduced by 49 %, pesticide use by 81 % and fertiliser use by 18 %. For trial farms in Pakistan, the equivalent reductions are: 32 % for water use, 32 % for pesticide use, and 38 % for fertiliser use.

The initial start-up phase, running from 2009 to 2012, is implementing the Better Cotton System in Brazil, India, Pakistan, West and Central Africa. The BCI strategic plan also aims to extend the Better Cotton System to China and Central Asia within this time.

Reference retailers
Listed retail members of the BCI are: Adidas, Asda, George, Hemtex, H&M, IKEA, KapAH, Levi Strauss & Co., Lindex, M&S, Migros, Sainsbury's and Tesco.

Case study 2.8: Best practice supply chain intervention and improvement demonstrated by Sainsbury's Dairy Development Group

Identification of dairy as a priority product group

Sainsbury’s sells 470 million litres of milk per year, and milk is a component in over 2000 products (Sainsbury's, personal communication). Milk cannot be readily substituted, and is preferably sourced from within the UK. Successive years of poor returns have contributed to a reduction in the number of practising dairy farmers, from 28 000 in the year 2000 to 12 000 in 2010. Meanwhile, dairy production is a major contributor to environmental impacts (section 2.2.5.3). Consequently, this supply chain was targeted by Sainsbury’s to pioneer intervention to improve supply sustainability.

The Dairy Development Group

Sainsbury’s works directly with 334 dairy farmers in seven milk fields throughout the UK through the 'Sainsbury’s Dairy Development Group' (SDDG) dedicated to this supply chain. Farmers are paid a premium above the market price for milk for implementing good agricultural practice. Sainsbury's also invests in on-farm initiatives to improve their animal welfare and ecoefficiency through:

- milk recording, 2 veterinary visits per year, one specialist veterinary visit every 18 months;
- information technology hardware, software and training;
- carbon footprinting;
- training and workshops on animal health and environmental management.

The SDDG scheme is primarily focused on 4 keys areas: (i) animal health and husbandry; (ii) environment and energy; (iii) collaborative working; (iv) business improvement. All data are collated and managed by independent consultants, with Sainsbury’s only seeing aggregated data. Farmers can benchmark their own data anonymously against their peer group.

Environmental performance monitoring

With respect to the environment, all farms are carbon footprinted annually, according to two methods:
(i) a practical, environmental scorecard approach in which physical behaviour (operational practices) on farms are recorded; (ii) using a GHG calculator based on inputs and practices (developed specifically by the SDDG and certified according to the PAS 2050 standard). All GHG emission data are compiled according to tier three GHG protocol standards (i.e. accounting for indirect effects). Each farmer’s results are colour rated against the wider group. Farmers are offered expert advice by consultants on how to reduce their environmental impact, alongside advice on animal health and productivity. Collated data highlight how key parameters vary considerably across participating farms, indicating high potential to improve average production efficiency and reduce associated environmental impacts.

Environmental benefits

Table 2.54 demonstrates the four-fold difference in the carbon footprint of the best compared with the worst performing farms in 2009. Differences arise owing to the ratio of grazing to fodder feeding, the types and sources of fodder used, manure management, and animal productivity (associated with health). There was a significant decrease in the carbon intensity of milk between 2008 and 2009, and GHG emissions from participating farms were reduced by 5000 t C per year up to 2009. However, caution is required inferring long-term trends as there is significant inter-annual variability associated with weather conditions. Meanwhile, improvements in animal welfare and associated productivity achieved by the scheme have increased the profitability of participating farmers by an estimated GBP 1.66 million, collectively.

Table 2.54: The range in the carbon footprint of milk across supplier farms

(kg CO_2eq. /l milk)	**2008**	**2009**
Best performing farms	0.84	0.52
Worst performing farms	2.56	2.24

Source: (Sainsbury's, personal communication)

Key lessons for retailers

A key lesson from Sainsbury’s experience is that farmers are initially suspicious about retailer intervention, and it can take considerable time (years) and effort to develop the constructive relationship necessary for relevant data sharing and effective intervention. Sainsbury’s initially focused on priorities identified by farmers themselves, and did not set immediate targets. Farmers are not requested to complete any bureaucracy themselves, and a high level of personal contact is maintained (every farmer is visited by a Sainsbury’s representative at least once per year). The approach and data management model developed for this sector are easily adapted to other sectors, and are currently being extended to Sainsbury's suppliers of meat (beef, sheep, pig, poultry farmers) and other foodstuffs (crop farmers).

Case study 2.9: H&M's Cleaner Production as an example of best practice in improving the environmental performance of indirect suppliers

Introduction
H&M's Cleaner Production Programme has been in operation for four years, and provides a good example of how retailer influence can be extended deep into the supply chain, beyond primary suppliers. The objective of the programme is to encourage the mills with dyeing processes (textile finishers) that supply the fabric to the factories that supply the garments to H&M to develop cleaner production techniques. Whilst supplier factories are audited according to H&M's Code of Conduct, fabric mills are second-tier suppliers that do not have a direct business relationship with H&M. Therefore, a targeted voluntary approach is employed. H&M inspectors select fabric mills for audit based on: (i) a significant business relationship with H&M suppliers; (ii) apparent scope for improvement. Following audits, inspectors propose appropriate measures for each mill to improve environmental efficiency.

Design and implementation
The Cleaner Production Programme focuses on 43 easy-to-implement environmental measures that achieve rapid results, and that are also associated with cost savings. Therefore, whilst it is entirely voluntary for mills to implement the proposed changes, the programme has been designed to maximise the motivation of mills to do so. The programme has been implemented in China and Bangladesh. H&M felt the need to strengthen the Cleaner Production Programme by engaging the dyeing mills (textile finishers) in a capacity building project called the Mill Development Programme. The Mill Development Programme was launched in China and Bangladesh in 2009, and is comprised of four main steps:

identifying fabric dyeing mills that supply major H&M garment suppliers;
raising awareness of H&M requirements across the fabric mills;
visiting mills to instigate self-assessment and identify issues for correction;
auditing.

Identifying best practice
Meanwhile, in Bangladesh, H&M is working with a number of partners on a long-term (six year) project that aims to develop and test water and energy saving methods, and to develop a best practice tool kit. Best practice information is being collated through peer-to-peer group communication in combination with consultant advice. Similarly, a set of dyeing mills have been chosen in China to do an intense Cleaner Production Programme with the help of external consultants and NGOs. Both the projects in Bangladesh and China were planned for launch in 2010.

Applicability

Any large retailer with significant sales of private label products and leverage over suppliers can collaborate with suppliers to drive continuous improvement.

This technique is applicable to suppliers whose environmental performance cannot be readily improved by mandatory compliance with third party (Section 2.2.6.4) or retailer defined (Section 2.2.6.5) environmental standards. However, there is an overlap with Technique 4 and Technique 5 where retailers assist suppliers to comply with third party standards or retailer requirements, respectively.

Economics

No specific economic data were provided. Retailers may initially offer suppliers a small price premium to encourage participation in improvement schemes, and must pay to support information collation and BMP dissemination. These costs should be balanced against reduced reputational and medium-term business supply chain risks associated with unsustainable practices, and against price premiums that retailers may consequently realise.

Where suppliers invest to implement BMPs and achieve performance improvements, costs should be balanced against improved security of demand from retailers, potential process efficiency gains, enhanced marketability of their products, and any price premiums they may consequently realise.

Driving forces for implementation

Maintaining business contracts with large retailers, potential operational efficiency gains, and in some cases product price premiums offered by retailers motivate suppliers to comply with retailer improvement programmes.

For retailers, all of the driving forces listed in Section 0 are relevant, but the following are particularly important for implementing widespread compliance with independent minimum standards:

- environmental awareness and responsibility
- consumer demands
- developing potentially more profitable value-added product ranges
- enhancing image and reputation
- reducing the reputational risk from 'product scandals'
- future-proofing supply chains.

Reference retailers

Adidas, Asda, George, Hemtex, H&M, IKEA, KapAH, Levi Strauss & Co., Lindex, M&S, Migros, Sainsbury's and Tesco

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2.2.6.7 Collaborative research and development to drive widespread supply chain improvement and innovation

Description
Collaborating with research institutes to assess impacts along entire product value chains, including consumption and end-of-life stages, enables retailers to focus intervention where it is most effective (Section 2.2.6.2). Front-runner retailers pursue research and development beyond supply chain assessment, primarily through:

- collaboration with a range of relevant stakeholders to develop widely applicable environmental standards for products and suppliers;
- collaboration with suppliers and research institutes to develop innovative solutions for particular processes or products.

Third party environmental standards provide the most robust and credible basis for product supply chain improvement, as described in Section 2.2.6.4, yet a number of priority product groups are not represented by relevant third party standards. Developing such standards is a priority to drive widespread improvement in product supply chains that is being driven by producers, branded-product manufacturers and NGOs, but in which retailers can play an important role. The development of credible and widely recognised third party standards requires the involvement of all major stakeholders. Retailer collaboration with other stakeholders can lead to selection and development of the most appropriate third party standards, which in turn can reduce standard proliferation and ultimately improve the effectiveness of all certification. This technique can maximise the returns on the work of supply chain stakeholders to improve environmental performance, and is driven by medium-term collective interests.

Collaboration between retailers, suppliers and research institutes is also essential for the development of innovative solutions for product lifecycle improvement. Product design, or methods of production, may be targeted to reduce environmental impact from a lifecycle perspective.

To optimise the effectiveness and efficiency of this technique, retailers should strategically focus collaborative efforts on product groups with the greatest improvement potentials (Section 2.2.6.2), and with stakeholder groups to which they can contribute the most knowledge and experience.

This technique is broad in its focus, and includes any retailer actions based around collaborative research and development that aim to drive either widespread supplier improvement or significant innovation. The most effective method to convey best practice across this broad technique is to summarise some current examples of best practice (Table 2.55 and Case study 2.10).

Achieved environmental benefits
Retailer engagement in the development of third party product standards can help to ensure that those standards are appropriate for widespread application, and thus can be used to drive widespread environmental improvement as indicated in Section 2.2.6.4.

Research aimed at identifying innovative solutions to supply chain sustainability challenges may not necessarily achieve immediate environmental benefits, but should lead to the implementation of widespread supply chain improvement options in the medium term. For example, the development of organic production methods (Case study 2.10) may lead to new farming techniques that can be implemented by all farmers (Section 2.2.5.11).

Table 2.55 includes a selection of collaborative projects in which retailers are involved to drive supply chain improvement, whilst Case study 2.10 focuses on one front-runner retailer for this technique.

Table 2.55: Some examples of innovative supply chain research coordinated by front-runner retailers

Examples	Environmental benefit
Carrefour collaborate with Tetrapack and Pricewaterhouse Coopers on the Global Packaging Project that employs LCA to identify the most environmentally responsible packaging option for various types of product, and develop appropriate environmental metrics of packaging performance (Carrefour, 2010).	Identification of environmental front-runner packaging options
Carrefour developed a new 'Carrefour&Pur' cosmetic range based on novel application of ultra high temperature sterilization to enable use of a greatly reduced number of ingredients that are 99.9% natural and organic, and exclude artificial preservatives, perfumes and colorants (Carrefour, 2009).	Reduced ecotoxicity and resource consumption
Carrefour worked with WWF to redesign its entire own-brand pesticide range, excluding glyphosate, and using more environmentally responsible active ingredients including an extract from geranium (Carrefour, 2010).	Considerably reduced ecotoxicity
Coop Switzerland led the construction of two tropical houses that use geothermal heat (Tropenhaus Frutigen) and waste heat from a gas compression station (Tropenhaus Wolhusen) to sustainably produce tropical fruit and fish (Coop Switzerland, 2009).	Avoids further depletion of rare fish stocks (e.g. sturgeon) Avoids high specific emissions of high-altitude CO_2, NO_x and VOCs
Coop Switzerland and Rewe have worked with organic cotton suppliers and apparel manufacturers to produce carbon-neutral t-shirts (residual CO_2 emissions offset through WWF gold-standard projects **within** the production chain). Coop Switzerland has a target for all organic cotton products to be CO_2-neutral by 2013 (Coop Switzerland, 2010).	100 % reduction in net GHG emissions
H&M have trialled the use of organic wool, recycled wool (from used garments), and recycled polyester (from PET and textile remnants) in garment manufacture (H&M, 2010).	Considerably reduced resource consumption Avoidance of significant soil, water and air pollution caused by conventional wool production
H&M worked with Dow Corning and suppliers to trial the use of a silicone-based chemical in denim-washing processes – it reduces water use by 25 %. Plan to extend project to additional suppliers in 2010, and eventually to all denim suppliers (H&M, 2010).	25 % reduction in water use
Otto's Eco Circle project involves customers returning worn polyester clothes, which are recycled into raw polyester for reuse in SportCheck ski outfits (CO_2 footprint of recycled polyester only one fifth of new polyester) (Otto, 2010)	80 % reduction in carbon footprint of recycled ski outfits
Rewe is working with various stakeholders, including the Chiquita marketing group, a local citizens group, and the German Technical Corporation, to restore 120 hectares of farmland to wetland, and develop sustainable practices, in the environmentally-sensitive Bocas del Torro province of Panama that supplies 80 % of Chiquita bananas sold in Rewe (Rewe, 2010).	Restoration of high conservation value habitats Maintenance of local ecosystem functions Reduced resource use Reduce soil, water and air pollution
Sustainability Consortium. Includes a number of retailers such as M&S and Royal Ahold, product manufacturers, scientific institutes and NGOs. Working on a wide range of issues through working groups dedicated to: measurement science, systems science, consumer science, home and personal care products, food beverages and agriculture, etc. (Sustainability Consortium, 2010)	Identification of options for product lifecycle impact reduction
Tesco funded Sustainable Consumption Institute. The institute at Manchester University focuses on four research themes: sustainable consumer behaviour and lifestyle, sustainable production and distribution, climate change and carbon, and making development more sustainable. Interdisciplinary research on water resource sustainability is a cross-theme topic.	Identification of options to promote more sustainable consumer behaviour

Environmental Indicators

Effective strategic supply chain research should ultimately result in reduced environmental impacts arising from the supply chains of priority product groups, although there may be a considerable time lag. Improved product and supplier environmental performance, as reflected in indicators proposed for Section 2.2.6.4 to Section 2.2.6.6 and Section 2.2.6.8 may reflect past supply chain research. Direct measures of retailer performance in terms of funding and coordinating strategic supply chain research include:

- expenditure on sustainable supply chain research (expressed in relation to turnover);
- qualitative assessment of whether the research is targeted at innovative, scalable and high-potential improvement options;
- specific environmental improvements attributable to implementation of research outputs.

Cross-media effects

The reference retailers have adopted a broad perspective on sustainability, and pursue improvement across a wide spectrum of environmental pressures, so negative cross-media effects should be minimal. It is important to base research and development on scientific data, and use tools such as LCA to optimise outcomes.

Operational data

Current best practice for driving supply chain innovation focuses on **applied** research that **engages** suppliers and key stakeholders such as plant breeders, pooling relevant expertise (Table 2.55 and Case study 2.10). The challenge for effective implementation of this technique is to balance strategic coordination and long-term objectives with practical outcomes (i.e. the development of innovative supply chain solutions that address environmental problems). Migros was the leading force behind the establishment of the RSPO standard (Case study 2.5), whilst a number of retailers were involved in the development of the BCI (Case study 2.7). Such collaboration represents best practice for this technique.

Some high profile examples of retailer research collaboration do not represent best practice for this technique. The US-based Sustainability Consortium (initiated by Walmart) has focused on supply chain data collation and impact assessment, representing best practice for Technique 2 in Section 2.2.6.2, but has not engaged in the supply chain innovation research. Meanwhile, the UK's Sustainable Consumption Institute (initiated by Tesco) has produced some useful papers and reports exploring the best methods to encouraging more sustainable consumption, but has not yet engaged in supplier innovation. These promising collaborative efforts could become best practice examples for this technique when research becomes more focused on implementing solutions to supply chain sustainability challenges.

Applicability

Any large retailer with own-brand supply chains can collaborate with research institutes or consultancies to improve supply chain sustainability.

Retailers should focus such research and development on product groups for which there are no existing commercially viable and widely applicable improvement options.

Economics

Research costs are typically small compared with retail turnover, and should be considered as an investment in securing sustainable and economically competitive supply chains.

Driving force for implementation

All of the driving forces listed in Section 2.2.4 are relevant, but the following are particularly important for implementing widespread compliance with independent minimum standards:

- environmental awareness and responsibility
- identification and implementation of cost-effective or cost-saving environmental improvement opportunities

- management of risk, and future-proofing key supply chains.

Reference retailers
Coop Switzerland, H&M, Migros, Otto, Rewe.

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Case study 2.10: A best practice example of a retailer coordinating research to identify innovative solutions to supply chain sustainability

Coop Sustainability Fund

Coop Switzerland funds and strategically coordinates CHF 13 million (EUR 9 million) of research per year through its Sustainability Fund to address key supply chain issues, and uses results to inform product sourcing and target supply-chain intervention (Coop Switzerland, 2010). The Coop Sustainability Fund has sustained long-term cooperation with the Swiss Research Institute for Organic Agriculture (FiBL) since 1992. Currently, Coop is sponsoring a project in which FiBL is working with the bioRe Association in India (set up by the Coop and Remei AG) to compare the lifecycle performance of organic and conventional cotton production systems (used to supply Coop Naturaline textiles).

Projects supported by the Coop Sustainability Fund include:

- the 'cool farming' project, in which ploughless soil tillage and nitrogen-fixing plants are used to reduce resource consumption and GHG emissions arising from agricultural production;
- a project attempting to extend the season for organic strawberry production in Switzerland;
- long-term plant breeding work by Getreidezüchtung, Peter Kunz and Sativa Rheinau AG to develop varieties of high-yielding organic wheat and spelt used in Coop's organic Naturaplan bread ;
- Coop aid for mountain regions, that provides support for the economically-marginal mountain farming systems that maintain high-nature-value (extensively managed) mountain landscapes;
- a project cultivating organic rape seed.

Identifying supply chain solutions

Coop also funds and collaborates with the Federal Institute of Technology Zurich (ETH) to compile lifecycle ecoaudits for specific product categories. The results of this research are used to prioritise product selection. For example, asparagus was identified as having the greatest potential for air-freight emission reductions, so the proportion of white asparagus air-freighted was reduced from 50 % in 2007 to zero in 2009. For green asparagus sourced from South American and California, where quality considerations necessitate continued air-freight, in-store promotions were halted and Coop is working to develop Morocco as a future supply country (the latter point represents innovation).

2.2.6.8 Promote front-runner ecological products

Description

As summarized in Figure 2.78 (Section 2.2.6), retailers' primary responsibilities with respect to improving the sustainability of supply chains are ensure that **all** products and suppliers achieve specified minimum levels of environmental performance (Section 2.2.6.4 and Section 2.2.6.5), or at least drive continuous improvement (Section 2.2.6.6). However, retailers can also play an important role in promoting the consumption of front-runner ‘niche’ ecological products. Such products are primarily represented by ISO Type I environmental labels, such as the EU Ecolabel, Germany’s Blue Angel, and the Nordic Swan, and organic certification for reasons outlined in Section 2.2.5.11. These products are associated with significant direct and indirect benefits (see Achieved environmental benefits), and from here on are referred to as 'ecoproducts'.

Ecoproducts are associated with a significant price premium, and therefore constitute a niche market bought by a minority of environmentally aware consumers who are able and willing to pay that premium. Also, by definition many ecoproducts constitute the top 10–20 % best environmental performing products (EC, 2010). Increased sales of ecoproducts within a particular retailer's stores may increase the overall sales of ecoproducts, or may substitute sales of similar products in other stores. In order to generate additional sales of ecoproducts, front-runner retailers work with suppliers to increase the rate of supplier certification according to exemplary standards and to reduce the price premium for such products. An example of this is C&A's work to encourage organic certification across cotton producers (Case study 2.11).

Customers are bombarded and often overwhelmed with product information. A recent US study found that whilst 20 % of consumers buy some 'green' products, a higher proportion would buy green products if they could easily identify them (Deloitte, 2009). There is considerable potential for retailers to increase sales of ecoproducts through influential communication and marketing, especially positioning and provisioning of information **within stores** (Deloitte, 2009). Retailers must provide consumers with clear and simple messages about different product groups, and clearly differentiate rigorously defined front-runners from all other products. In particular, retailers should clearly distinguish communication and labelling for third-party-certified ecoproducts from communication of less rigorous product improvement achieved through retailer requirements (Section 2.2.6.5) and programmes for continuous improvement (Section 2.2.6.6).

An effective way to communicate front-runner ecological performance to consumers is to consolidate ecoproducts into exclusive own-brand ecological ranges. Albert Heijn launched their 'puur&eerlijk' (pure & simple) umbrella range in 2009 (Table 2.59) in response to a customer survey that indicated a clear desire for more simple and consistent labelling to identify sustainable products.

Achieved environmental benefits

Ecoproducts are associated with considerably lower lifecycle environmental impacts than average conventional products (Table 2.56). In addition to direct benefits, ecoproducts are associated with important indirect environmental benefits, especially if they become accepted as benchmarks by other suppliers (Figure 2.86). Consequently, stimulating demand for ecoproducts has three main environmental benefits:

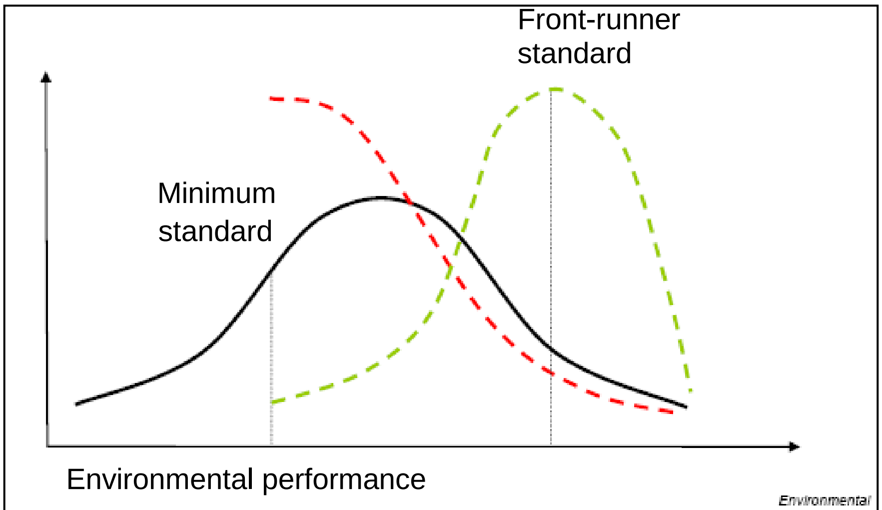
- the avoided (excess) environmental impact associated with consumption of the substituted conventional product
- reduced consumption owing to higher expenditure on ecoproducts
- mass market commercialisation of environmentally superior production processes (innovation).

The main features and achieved environmental benefits are summarised in the descriptions of some retailer ecological ranges for food products (Table 2.59) and non-food products (Table

2.60). Achieved environmental benefits for particular product groups are the same as those listed in Table 2.56, and include the less tangible benefit of stimulating innovation (Section 2.2.5.11).

Table 2.56: The two main types of standard representing front-runner ecoproducts promoted via labelling in this technique

Standard type	Features	Main environmental benefits
EL: Ecolabel (Blue Angel, EU Ecolabel, Nordic Swan)	The listed environmental labels are independent of one another but represent equivalent exemplary environmental standards for non-food products. The most certified product categories are chemical and cleaning products. Essentially, product performance across relevant environmental hotspots must be in the top 10–20 % for the product category.	Considerable reduction in **lifecycle** environmental impact relative to average products within the same group
OC: Organic	Organic product certification is awarded by a number of certification organisations, with some differences in specific requirements, but within the EU these are all in compliance with Commission Regulation (EC) No 889/2008. Foods may only be labelled 'organic' if at least 95 % of their agricultural ingredients are 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.	Enhanced agricultural biodiversity Improved soil quality Lower resource consumption Agricultural innovation



Source: Misiga (2010)

Figure 2.86: Ecoproducts can exert an environmental performance 'pull' effect on entire product groups if they become benchmarks for environmental performance

Appropriate environmental indicator

Indicators of product environmental performance should be based on LCA, or similarly comprehensive methods as outlined in Section 2.2.6.2. Retailers frequently use independent certification of products to demonstrate exemplary environmental performance.

The primary indicator of retailer performance for this technique is:

- the percentage of sales within a product group certified according to front-runner exemplary standards indicated in Table 2.56.

Table 2.57 summarises best retail performance across product categories. Few retailers provided a detailed breakdown of organic sales across product categories. Data from Coop Switzerland show a wide variation in the proportion of organic sales across food categories, ranging from 3 % for coffee to 23 % for poultry and eggs, and 29 % for farmed fish, with overall 8 % of food sales being organic. Beyond the proportion of organic fish sold (Table 2.57), other data verify Coop Switzerland as a front-runner retailer in this technique (Table 2.59 and Table 2.60).

Table 2.57: Performance of leading retailers and proposed benchmarks of excellence, with respect to sales of ecoproducts within priority product groups (expressed as percentage of product group certified)

	Product group	Applicable standards	Best performers 2010	Targets	Proposed benchmark
FOOD PRODUCTS	Coffee, tea	OC	3 % OC[CS]		10 % OC
	Dairy	OC	12 % OC[CS]		10 % OC
	Farmed fish	OC	29 % OC[CS]		10 % OC
	Fats and oils	OC	11 % OC[CS]		10 % OC
	Fruit and vegetables	OC	15 % OC[CS]		10 % OC
	Grain products	OC	20 % OC[CS]		10 % OC
	Poultry, eggs	OC	23 % OC[CS]		10 % OC
	Red meat	OC	10 % OC[CS]		10 % OC
	Seafood (wild catch)	MSC	See Section 2.2.6.4		100 % MSC
	Sugar	OC	8 % OC[CS]		10 % OC
NON-FOOD	Electronic goods	EL			10 % EL
	Household chems	EL	6 % EL[KFS]		10 % EL
	Textiles	OC	10 % OC[C&A]; 60 % OC[CS]	100 % 'OC or sustainable' (2020)[C&A]	50 % OC
	Wood and paper	FSC	See Section 2.2.6.4		100 % FSC
NB: EL = Ecolabel, FSC = Forestry Stewardship Council, OC = organic, CS = Coop Switzerland, KFS = Koopertaiva Förbundet Sweden (Coop Sweden)					

Within KF Sweden, the Coop Kunsum sub-group achieved an 8.6 % sales share for organic food. Approximately 10 % of cotton sold by C&A was organic in 2010, and C&A has a target for 100 % of cotton to be either organic or other 'sustainable' certified by 2020 (Table 2.57). Meanwhile, 60 % of the cotton in textiles sold by Coop Switzerland is organic.

Benchmarks of excellence proposed in Table 2.57 are 50 % for organic cotton certification, 10 % for organic food certification, and 10 % for environmental label certification within relevant categories. These benchmarks are based on front-runner retailer sales, but also EU targets for front-runner environmental products (EC, 2010). As in previous sections, benchmarks of excellence proposed in Table 2.57 should be interpreted for each product group accordingly:

- the retailer demonstrates on-track progress within the context of a detailed plan to achieve the proposed benchmark.

It may be appropriate to express performance for more disaggregated product groups than the summary product groups presented in Table 2.57.

In addition to the sales of organic and environmental labelled products across product groups (primary performance indicators), retailer performance for this technique is also indicated by the total percentage of sales represented by specific ecoranges or sustainability ranges (Table 2.58, Table 2.59 and Table 2.60).

Table 2.58: Front-runner retailer ecological range sales as a percentage of overall retail sales

Range	Sales (%)
Coop 'sustainable' labels	5.0 % retail sales
KF Sweden Änglamark	2.9 % total sales
Migros 'sustainable labels'	4.9 % retail sales

Cross-media effects

Ecoproducts certified with an ISO Type-I label have been assessed as ecological front-runners across a range of relevant environmental criteria, and are not associated with significant cross-media effects.

The benefits of organic production (lower resource consumption and environmental impact, stimulation of innovation, and lower consumption owing to higher prices), may need to be balanced against the environmental consequences of increased agricultural land appropriation where this is required to compensate for lower yields (see Section 2.2.5.10). Indirect land use effects may occur at a global scale, and are therefore difficult to estimate.

Operational data

Table 2.59 and Table 2.60 provide examples of retailer ecological and sustainability ranges used to promote front-runner ecological products. Retailers may promote ecoproducts under a single umbrella sustainability range comprised of front-runner products across environmental, social and animal welfare criteria (e.g. Albert Heijn's 'puur&eerlijk' range, KF Sweden's 'Änglamark' range), or they may promote ecoproducts within a specific ecological range (e.g. Coop Switzerland's 'Naturaplan' range, Migros' 'Terra Suisse' and 'Bio' ranges). It may take some time for front-runner ranges to become recognised and trusted by customers: a long-term sustainable supply chain strategy is required (see Section 2.2.6.1).

Retailers can promote ecoranges through prominent product placement and competitive pricing, including promotions. Advertising is more effective in-store than out of store (Deloitte, 2009). Front-runner retailers work closely with suppliers to increase availability and reduce the price premium of ecoproducts (Case study 2.11).

Table 2.59: Some examples of retailer sustainability ranges for food products

Retailer	Product range
Albert Heijn	Albert Heijn's 'puur&eerlijk' (pure & honest) range of more sustainable private label products was launched in 2009. The puur&eerlijk range is comprised of four different food product categories (plus one non-food category: Table 2.60), each with their own packaging colour and logo from an independent certification organisation: (i) Organic, based on EKO certification; (ii) Fairtrade, based on Max Havelaar certification; (iii) Sustainable catch, based on MSC certification; (iv) Free-range meat, certified according to Dierenbescherming (Dutch animal welfare organisation) criteria. Albert Heijn developed 100 new products especially for the puur&eerlijk range, which comprised 340 high turnover products at the end of 2009 (target to reach 450 products in 2010). The range was launched with an intensive advertising campaign, and a 25 % to 50 % discount during the first two weeks.
Carrefour	Carrefour's AGIR bio range comprises 500 organic food products with prices, on average, 25 % lower than equivalent products in specialist stores (Carrefour, 2010).
Coop Switzerland	Coop Switzerland's Naturaplan range comprises over 1600 organic food items (one of the largest organic food ranges in the world). All products are certified according to the stringent Bio Bud standard (products cannot be air-freighted or grown in heated greenhouses). The Naturaplan label accounts for 7 % of Coop Switzerland's food sales and for over 50 % of organic food sales in Switzerland (Coop Switzerland, 2010; Coop Switzerland, personal communication).
	Coop Switzerland's 'Fresh from the regions' range is comprised of local, organically-grown products, sometimes stocked in as few as five stores, delivered directly to by local suppliers.
KF Sweden	KF Sweden's Änglamark label (also applied to non-food products: Table 2.60) comprises products that have been certified according to exemplary standards, primarily organic (through KRAV or UK Soil Association certification). KF Sweden stock 1736 organic products, accounting for 6.7 % of sales. Some food products in the Änglamark range carry additional certification such as Fair Trade. KF Sweden has an overall market share of 22 % in Sweden, but is responsible for 40 % of all ecosales. Food products with relatively high Änglamark representation include: eggs (19 %), fresh vegetables (6 %), fresh meat (6 %), cereal (5 %) (KF Sweden, personal communication). 18000 farmers have improved ecological management practices to achieve certification.
Migros	Migros Bio organic food range is certified according to the stringent Bio Bud standard for Swiss agriculture. Imported products are certified according to EG 834/2007. Air freight is forbidden. Migros Bio comprises 1000 products and accounts for 3 % of Migros food sales (Migros, 2010).
	Migros Terra Suisse range guarantees that food products are produced within Switzerland using limited quantities of agrochemicals. Minimum animal welfare standards are also upheld. Terra Suisse accounts for 5 % of Migros food sales (Migros, 2010).
REWE	REWE International AG introduced the 'Ja! Natürlich' organic range in 1994. This range now comprises over 1000 products, and accounts for nearly 50 % of turnover in the Austrian organic market. REWE International AG's PENNY division has sold the 'Echt B!O' affordable organic brand since 2004, and is supplied by 7000 organic farmers who are also company partners.

Table 2.60: Some examples of retailer sustainability ranges for non-food products, and associated environmental benefit

Retailer	Product range
Albert Heijn	Albert Heijn's 'puur&eerlijk' range includes a non-food product category that also carries the 'Eco-friendly', and is based on independent certification according to Nordic Swan and Blue Angel environmental label criteria.
C&A	C&A organic cotton range is produced exclusively from certified organic cotton (see Case study 2.11) and carries no price premium over conventional products.
B&Q	B&Q's One Planet Home Range consists of 4000 products, selected in conjunction with the BioRegional charity. It includes independently-certified exemplary ecological products (e.g. FSC wood products), but also standard products such as home insulation that can help customers to live a more sustainable lifestyle.
Coop Switzerland	Coop Switzerland's Naturaline range comprises over 440 certified organic, fair-trade textile products (largest such range in the world). Over 93 % of Coop Switzerland's cotton-wool sales are Naturaline branded, and Naturaline accounts for 0.9 % of Coop Switzerland's non-food sales. Coop and Rewe demand supports 10 300 organic cotton farmers in India and Tanzania.
	Coop Oecoplan range is comprised of 1400 front-runner ecological products. It includes products with low energy consumption, products associated with renewable energy, products with low material requirements or made from sustainably harvested, organic or recycled materials, non-polluting products and products for organic cultivation. Coop collaborated with experts to develop Oecoplan requirements for product groups, largely based on independent certification (A+ or A++ energy rating, Bio Suisse, Blue Angel or EU Ecolabel environmental label, FSC). Oecoplan range accounts for 1.4 % of Coop Switzerland's non-food sales, but 11 % of paint sales, 86 % of sales of fridges and freezers, and 90 % of plant sales (Coop, 2009b).
KF Sweden	Non-food products in KF Sweden's Änglamark are independently certified according to exemplary standards such as the Nordic Swan and EU Ecolabel environmental labels, and FSC. Some of these products may carry additional certification, such as the Swedish Astma & Allergiförbundets label (non-allergic label). Priority product groups with relatively high levels of Änglamark representation are: tissue paper (19 %), textiles (6 %), and detergents (6 %). In total, 1480 of KF Sweden's non-food products are environmental labelled, accounting for 4 % of overall sales, while 2.9 % of overall sales are Änglamark labelled (KF Sweden, personal communication).
Migros	Migros "Bio Cotton" range. Independently verified compliance with Euro Bio Regulations that ensure organic production of clothes and textiles. The entire supply chain is independently tested for environmentally harmful substances and processes by Migros-owned eco-programme. Migros Bio Cotton accounts for 0.2 % of Migros non-food sales (Migros, 2010).
Otto	Purewear organic cotton range sold by Otto, Unito and Witt. In 2008/9, 293 tonnes organic cotton certified by Skal Cotton Union were used in this range.
	Otto Cotton Made in Africa textile range. Fixed environmental and social quality standards audited by an independent firm within a strict verification system. Source countries include Benin, Burkina Faso, Zambia and Mozambique. 85 000 tonnes 'sustainable' cotton per year from 160 000 ha, supporting > 130 000 smallholders and their families (Otto, 2010).

Case study 2.11: C&A's collaborative work to develop an extensive organic cotton supply chain as a best practice example of improving environmental product accessibility to consumers

Strategy
C&A began exploring options to use organic cotton in 2004, and joined the Organic Exchange (now Textile Exchange) initiative in 2005. In 2007 C&A's European Executive Board agreed on a long-term plan to expand the use of organic cotton, and C&A launched a broad range of organic clothing accompanied by advertising campaigns. Crucially, C&A sells clothing produced from organic cotton at the same price as clothing produced from conventional cotton.

In 2008, C&A, Organic Exchange and the Shell Foundation initiated a five-year project in India to scale up the supply of organic cotton to C&A. Amongst aims of work in India are: (i) to set up a new organisation (Cotton Connect South India) that will assist companies and business partners to develop strategies for the management of sustainable cotton supply chains; (ii) develop a model for capacity expansion for application in regions such as China, Africa, South America, and Turkey.

Encouraging organic farmers
Cotton farmers making the transition to organic certification face a considerable risk during the three-year transition phase. C&A cooperates with selected spinner/grower groups and places appropriate order volumes to establish economically-viable operations which aim to optimise efficiencies throughout the whole supply chain, whilst also seeking to ensure the integrity of the final product. In addition, opportunities for organic cotton farmers to increase value-added to their product through additional sorting, drying and roasting of crops in rotation with cotton have been identified by Organic Exchange and the Shell Foundation.

In 2008, C&A and Organic Exchange ran a workshop on organic production techniques for over 200 farmers from 24 organic cotton projects in India. Over 2008 and 2009, three value chain conferences were organised to disseminate information on C&A's organic cotton strategy and expectations to supply chain partners, stakeholders and farmer organisations. Expectations regarding integrity, quality, certification, labelling and environmental standards (particularly water and energy use) have been conveyed.

Supply chain coordination
C&A actively coordinates the supply chain. In 2008, C&A asked 30 suppliers to buy organic cotton yarns and fibres from six specific Indian spinning mills, who in turn obtained organic cotton from selected farms. C&A, Organic Exchange and Shell Foundation have formed a partnership under the name 'Cotton Connect'. Cotton Connect is a business organisation that aims to collaborate with retailers and fashion brands to make global cotton supply chains more sustainable (economically, socially and environmentally), including targeted support to encourage widespread transition to organic cotton production.

In 2009, 15 000 Indian farmers worked on the C&A organic cotton project, and 18 million clothing items (8 % of C&A's entire cotton collection) were made from certified organic cotton. In 2008, organic cotton accounted for EUR 200 million of C&A's retail sales, and C&A was recently confirmed as the largest buyer of organic cotton globally. For 2010, C&A aim to sell 23 million products made from organic cotton, to account for 10 % of cotton products. By 2020, C&A aim to use 100 % cotton that is either certified organic or cultivated according to more sustainable methods for their entire product range.

Applicability
Any retailer can promote ecoproducts through their procurement and marketing strategies, whilst any large retailer can introduce an own-brand ecological or sustainability range.

Front-runner ecological standards are available for a wide range of product groups. Organic certification is available for most food products, whilst environmental label certification is available for a wide range of the most environmentally relevant non-food products.

Economics
No specific economic data were provided. Compliance and certification costs are directly borne by suppliers, but should be balanced against the considerable price premiums usually commanded by ecoproducts.

Similarly for retailers, costs incurred in the sourcing and marketing of ecoproducts are usually lower than the premium prices consumers are willing to pay for ecoproducts. Typically, retail profit margins are significantly higher for ecoproducts. However, for this technique to be effective, retailer ecorange products should be less expensive than branded ecoproducts. For example, Carrefour (2010) claim that their AGIR bio range is, on average, 25 % less expensive than equivalent products in specialist stores.

In addition, retailers should consider reputational and supply chain risk management benefits associated with wider ecoproduct sourcing.

Driving forces for implementation

Consumer demand is the main driving force for retailers to sell environmental products. Higher profit margins motivate suppliers and retailers to invest in environmental product certification and promotion, respectively. For retailers, all of the driving forces listed in Section 0 are relevant, but the following are particularly important for encouraging ecological consumption:

- environmental awareness and responsibility
- consumer demands
- developing more profitable value-added product ranges
- enhancing image and reputation.

Reference retailers

B&Q, C&A, Coop Switzerland, KF Sweden, Migros, Otto, Rewe.

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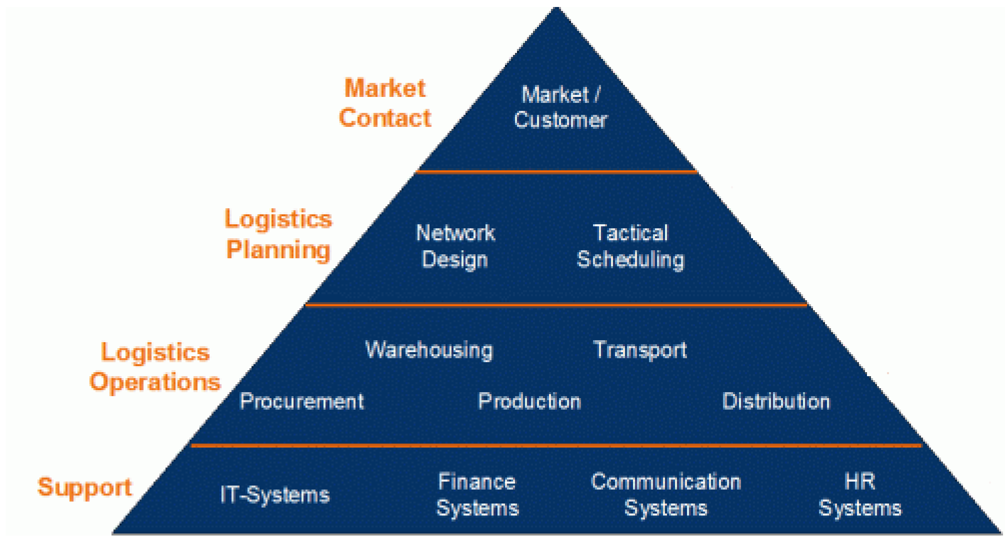
2.3 Best environmental management practice to improve transport and logistics operations

2.3.1 Chapter introduction

Retail transport and logistics

The primary function of efficient transport and logistics (T&L) operations is the safe, punctual delivery of merchandise to retailers' distribution centres and stores. This function is critical to the commercial success of retail businesses, and avoids unnecessary environmental impacts attributable to the disposal of late-delivered perishable food (Chapter 2.4), including impacts arising from compensatory production (Chapter 2.2).

The T&L operations underpinning deliveries are becoming ever more complex, owing to an increasing number of products, an increasingly globalised network of suppliers, and trends towards inventory minimisation and just-in-time deliveries. In addition, T&L operations influence or are influenced by many aspects of retail strategy and operations (Figure 2.87); so any modifications must consider a multitude of possible effects. However, there is considerable scope to reduce the significant environmental impacts associated with T&L operations themselves without compromising critical primary functions. In fact, some improvement options involving logistical collaboration may allow for a higher frequency of efficient deliveries for perishable products.



Source: Bestlog (2010)

Figure 2.87: The key role of transport and logistics operations within retail strategy and operations.

Supplier and retail T&L operations are typically responsible for a relatively small share of the lifecycle environmental impact of products (Chapter 2.2), but represent a significant source of environmental impact over which retailers have either direct control, or significant influence through contracts with third party logistics providers. Transport and logistics operations typically account for a substantial portion of retailers' direct emissions, although the exact proportion varies considerably across retailers of different types and sizes. IKEA (2010) calculate that goods transport accounts for 48 % of scope 1 and 2 GHG emissions according to GHG Protocol reporting standards (i.e. excluding upstream emissions associated with raw-material extraction and production) (WBCSD/WRI, 2004). For large grocery retailers, T&L operations account for between 10 % and 25 % of scope 1 and 2 GHG emissions([20]). Meanwhile, although typically making a small contribution to product environmental footprints, T&L can make a substantial contribution to the environmental footprints of particular products. Rizet et al. (2008) calculated that ship transport from New Zealand dominates the lifecycle energy demand of apples sold in France (Figure 2.88). Aside from GHG emissions and associated climate change, the major sustainability pressures associated with goods transport are:

- air pollution (acidification, ozone formation, and other human health effects)
- resource depletion (predominantly oil)
- water pollution (e.g. heavy metals and PAH runoff from roads, chemical spillages)
- ozone depletion (from leakage of refrigerants used for transportation)
- road accidents
- congestion of passenger transport corridors
- noise.

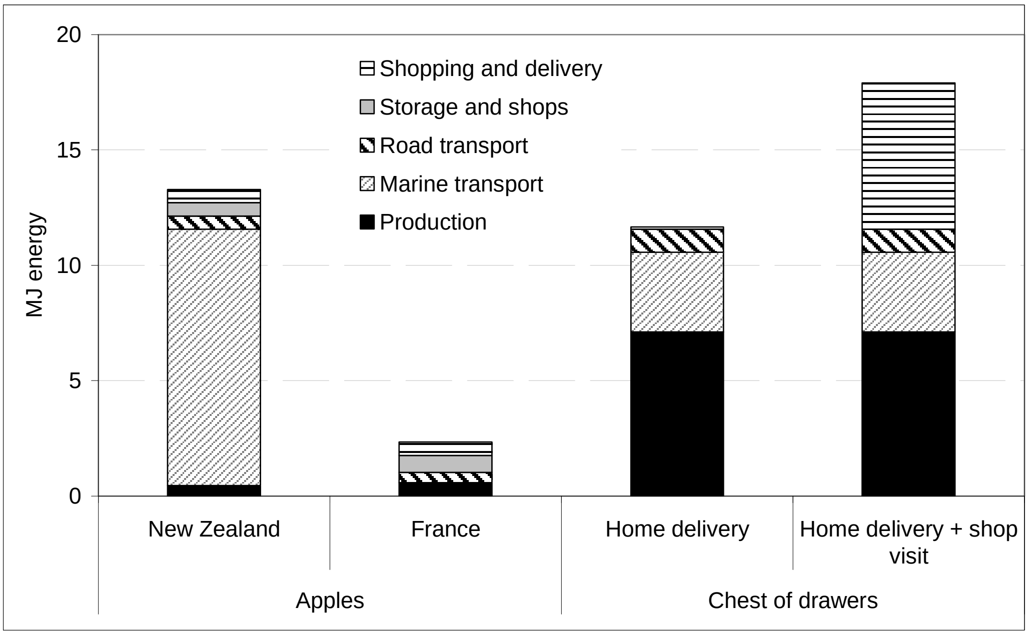


Figure 2.88: Energy consumption for key transport and handling stages in the supply of apples from New Zealand and France and chests of drawers to consumers in France, compared with estimated energy consumption during production.

NB: Based on data in Rizet et al. (2008).

Retailers do not account for the full ranges of environmental impacts associated with their T&L operations. More fundamentally, many retailers still do not reliably monitor and report on some basic indicators of T&L efficiency – e.g. fuel/energy consumption normalised per unit load delivered, and per load-km travelled, or the share of different transport modes. In part, this is because a large portion of retail T&L activities are outsourced to third party T&L providers, in which case emissions may not be known or accounted for by the retailer.

European context

Overall within Europe, the transport and handling of goods is a major contributor to environmental impact, and activity has increased rapidly in recent years – mirroring growth in

([20]) 10 % for Carrefour in 2009 (Carrefour, 2010); 16 % for Tesco in 2009 (Tesco, 2010); 25 % for Coop Switzerland in 2008 (Coop Switzerland, 2009).

consumption patterns. Between 1995 and 2006, total goods transport within the EU-27 increased from 3 060 billion tkm to 4140 billion tkm (Eurostat, 2009). Over half of this increase was attributed to road transport, which accounts for almost half of goods transport within the EU (Table 2.61). Sea and rail account for 37 % and 10 % of intra-EU goods transport, respectively, whilst inland waterways account for 3 %, and air freight for just 0.1 %. Current data indicate that freight transport declined between 2007 and 2009, to stabilise at a level slightly below that of 2006 (Eurostat, 2010). Imports from outside the EU account for a significant portion of goods transport generated by EU retail activity. Such imports are dominated by air and sea transport, which have been estimated to contribute an additional 12.7 % to EU-27 transport-sector GHG emissions (although these are not included in GHG accounting under the Kyoto Protocol).

Table 2.61: The modal share of goods transport within the EU-27 in 2006

Mode	Billion tkm	Share
Road	1888	46 %
Rail	435	10 %
Oil pipeline	135	3 %
Inland waterways	138	3 %
Sea (domestic/intra EU)	1545	37 %
Total	4140	
Source: Eurostat (2009)		

Beyond consumption growth, a number of factors have contributed to increased goods transport, and associated environmental pressures. In particular, McKinnon (2008) attributed increasing average haul-length for goods to:

- wider sourcing of suppliers and expansion of market areas (finding better or cheaper suppliers)
- centralisation of economic activity in order to exploit economies of scale and reduce the number of stockholding points
- circuitous routing of goods in order to utilise cheaper, more frequent or less congested services.

In addition, lean production with short lead times has favoured smaller, less frequent deliveries for some products. Meanwhile, although the concentration of international freight transport through hub ports and airports lengthens land-based feeder movements, concentration of national/regional freight in centralised hub-based distribution systems can improve efficiency by creating opportunities to use more efficient modes and coordinate (optimise) delivery operations across suppliers and retailers. Consequently, optimisation with respect to fuel and environmental efficiency is complex and challenging.

2.3.2 Chapter scope

This chapter focuses on T&L operations, which include the storage of goods in distribution centres (DCs) and other facilities. Energy consumption in DCs makes a small but significant contribution to the environmental impact of T&L operations, and can be minimised by the implementation of many of the best practice techniques described in Chapter 2.1 for energy efficiency in stores. Readers are referred to Chapter 2.1 for best practice in reducing energy consumption in DCs. Waste management, including disposal and recycling, necessitates T&L operations. Casino attributes 3.7 % of their operational GHG emissions to waste transport

(Casino, 2010). This chapter considers how waste management T&L operations may be integrated into product delivery operations.

Customer transport to and from stores also has a significant environmental impact. IKEA estimates that 10 % of the lifecycle GHG emissions attributable to their entire product assortment arises from customer transport to and from their stores (IKEA, 2010). Casino estimate that customer transport adds 38 % to operational GHG emissions (excluding product manufacture), compared with 12 % for goods transport to stores (Casino, 2010). Rizet et al., (2008) estimate that customer shopping and delivery accounts for over one third of the lifecycle energy consumption of a chest of drawers sold in Paris (Figure 2.88). Many factors affect customer transport emissions, which can be difficult to attribute to particular products or stores. Relevant factors such as town planning, public transport infrastructure and pricing and vehicle emissions are outside the scope of this document. This chapter considers customer transport emissions where they are relevant to retailer practices with respect to optimising T&L operations.

Figure 2.89 provides a schematic overview of the main points and routes considered as T&L operations within this chapter. The following basic steps are typical for most products and large retailers:

- transport from the supplier to the distribution centre (DC)
- storage and preparation of orders at the DC
- delivery to the retail outlet.

The organisation of the distribution chain can vary according to the product, the demand and the required delivery time. For example, some fresh local food produce may be delivered directly from suppliers to retail outlets, whilst other products may be stocked in distribution centres for a period of time, with additional incurred costs. Typically, suppliers are responsible for delivery of their products to the DC (or store if direct), whilst retailers are responsible for deliveries from DCs to stores. Retailers may manage T&L operations directly, or delegate responsibility to third party T&L providers. Only 20 % of Carrefour's products are delivered by Carrefour's dedicated fleet. Nonetheless, all large retailers ultimately coordinate T&L activities for their products.

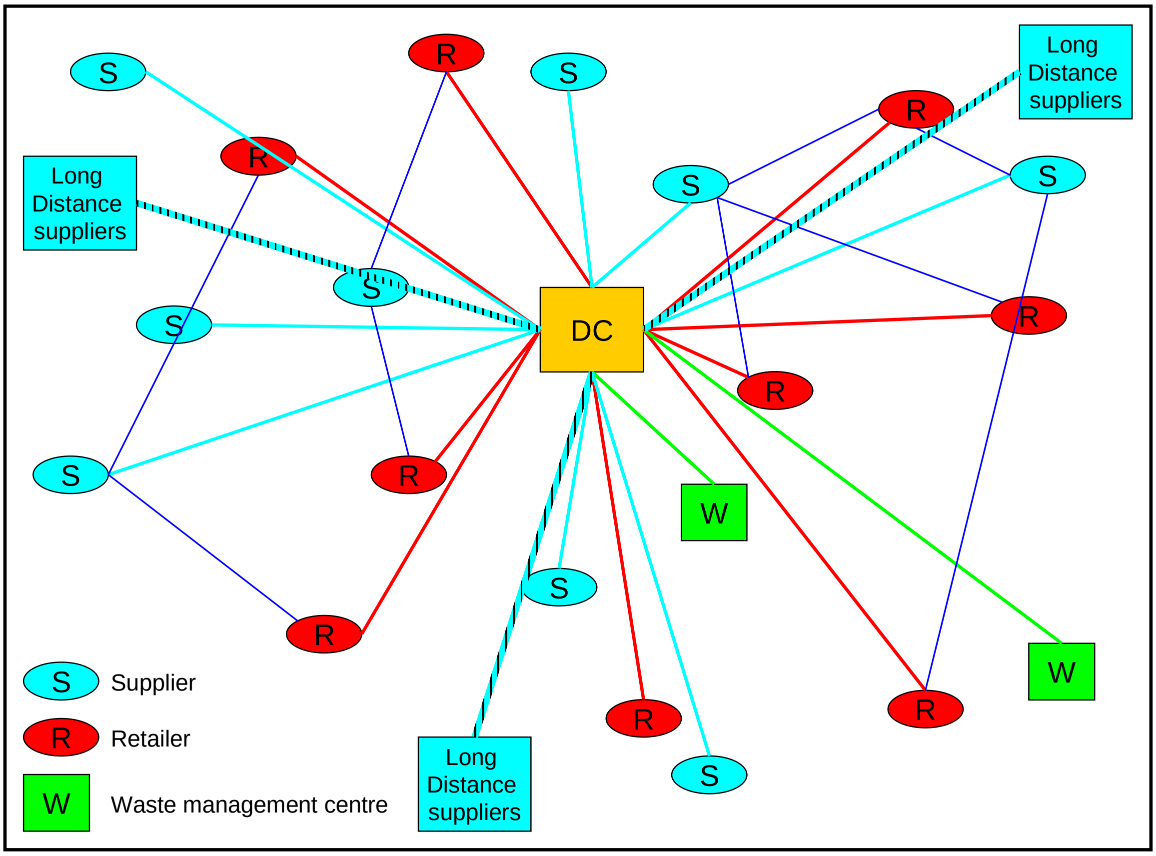


Figure 2.89: **Simplified schematic of the main transport routes for retail sector goods and waste**

Figure 2.90 indicates what is considered within this chapter, in particular techniques described in Section 2.3.4. Many products have long and complex value chains (see Section 2.2.5), and it is important to consider the impact of transport when assessing overall product impacts to inform sourcing decisions and improvement options (Section 2.2.6). However, transport beyond primary suppliers (e.g. between primary and secondary suppliers, secondary and tertiary suppliers, etc) is outside the scope of retailer influence in terms of T&L management, and consequently is not considered in this chapter (Figure 2.90). There is considerable opportunity for retailers to optimise T&L operations through integration with primary supplier T&L operations.

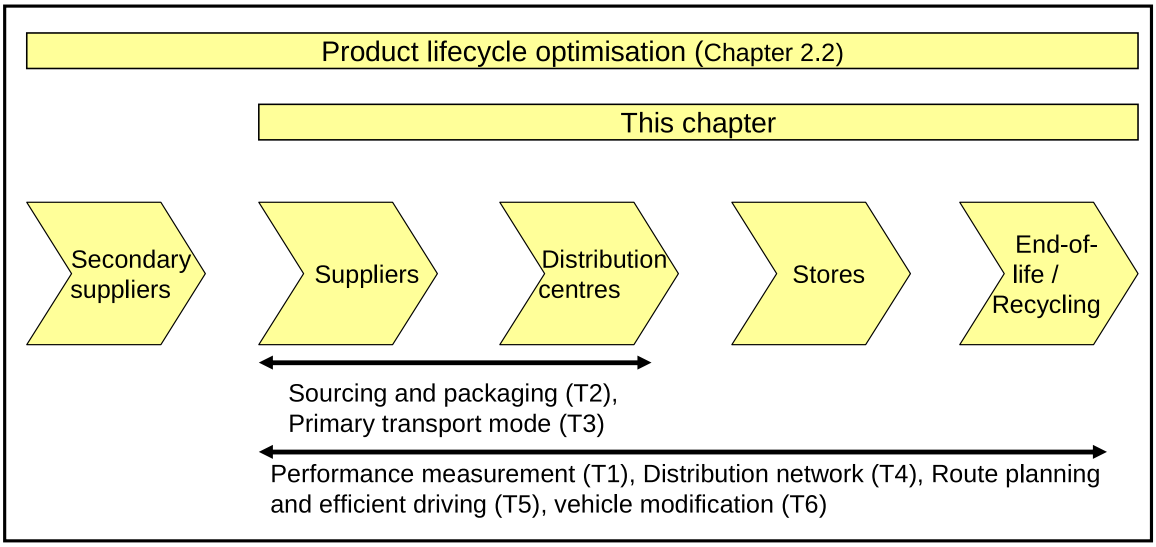


Figure 2.90: **Major points within the T&L network considered within the six techniques (T1 to T6) described in this chapter, and in product lifecycle optimisation (chapter 2.2)**

In summary, the major T&L routes considered in this technique are:

- primary suppliers to retailers (products)
- primary suppliers to distribution centres (products)
- distribution centres to retailers (products)
- retailers to waste facilities (waste)
- retailers to distribution centres (waste)
- distribution centres to waste facilities (waste).

2.3.3 Drivers of transport and logistics improvement

Annual sustainability reports document a recent and increasing focus by retailers on the measurement and improvement of transport efficiency and associated carbon footprint. Based on a case study of transport for the European chemical sector, which is regarded as a leading sector in terms of transport efficiency, McKinnon and Piecyk (2010) concluded that measuring and reducing the carbon footprint of transport operations is at an early stage, and that there are many opportunities to achieve short to medium-term savings. They emphasised the importance of companies working closely with transport providers.

Realisation of cost-saving opportunities in T&L operations often requires initial investment, and a significant barrier to this is the low profitability of the T&L sector in recent years (Climate Change Corp, 2008). Conversely, the major driver of this decline in profitability – an increase in fuel prices that account for up to 40 % of operating costs – also provides a major incentive for efficiency improvement in terms of business planning and risk mitigation. Therefore, there is usually a strong medium-term business case for retailers to invest in the T&L infrastructure, and to provide financial support for T&L providers to make these investments in return for competitively-priced and stable contract agreements. The drivers for retailers to reduce the energy consumption and environmental impact of their T&L operations may be summarised as:

- corporate social responsibility;
- realising cost-saving opportunities associated with efficient T&L operations;
- reducing exposure to energy price volatility (risk management);
- realising cost effective carbon footprint reductions;
- reducing potential future liabilities associated with carbon pricing.

2.3.4 Best environmental management practices for improving transport and logistics operations: techniques overview

Background

There are four fundamental factors underpinning the efficiency and environmental impact of retail goods transport. For one tonne of a given product, these four factors are:

- distance travelled
- mode of transport used
- vehicle load factor
- vehicle efficiency (within a particular mode).

Each of these fundamental factors is in turn affected by multiple contributory factors. For example, distance travelled is primarily a function of source location, and therefore requires integration with other sustainable supply chain consideration (Section 2.2.6.2). However, the mode of transport, the structure of the distribution network, and the specific routes taken, can all have a significant influence on the total distance travelled. In addition, these factors are strongly interdependent. For example, the mode of transport used and vehicle load factors are both critically dependent on features of the distribution network. Optimising these interdependent criteria is a complex challenge, and requires a holistic approach. In the first instance, it is essential that retailers collate the data necessary to assess the efficiency and environmental impact of their T&L operations, including those that are outsourced and those of their suppliers.

Figure 2.91 indicates the different levels of retailer involvement required to control various factors important to T&L efficiency through key decision points. Some basic steps can be taken to increase the efficiency of road transport per tkm (from driver training to aerodynamic modifications). Further steps, requiring additional engagement on the part of retailers (or third party T&L providers) include increasing vehicle load factors, reducing empty running, and minimising route distances through optimised route planning. More advanced options include optimisation of the distribution network to accommodate efficient long-distance transport modes and generate new opportunities for load maximisation and back-hauling – including through the coordination of transport and logistics requirements with suppliers and other businesses. Finally, a fully integrated approach to transport and logistics considers the consequences of sourcing decisions and store locations on goods transport and customer transport, respectively (balanced against other sustainability criteria).

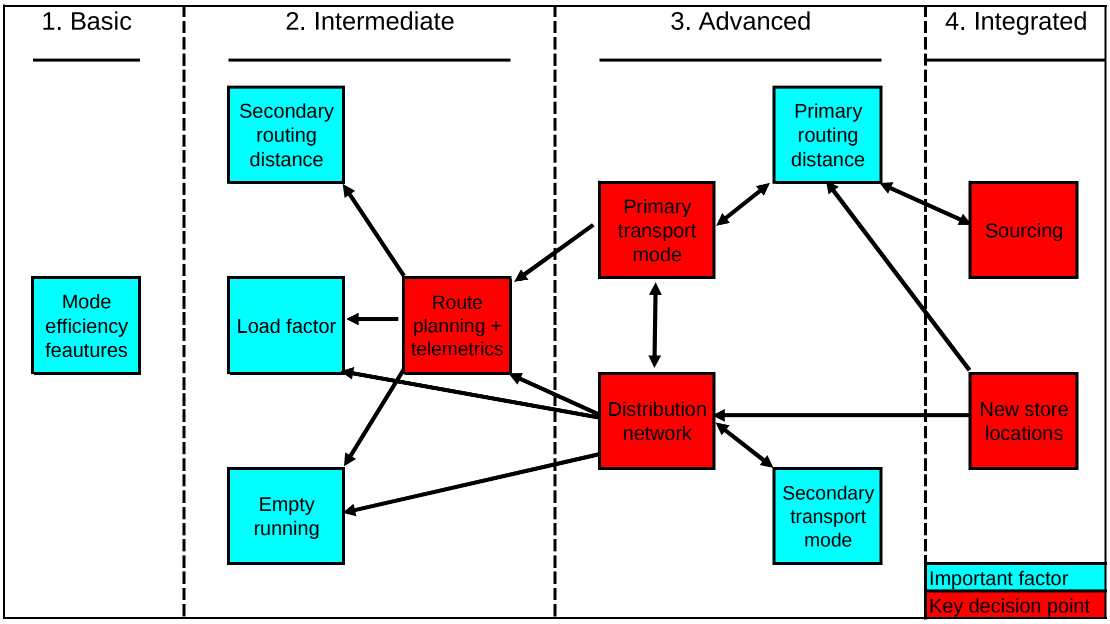
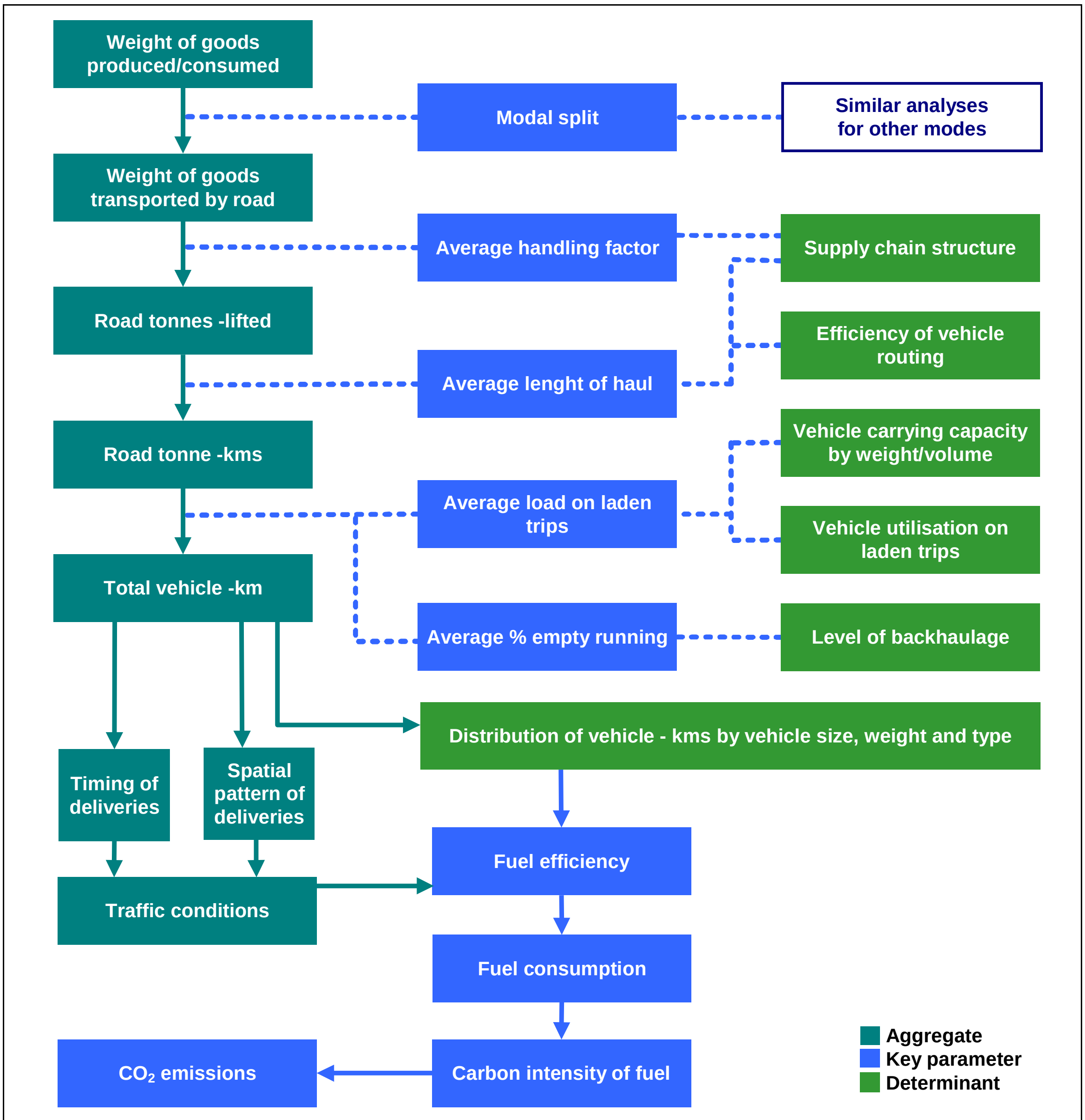


Figure 2.91: Important factors and decision points relevant to the optimisation of retail transport and logistics operations, categorised according to level of retailer engagement required

Figure 2.92 provides a more detailed overview of the inter-relationships between key factors determining the efficiency and GHG emissions of road transport - an essential component of the transport chain for all retailers (Section 2.3.4.4). It includes factors such as total vehicle tkms travelled, which are determined not just by the average distance and weight of goods transported, but the average weight of the truck relative to the load (i.e. average truck size, load factor, and empty running).



Source: McKinnon and Piecyk (2010)

Figure 2.92: Factors affecting road transport efficiency and CO_2 emissions

Front-runner retailers influence 'advanced' T&L factors defined in Figure 2.91. Figure 2.93 proposes a sequence of questions and decisions for particular product groups that represent best practice in T&L optimisation, based on a systematic and fully integrated retailer approach (Figure 2.91). Such an approach should consider:

- source location (balanced against other sustainability criteria – e.g. using a balanced score-card approach);
- transport mode, shifting products to more efficient modes where possible;

- distribution network and logistics to minimise vehicle kms and maximise load (including coordination with suppliers and integration of waste return);
- vehicle impact (efficiency and energy source).

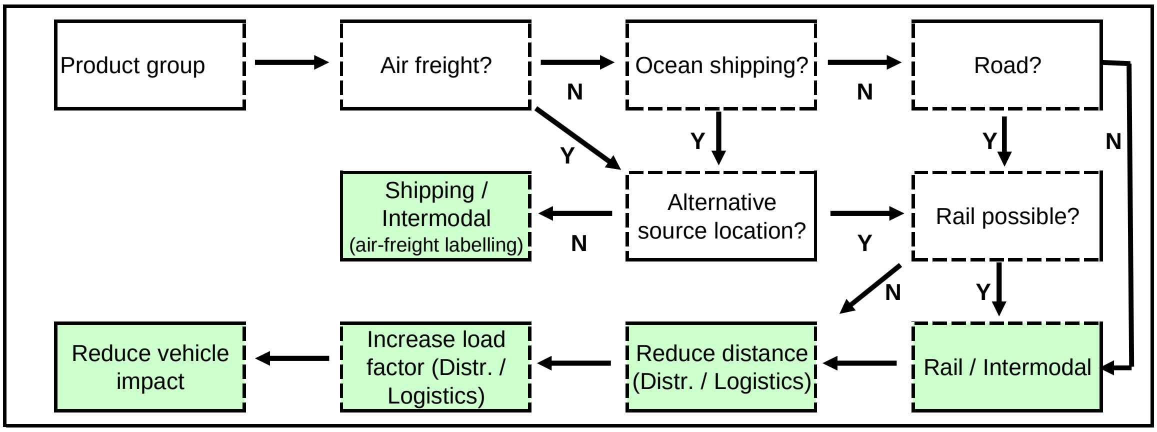


Figure 2.93: Flow chart of an integrated (best practice) approach to systematic reduction of the environmental impact of transport and logistics operations for a particular product group

Techniques

Table 2.62 categorises best practice for improving the efficiency of T&L operations into separate approaches and associated techniques that are described in this chapter. Techniques are ordered according to the ideal sequence of best practice actions to systematically minimise the environmental impact of T&L operations for a particular product group. Monitoring and reporting the performance of T&L operations (Technique 1 in Table 2.62) is a prerequisite (Approach 1 in Table 2.62) to improving the efficiency of T&L operations. Retailers may then either pursue a basic operational optimisation approach (Approach 4 in Table 2.62), involving route planning (Technique 5 in Table 2.62) and vehicle improvement (Technique 6 in Table 2.62), or they may take an integrated approach (Approach 2 in Table 2.62) that includes sourcing and packaging (Technique 2 in Table 2.62) and modal shifts (Technique 3 in Table 2.62). Strategic planning (Approach 3 in Table 2.62) involves optimisation of the distribution network (Technique 4 in Table 2.62), representing an advanced level of retailer engagement in Figure 2.91.

Table 2.62: Portfolio of retailer approaches and best practice techniques to improve the efficiency of transport and logistics operations

Approach	Best practice technique	Key components	Examples	Section
1. Prerequisites	1. Green procurement and environmental requirements for transport providers	Procurement of certified transport providers	IKEA, H&M	Section 2.3.4.1, p. 239
		Requirements for transport providers	IKEA	
	2. Efficiency monitoring and reporting for all transport and logistics operations	Data collation		Section 2.3.4.2, p. 245.
		KPI reporting	Kingfisher	
		Benchmarking	IKEA	
2. Integrated approach to product sourcing (see supply chain assessment in section 2.2.6.2)	3. Integrate transport efficiency into sourcing decisions and packaging design	Regional/local sourcing	Coop Switz	Chapter 2.2 and section 2.3.4.3, p. 255
		Product / packaging volume minimisation	IKEA	
	4. Shift towards more efficient transport modes	Rail	Coop Switz/Migros	Section 2.3.4.4, p. 258
		Inland waterways	Carrefour	
3. Strategic planning		Shipping		
		Larger trucks (including double deck trucks)	M&S, B&Q	
	5. Optimise the distribution network	Strategic centralised hubs (integration of efficient modes)	Coop Switz/Migros	Section 2.3.4.5, p. 273
		Consolidated platforms	IKEA	
		Direct routing	H&M	
4. Operational optimisation	6. Optimised route planning, use of telematics and driver training	Back-loading waste	Carrefour	Section 2.3.4.6, p. 267
		Back-loading supplier to DC deliveries	Sainsbury's	
		GPS route optimisation	Casino	
		Driver training	Migros	
		GPS cruise control		
		Night-time deliveries	Albert Heijn	
	7. Minimise the environmental impact of road vehicles through purchasing decisions and retrofit modifications	Aerodynamics	M&S	Section 2.3.4.7, p. 273
		Low rolling resistance tyres		
		Euro V and efficient engines	Albert Heijn	
		CNG/biogas	Albert Heijn	
		Mild hybrid	Colruyt	
		Low-noise trucks	Albert Heijn	

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2.3.4.1 Green procurement and environmental requirements for transport providers

Description

Small retailers outsource T&L operations to third party providers. Large retailers often have in-house T&L departments that perform secondary distribution from DCs to stores, but rely on third party providers for at least some primary distribution operations (e.g. ocean shipping). Therefore, green procurement of T&L operations is the primary technique for T&L improvement applicable to SMEs. For large retailers, green procurement and specific requirements are an integral component of improving T&L operations, and a prerequisite for best environmental management practice techniques subsequently referred to in this chapter.

Large retailers may also outsource secondary distribution operations to third party T&L providers. From an environmental improvement perspective, there are positive and negative effects of extensive T&L outsourcing for large retailers (Table 2.63). Essentially, outsourcing can ensure that T&L operations are managed by specialist experts with a strong incentive to maximise efficiency and the potential to coordinate efficient distribution across multiple clients. However, outsourced T&L providers may not have a remit for, and strategic overview of, all retailer T&L operations, and do not have a remit to identify integrated sourcing and transport solutions. In addition, retailers may have stronger CSR and marketing incentives to implement longer payment environmental improvement options. The balance of these aspects is heavily dependent on specific circumstances, including features of supply networks for particular retailers, and the T&L provider client base.

Table 2.63: Positive and negative aspects of retailers using a third party T&L provider, versus in-house T&L services

Positive aspects	Negative aspects/limitations
Specialist management expertise in T&L operations	May not be fully responsible for, and have a strategic overview of, all retailer T&L operations
Possible coordination of distribution across clients to realise optimised loading and back-hauling	May not have sufficient client density to optimise loading and back-hauling
Strong cost incentive to optimise operational efficiency	CSR incentives may be weaker than for retailers (lower public profile)
Efficient providers of low-volume T&L requirements (small retailers)	Identification and realisation of integrated transport and sourcing solutions is outside remit

This technique describes best practice wherever retailers use outsourced providers. Essentially, retailers should use third party certification or improvement programmes, contract requirements and selection criteria to ensure that purchased T&L operations:

- are environmentally efficient;
- can be incorporated into retail environmental monitoring and reporting systems;
- follow best environmental management practice techniques outlined in this chapter.

The development of environmentally sound product source locations (Section 2.3.4.3), the selection of efficient transport modes (Section 2.3.4.4) and the development or selection of efficient distribution networks (Section 2.3.4.5) either influence or involve green procurement decisions wherever third party T&L providers are involved. This technique is therefore cross-cutting for many retailers.

There are few widely applicable third party standards specifically representing good environmental performance for T&L providers. However, there are some general and specific third-party-verified reporting standards applicable to T&L providers, some of which also require a basic level of environmental management. With respect to general environment-related standards, formal environmental management systems such as ISO 14001 and EMAS may be required from T&L suppliers. Meanwhile, three examples of third party (primarily reporting) standards specific to T&L operations, and used by retailers, are:

- Clean Shipping Project
- European Retail Round Table (ERRT) Way Ahead Programme
- US Smartway Programme.

The Clean Shipping project (http://www.cleanshippingproject.se/index.html) was initiated in Sweden, and is aimed at improving the environmental performance of the shipping industry by requiring shipping providers to report on their environmental performance across 20 criteria (including chemical, water and fuel use, and waste control, CO_2, NO_x, SO_x and PM emissions), and to achieve basic minimum standards. The primary objective of the project is to empower purchasers of T&L operations, including retailers, to select providers with better environmental performance.

The ERRT Way Ahead Programme http://www.way-ahead.org/ evolved from the Environmental Performance Survey referred to in Case study 2.12.

The primary objective of this programme is to facilitate information exchange between transport providers and retailers (or other stakeholders). It is based on a standard questionnaire for transport providers which aims to identify implementation of various management options relevant to environment and safety. These include:

- extensiveness and frequency of driver training
- driver-level fuel consumption and reward system
- percentage of alternative fuel used
- percentage of fleet using an alternative technique
- details of speed limit policy and control system
- details of idling policy and control system
- percentage fleet using low-rolling-resistance tyres
- details of tyre pressure monitoring system
- age distribution of trucks
- environmental management system implementation level.

The Smartway Programme (http://www.epa.gov/smartwaylogistics/) is run by the US Environmental Protection Agency, and requires transport providers to report emissions data on a yearly basis, in addition to complying with environmental and fuel efficiency targets.

Achieved environmental benefits

Reporting on environmental performance and implementation of environmental management practices encourages third party T&L providers to implement the improvement options, and realise associated environmental benefits, described throughout this chapter. In particular, this technique can encourage T&L providers to:

- use cleaner (lower-sulphur content) shipping fuels;
- use more efficient and cleaner (e.g. EURO V) trucks;
- use alternatively-powered (biogas or hybrid) trucks;
- shift towards more efficient transport modes.

Appropriate environmental indicator

The most appropriate indicator of retail environmental performance with respect to environmental (reporting) requirements for third party T&L providers is:

- the percentage of transport provided by third party T&L providers that complies with specified standards, requirements, or best practice techniques outlined in this document.

Table 2.64 provides a summary of environmental reporting requirements across various suppliers providing third party T&L services to two leading retailers.

Table 2.64: Performance of two leading retailers with respect to environmental requirements for third party T&L providers

Retailer (year)	Clean Shipping project reporting	Way Ahead reporting	Smartway registered	Retailer defined
H&M (2009)	67 %	NA	70 % (US only)	NA
IKEA (2009)	100 %	100 %	100 % (US only)	100 %
Source: From data in H&M (2010) and IKEA (2010).				

Transport accounted for 51 % of H&M's direct carbon footprint in 2009 (H&M, 2010). H&M has targets for all US suppliers to be Smartway certified, and all shipping providers to be signed up to the Clean Shipping project, in 2010.

A proposed benchmark of excellence is:

- 100 % of T&L providers comply with either: (i) third-party-verified environment-related standards; (ii) specific environmental requirements; (iii) best environmental management techniques contained in this document.

Cross-media effects

There are no significant cross-media effects associated with this technique. Requirements made of third party T&L providers should relate to the major environmental pressures associated with T&L operations.

Operational data

For large retailers who outsource parts of their T&L operations, green procurement of these operations is a cross-cutting technique that should be considered within subsequent techniques described in this chapter. Requiring T&L providers to report basic environmental performance data is an integral part of T&L monitoring and reporting best practice described in Section 2.3.4.2. Shifting towards more efficient distribution networks (Section 2.3.4.5) and environmentally preferable transport modes (Section 2.3.4.4) often necessitates the selection of better-performing T&L providers (e.g. train operators in place of lorry operators, shipping operators in place of air freight operators), and may be regarded as green procurement. For example, Migros procures sufficient rail transport from the Swiss rail company SBB to necessitate full-time operation of 400 rail wagons (Table 2.76).

IKEA provides an example of best practice with respect to green procurement and specific environmental requirements for third party T&L providers (Case study 2.12).

Case study 2.12: IKEA requirements for third party T&L providers

IKEA has 278 suppliers of transport services (supplymanagement.com, 2010). All these T&L providers must comply with relevant requirements set out in IKEA's IWAY code of conduct for suppliers (see Case study 2.6 in Section 2.2.6.5), but also with industry-related requirements specified in a transport-specific supplement to IWAY. Below is a summary of the key points (IKEA, 2010; supply management.com, 2010).

Key requirements stipulated by IKEA for T&L providers include:

- trucks must be 10 years or younger (5 years for vehicles less than 3.5 tonnes);
- all T&L providers must complete/update the Environmental Performance Survey (EPS) from the ERRT Way Ahead Programme annually;
- T&L providers in Europe must achieve a minimum EPS score of at least 100;
- T&L providers in Russia & Asia Pacific must achieve an EPS score of at least 50;
- T&L providers in North America must be a registered to the EPA Smartway programme and have a score of at least 1.0;
- all T&L providers must have practical plans for reducing CO2 emissions, including annual targets;
- all shipping providers must comply with the environmental performance reporting requirements of the Clean Shipping Project;

Applicability

This technique is applicable to all retailers. It is the primary technique for influencing T&L environmental performance for retailers who rely entirely on third party T&L providers (e.g. most small retailers).

Economics

As demonstrated in subsequent sections, many techniques that reduce the environmental impact of T&L operations are associated with improved efficiency and reduced costs. Therefore, more environmentally-sound third party T&L providers, and those complying with specific environmental requirements, do not necessarily provide a more expensive service. Where there is a price premium associated with better performers, this should be balanced against the positive marketing effect of a good (environmentally responsible) reputation.

Where retailers work with third party T&L providers and suppliers to implement improvement options, for example by providing finance for investment, economic benefits associated with efficiency gains can be reflected in annually-updated contracts (e.g. Case study 2.16 in Section 2.3.4.5).

Driving forces for implementation

Retailers require third party T&L providers to comply with improved levels of environmental management and performance in order to:

- fulfil CSR responsibilities;
- reduce their overall (reported) environmental burden;
- reduce the environmental burden of particular product groups.

In addition, retailers require third party T&L providers to comply with reporting requirements in order to:

- fulfil organisation-level CSR reporting (e.g. operation carbon footprint);
- efficiently target environmental performance improvement options;
- calculate product environmental footprints.

Reference retailers
H&M, IKEA.

Reference literature

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2.3.4.2 Efficiency monitoring and reporting for all transport and logistic operations

Description

In order to improve the environmental efficiency of T&L operations, it is first necessary to define, measure and benchmark relevant indicators. Monitoring energy consumption and associated CO_2 emissions is integral to efficiency optimisation and to the reporting of key environmental performance indicators in CSR reports. The major objectives of T&L monitoring are to:

1. enable calculation of total environmental burden (e.g. t CO_2 eq. yr^{-1}) attributable to retailer operations;
2. calculate product environmental footprints (e.g. PCF);
3. benchmark and improve the efficiency of T&L operations.

In the first instance, these objectives can be achieved by applying generic energy use and emission factors to various stages of the transport chain (e.g. average data for different modes of transport: Table 2.74 and Figure 2.95 in Section 2.3.4.4). Table 2.65 refers to the basic data required to begin assessing T&L performance (specific performance indicators are defined subsequently in Table 2.68). Objective 1 can be realised with only basic data, for example total fuel use across T&L operations. This may be used to identify absolute performance trends over a number of years, but does not provide insight into efficiency and improvement options. Objective 2 may be realised using basic data such as average transport distance by different modes for particular product groups, and default emission factors. Where T&L operations are outsourced, retailers may need to establish specific reporting requirements (Section 2.3.4.1) in order to obtain the data necessary to realise Objectives 1 and 2 above.

To effectively realise objective 3, and enable the identification of improvement options, detailed information on the actual performance of T&L chains is required. For a truck fleet, this would include the vehicle size distribution, average loading factors for different sizes, distribution of EURO emission standard compliance, etc. To compare the **efficiency** of alternative modes, vehicle sizes or loading rates, performance must be expressed in units normalised for distance travelled by weight/volume (e.g. per tkm). To compare the performance of alternative sourcing options, distribution network options, or routing options, performance must be expressed in relation to the final weight or volume delivered (e.g. per t or m^3 delivered). This latter measure indicates the absolute performance of T&L operations, and can be used to reflect the cumulative effect of all techniques described in this chapter.

Table 2.65: Key input data for monitoring T&L operations

Description	Ideal units	Alternative units
Punctuality in delivery	% on-time deliveries	
Reliability of the preparations	% delivered in acceptable condition	
Total fuel consumption	MJ primary energy	Litres (diesel)
Transport CO_2	t CO_2	
Transport by mode	tkm by mode	km by mode
EURO standard compliance	% of truck fleet	
Transport distance by product	km (average)	
Volume delivered	m^3 or tonnes	Pallets(*)
(*) 120 × 80 cm pallet.		

The range of environmental pressures associated with T&L operations are presented in Section 2.3.1 and Section 2.3.4.4. Ultimately, many of these pressures are correlated with energy consumption, and can be directly calculated from data on the type and quantity of fuel consumed (e.g. CO_2 and SO_x emissions). Fuel consumption data should be readily available to T&L managers (either within retail organisations, within T&L providers, or within supplier organisations), and can easily be normalised according to the quantity (tonnes, m^3, pallets) of goods delivered and distance transported. Therefore, the energy and CO_2 intensity of goods transported are the two primary indicators of environmental performance recommended for retailers in this section.

Case study 2.13 provides an example of T&L monitoring that addresses CSR reporting requirements, and enables the identification of specific T&L performance in order to track efficiency improvements. Some front-runner retailers such as Migros also report on non-CO_2 emissions such as NO_x and PM from their dedicated fleets, and total distance travelled by rail (Coop Switzerland, 2010; Migros, 2010). Front-runner retailers including H&M and IKEA require third party transport providers to participate in standardised reporting programmes (see Section 2.3.4.1 and Case study 2.12)

The UN Global Reporting Initiative (GRI) has produced a pilot document (UN, 2006) on reporting for the T&L sector that includes sector-specific indicators that are additional to standard GR3 reporting guidelines. Some of these indicators are listed in Table 2.65, and are largely based on descriptions of actions to improve T&L performance or mitigate against environmental impacts. Retailers are referred to the UN GRI reporting guidelines, some technical aspects of which are included under 'Operational data', below. This technique focuses on the technical aspects of best practice for retailer monitoring and reporting of T&L environmental performance.

Table 2.66: Indicators proposed for the transport and logistics sector in the UN GRI pilot sector supplement

Aspects	New indicators
Fleet Composition	Breakdown of fleet composition. (See Annex 1 for details)
Policy	Description of policies and programmes on the management of environmental impacts, including: • initiatives on sustainable transportation (e.g. hybrid vehicles) • modal shift • route planning.
Energy	Description of initiatives to use renewable energy sources and to increase energy efficiency. In describing initiatives to increase energy efficiency, reporting organisations should explain how they are benchmarking their energy efficiency to assess improvements.
Urban air pollution	Description of initiatives to control urban air emissions in relation to road transport (e.g. use of alternative fuels, frequency of vehicle maintenance, driving styles, etc.).
Congestion	Description of policies and programmes implemented to manage the impacts of traffic congestion (e.g. promoting off-peak distribution, new inner city transport modes, percentage of delivery by modes of alternative transportation). Note: ‘Impact’ refers to environmental, economic, and social dimensions.
Noise/vibration	Description of policies and programmes for noise management/abatement.
Transport infrastructure development	Description of environmental impacts of the reporting organisation’s major transportation infrastructure assets (e.g. railways) and real estate. Report the results of environmental impact assessments.

Achieved environmental benefits

A comprehensive monitoring and reporting system for goods-transport will enable retailers to identify, and improve the efficiency of:

- product sourcing (section 2.3.4.3)
- modal splits (section 2.3.4.4)
- distribution network (section 2.3.4.5)
- route planning (section 2.3.4.6)
- vehicle design and modification (section 2.3.4.7).

Improved efficiency in each of these areas will translate into reduced environmental pressures, as described in the subsequent sections. For example, measuring the specific efficiency of Kingfisher's dedicated transport fleet is a prerequisite for the ongoing efficiency improvements targeted for and achieved by that fleet (Case study 2.13). Detailed monitoring of truck loading efficiency at different stages of transport (IKEA, 2010) has informed the optimisation of packaging (Case study 2.15 in Section 2.3.4.3) and of the distribution network according to the supplier cluster concept. (Case study 2.16 in Section 2.3.4.5). Some examples of specific T&L performance improvements reported by retailers are included in Table 2.67.

Table 2.67: Some examples of reported environmental performance improvement across retail T&L operations

Retailer	Measurement unit	Performance improvement
H&M		
IKEA	kg CO_2/m^3 delivered	12.4 % reduction 2006–2009
Migros		
M&S	l diesel/store per month	22 % reduction 2006–2009
Sainsbury's		
Tesco		

Appropriate environmental indicators

Absolute T&L impact, expressed as total fuel use or tonnes CO_2 emitted by all T&L operations, is a key component of absolute business impact that should be used as a sustainability indicator alongside business performance indicators to comply with transparency requirements in annual reports. It should be interpreted in the context of business performance, and does not necessarily reflect the efficiency of T&L operations.

A wide range of indicators can be used to identify specific aspects of T&L performance, following collation of basic data specified in Table 2.65, and preferably additional data. Selecting the most appropriate indicators depends on the purpose of the monitoring and/or reporting. Ultimately, the environmental performance of T&L operations is measured by metrics such as kg CO_2 per tonne or m^3 product delivered (Table 2.69). However, a number of important efficiency indicators may be used by retailers to identify specific aspects of performance that could be improved, such as load factors and routing distances (Table 2.68). IKEA (2010) reported filling rates of 63.1 % for trucks moving between suppliers and warehouses, and 59.8 % for trucks moving between warehouses and stores.

Table 2.68: Key efficiency (specific performance) indicators for T&L operations

Description	Units
Load factor	% volume capacity utilised
	% weight capacity utilised
Energy intensity	MJ/tkm
	MJ/m^3.km
	MJ/pallet.km
CO_2 intensity	CO_2 eq./tkm
	CO_2 eq./m^3.km
	CO_2 eq./pallet.km
Volume-weighted average routing distance	km

Table 2.69: Final environmental performance indicators for T&L operations

Units	Examples
kg CO_2 eq./t	24 kg (Kesko)
kg CO_2 eq./m^3	
kg CO_2 eq./pallet	7.8 (Carrefour)
kg CO_2 eq./case	0.0122 (Sainsbury's) 0.0146 (Tesco)

Variations of the indicators specified Table 2.68 and Table 2.69 may be used for specific purposes. M&S measures specific fuel consumption of their food delivery fleet relative to the total number of stores serviced (each store receives at least one delivery per day) (M&S, 2010). This is a valid measure of final environmental performance for the purposes of identifying trends, and indicates that the environmental performance of M&S' T&L operations have improved by 22 % between 2006/7 and 2009/10 (from 2 556 to 1991 l per store per month). However, such indicators do not allow for an accurate comparison across retailers, and should not substitute indicators proposed in Table 2.68 and Table 2.69.

There are two proposed benchmarks of excellence for this technique:

- for 100 % T&L operations between first-tier suppliers, retail stores and waste management facilities, including those performed by third party transport providers, the following indicators are reported:
  - percentage transport by different modes
  - kg CO2 eq. per m3 or per pallet delivered

- for all **in-house** T&L operations between first-tier suppliers, retail stores and waste management facilities (section 2.3.4.1), the following indicators are reported:
  - truck load factor (% weight or volume capacity)
  - kg CO2 eq. per tkm.

Cross-media effects

Energy consumption and CO_2 emissions correlate strongly with overall environmental pressure from transport operations, but may deviate in some instances. In particular, heavy fuel oil used in shipping results in high SO_x and NO_x emissions relative to CO_2 emissions (Figure 2.95 in Section 2.3.4.3). Optimisation of retailer T&L operations should account for any indirect effects on secondary transport providers, product sourcing, and customer travel.

Operational data

In terms of appropriate units, tkm is an indicator widely used in statistical publications to convey T&L efficiency, but is rarely reported by retailers. Retail sustainability reports usually refer to final T&L performance in terms of fuel consumption or CO_2 emitted per m^3 (IKEA), per case (Tesco), or per item (Inditex, M&S) delivered. McKinnon (2009) found that 'wooden pallets' or 'roll cages' were the units commonly used by UK companies participating in a transport benchmarking study. Many retail shipments are volume-limited rather than weight-limited (Lumsden, 2004), and measures to improve load efficiency (e.g. dense packaging of products) will not be reflected positively by volume-normalised reporting. To improve transparency and comparability within the constraints of data availability, it is recommended that transport efficiency be assessed in relation to tkm transported where possible, and final performance in relation to volume (m^3 or pallet or case) delivered.

Where shipping units are reported as 'Twenty-foot Equivalent Units' (TEU), they can be converted into tkm based on the factors proposed by IFEU (2010):

- light goods: 6 tonnes per TEU
- medium-density goods: 10.5 tonnes per TEU.

The UN GRI pilot document for the T&L sector (UN, 2006) contains a number of specific recommendations for T&L energy reporting (in addition to standard GR3 reporting guidelines). Energy consumption should be reported:

- in joules
- separately for individual mobile (e.g. air, sea, road, rail) and non-mobile (e.g. office, warehouse) sources
- according to source
- normalised using units such as cubic-metre-km, tonne-km, delivery item, freight unit (e.g. TEU-km)
- include all energy used to produce and deliver energy products purchased by the reporting organisation (including indirect and electricity-generation emissions).

Table 2.70 includes some conversion factors relevant for the calculation of T&L energy use. Emissions of CO_2 can be calculated from standard emission factors applicable to different fuel types, assuming complete oxidation during combustion (Table 2.70). Non-CO_2 emissions are heavily dependent on the specific combustion technology, conditions, and abatement technology, so cannot be calculated from standard default emission factors applied to fuel type. Where operating conditions are specified more precisely, non-CO_2 emissions may be estimated from emission factors published by various sources (e.g. IPCC, 2006; IFEU, 2010; Tremove, 2010).

Table 2.70: Some characteristics of major transport fuels, including direct CO_2 emissions from combustion

Fuel	Density	Energy content	CO_2
	kg / l	MJ / l	kg / l
Gasoline	0.72	32.1	2.24
Diesel, MDO, MGO	0.83	36.0	2.63
Biodiesel	0.83	38.1	2.79
Kerosene	0.80	35.3	2.52
Heavy fuel oil	0.98	40.4	3.07

NB: MDO = Medium Density Oil; MGO = Medium Grade Oil
Source: IPCC (2006) and IFEU (2010)

When comparing alternative fuel options, and for completeness of reporting, indirect emissions associated with fuel supply chains should also be accounted for (Table 2.71). For example, gasoline combustion is associated with low direct emissions of SO_x, but high indirect SO_x emissions attributable to processing, compared with diesel – based on IFEU data presented in Table 2.71. Where transport is powered by electricity, emissions can be calculated from country-specific electricity emission factors.

Table 2.71: Indirect emissions arising during the extraction, processing and transport of different fuels, expressed in relation to one kg of fuel

Fuel	Efficiency*	CO_2	NO_x	SO_2	NMVOC	PM
		kg /l	g /l	g / l	g / l	g / l
Gasoline	75 %	0.4824	1.52	4.18	1.52	0.21
Diesel, MDO, MGO	78 %	0.390	1.49	3.64	1.26	0.19
Biodiesel	60 %	0.739	5.25	1.36	0.95	0.60
Kerosene	79 %	0.36	1.41	3.44	1.21	0.18
Heavy fuel oil	79 %	0.392	1.65	3.91	1.44	0.21

(*) Final energy related to primary energy.
Source: IFEU (2010), based on Ecoinvent (2009).

Blanco and Craig (2009) found that transport emissions calculated from actual data were, on average, 27 % higher than emissions predicted from standard emission factors, for various transport chains. To improve the accuracy of energy consumption or energy efficiency calculations, and to ensure that monitoring data both incentivise and reflect routing optimisation (Technique 4 in Section 2.3.4.5 and Technique 5 in Section 2.3.4.6), it is important that transport distance be accurately accounted for.

Shipping distances are often 10–21 % greater than direct port-to-port distances, owing to multiple port-calls (Blanco and Craig, 2009). Air freight distances are at least 4 % greater than direct airport-to-airport distances. To calculate typical air transport distances, IFEU (2010) proposes the following formula based on the shortest distance between two points, the Great Circle Distance (GCD):

Real flight distance = (GCD - 185.2 km) x 1.04 + 185.2 km + 60 km

In addition, GHG emissions from air transport should be multiplied by the appropriate Radiative Forcing Index (RFI) factor, depending on the altitude, in order to more fully reflect their climate impact (Table 2.72).
Meanwhile, road and rail transport distances are highly dependent on the road and rail network in relation to the points of origin/destination. In the EcotransIT model, country-specific topography is considered in energy consumption and emissions factors for heavy goods vehicles (IFEU, 2010), with deviations of 5 % lower (relative to European average) for 'flat countries' (Denmark, Netherlands and Sweden) and 5 % higher for 'mountainous countries' (Switzerland and Austria). The effects of factors such as those listed above highlight the need for **activity-specific data**, and can be particularly important when calculating the net potential benefit of transport of modal shifts (Section 2.3.4.3).

Table 2.72: Radiative Forcing Index factor applied to aircraft GHG emissions, depending on altitude (flight length)

Flight distance (km)	Flight % above 9000m altitude	Average RFI factor
500	0 %	1.00
750	50 %	1.81
1000	72 %	2.18
2000	85 %	2.53
4000	93 %	2.73
10000	97 %	2.87
Source: IFEU (2010).		

Kingfisher reporting on T&L operations, to fulfil CSR reporting and efficiency improvement objectives, is detailed in Case study 2.13 as an example.

Case study 2.13: Kingfisher reporting of T&L emissions from own fleet and T&L providers for CSR and performance improvement purposes

CSR reporting

Kingfisher reports on their corporate carbon footprint according to GHG Protocol guidelines. Figure 2.94 displays total GHG emissions presented in Kingfisher's 2010 Sustainability Report (Kingfisher, 2010). In addition to direct (Scope 1) GHG emissions calculated from fuel use within their dedicated fleets (see below), Kingfisher include estimates of indirect (Scope 3) emissions associated with their operations based on external haulage data collected from 88 % (by turnover) of T&L provider companies. Accounting for both direct and indirect (outsourced) GHG emissions ensures a complete overview of absolute T&L impact, and reduces the risk that actions taken to improve the performance of dedicated fleets lead to the displacement (outsourcing) of emissions to third party T&L providers.

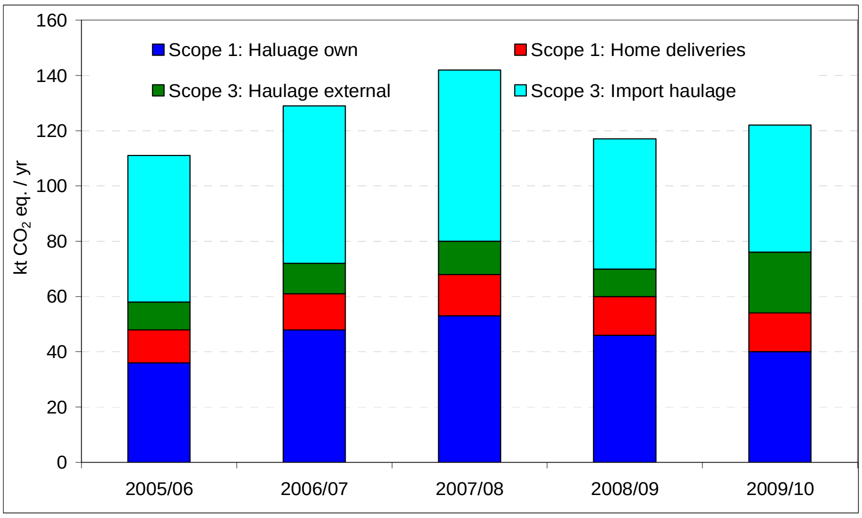

Figure 2.94: Thousand tonnes CO_2 eq. from different parts of Kingfisher's T&L operations, classified as Scope 1 (direct) and Scope 3 (indirect) according to GHG Protocol guidelines

T&L performance reporting

In 2010, three major Kingfisher companies had dedicated fleets. These accounted for 100 % of company store deliveries (Screwfix), 70 % of company store deliveries (B&Q) and 25 % of company store deliveries (Castorama). Table 2.73 presents a summary of specific performance for Kingfisher's entire dedicated fleet, based on data presented in their 2010 Sustainability Report (Kingfisher, 2010). Data presented in Table 2.73 include specific fuel-consumption indicators (km/l and l/m^3 delivered) that can be used to monitor and benchmark the efficiency of Kingfisher's dedicated delivery fleet. It is notable that vehicle fuel efficiency (km/l) remained relatively constant whilst loading efficiency varied considerably, and declined overall, between 2005 and 2010. Identifying the cause of this divergence to inform corrective action requires information on the average load factor or average distance travelled (Table 2.68). These data are not published in Kingfisher's 2010 Sustainability Report. However, based on efficiency indicators in Table 2.73, B&Q have a target to reduce specific fuel consumption from their dedicated fleet by 10 % relative to 2007/8 by 2012/13. In 2010, a 6 % reduction relative to 2007/8 had been achieved.

Table 2.73: Kingfisher reporting of parameters relevant to the environmental performance of their dedicated fleet

	2005/06	2006/07	2007/08	2008/09	2009/10
Diesel (thousand litres)	13 364	18 010	19 965	17 336	14 956
CO_2 from diesel (thousand tonnes)	36	48	53	46	40
Distance travelled (thousand km)	43 483	56 411	64 559	56 353	48 293
Volume delivered (thousand m^3)	3 801	4 445	4 594	4 063	3 641
Fuel efficiency (km/l)	3.25	3.13	3.23	3.25	3.23
Loading efficiency (l/m^3 delivered)	3.52	4.05	4.35	4.27	4.11
Vehicle number	294	273	305	266	288
Vehicles EURO IV or higher	0 %	0 %	54 %	93 %	100 %

Source: Kingfisher (2010).

Applicability
Any retailer can estimate the environmental impact of their T&L operations based on average energy consumption and emission factors, at least based on assumptions about third party T&L routing.

Larger retailers can calculate more detailed energy and environmental performance metrics for T&L operations, based on data collation systems for in-house operations and reporting requirements imposed on third party T&L providers and suppliers.

Economics
The costs of implementing a monitoring and reporting system for T&L operations are not precisely known, but are expected to be small compared with the potential economic benefits of more efficient T&L operations. This applies to both retailers and third party providers.

Driving force for implementation
For retailers and third party T&L providers, the monitoring and reporting of environment-related parameters associated with operational performance is performed in order to:

- fulfil CSR responsibilities;
- identify options for efficiency improvements;
- reduce their overall (reported) environmental burden.

In addition, the following driving forces are important for retailers:
- reduce the environmental burden of particular product groups;
- public image and marketing.

Reference retailers
Coop Switzerland, H&M, Kingfisher, Migros.

Reference literature

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2.3.4.3 Integrate transport efficiency into sourcing decisions and packaging design

Description

Transport is an important consideration within sustainable sourcing decisions. Section 2.2.6 and Technique 2 (Section 2.2.6.2) in Chapter 2.2 describe how transport can make a substantial contribution to the lifecycle environmental impacts of particular products. Section 2.2.5.9 highlights how air-freight can lead to near ten-fold increase in the carbon footprint of asparagus flown from Peru to Switzerland, while Section 2.2.5.8 shows that cane sugar shipped from Paraguay has a considerably lower carbon footprint than sugar produced from sugar beet grown in Switzerland. Similarly, a UK study showed that, outside the summer growing season, tomatoes imported from Spain have lower lifecycle energy requirements than tomatoes grown in heated greenhouses in the UK (McKinnon and Piecyk, 2009). In the latter two examples, minimisation of transport distance and associated environmental impact conflicts with optimisation of lifecycle environmental performance. Consequently, simple metrics such as 'food miles' (kilometres travelled by that food) are not necessarily a reliable indicator of sustainability (AEA, 2005).

Reducing T&L environmental impact through sourcing decisions for individual product groups should therefore be informed by fully integrated assessment of all product impacts, as described in Technique 2 in Section 2.2.6.2. Readers are referred to Technique 2 in Section 2.2.6.2 and Case study 2.14 for the sourcing aspect of this technique. A number of retailers are promoting seasonal and locally-grown produce, which can reduce both T&L and overall lifecycle impact where it avoids long-distance transport and does not necessitate use of heated greenhouses. In addition to Coop Switzerland (Case study 2.14), M&S are sourcing more tender stem broccoli and sprouts from Morocco instead of South Africa and Kenya and are working to extend the UK growing season for a number of fruits and vegetables.

Case study 2.14: Coop Switzerland's integration of T&L impacts into product assessment and sourcing

Assessment and improvement

Coop Switzerland assessed all air freighted imports to identify opportunities for air freight reduction. The greatest potential for reductions was found to be in white and green asparagus sourced overseas. Consequently, Coop improved the efficiency of T&L operations and control of refrigeration so that the percentage of white asparagus transported by ship and truck increased from 50 % in 2007 to 100 % in 2009.

Fully integrated sourcing considerations

Quality considerations for green asparagus prevent long-distance ship transport. Therefore, in 2009, Coop ceased promotion (through special offers) of green asparagus air freighted from Peru, Mexico and California. This step alone reduces the quantity of air freighted green asparagus by 400 tonnes per year, saving 7 200 t CO_2 eq. per year. Meanwhile, Coop is working to source green asparagus from new suppliers being established in Morocco in order to avoid the need to air freight green asparagus in the future.

Widespread transport reduction

Beyond the case of asparagus, Coop Switzerland is constantly expanding its range of seasonal and regional fruits and vegetables through sourcing and promotion actions. The entire Coop Naturaplan range is subject to the strict Bio Suisse guidelines, which permit a product to be imported only if it is not available in Switzerland in sufficient quantity or adequate quality (Section 2.2.6.8). Meanwhile, Coop's smaller 'organic – fresh from the region' label includes products sourced from nine different regions and delivered by suppliers directly to Coop's regional distribution centres. Coop applies a strict definition to ensure that all or most of such products originate from within the region: 100 % for a single raw material product and 90 % for compound products. Where production quantities are small, Coop sells the regional organic specialities locally – sometimes in as few as four or five points of sale.

The remainder of this section elaborates on the packaging improvements that can be made by retailers to improve T&L efficiency. A large proportion of retail transport is limited by volume rather than weight. Lumsden (2004) presents data on general cargo transport in Europe, showing that long-distance trucks are, on average:

- 92 % loaded according to number of pallets
- 82 % loaded by volume
- 57 % loaded by weight.

Packaging changes can optimise the shape and overall density of packaged products, thus enabling a greater mass of product to be loaded into transport containers/vehicles. This technique is best described by the example of IKEA, a front-runner retailer in maximising product density through both design and packaging (Case study 2.15).

Case study 2.15: IKEA packaging to maximise load density

IKEA approach
IKEA regard smart packaging as the best way to maximise transport efficiency and reduce environmental impact (IKEA, 2010). Products are **designed** to be flat-packed and to fit exactly onto standard transport pallets. In 2009, IKEA's T&L CO_2 emissions per m^3 product delivered were 12.4 % lower than in 2006 (Table 2.67 in Section 2.3.4.2).

Tea light candle example
IKEA held an 'air hunting competition' that encouraged employees to identify air space contained in product packaging that could be removed to increase product density and improve transport efficiency (Bestlog, 2010). One product identified from this exercise was the Glimma tea candle that was packaged loosely in bags containing 100 candles.

IKEA subsequently achieved a 30 % reduction in packaging volume for transport by replacing the bags of loose candles with packs of 5 layers (each 4 × 5 candles) stacked between separating boards. Now, each transport pallet can be loaded with 360 packs instead of the original 250, leading to a reduction in international pallet distribution from 60 000 to 42 000 per year. In addition, the new packaging requires less shelf space and reduces handling costs.

Further optimisation
A 40 ft container fully loaded with pallets of 360 packs would weigh 22 tonnes, and would exceed the weight limit for some vehicle combinations in some European countries. Therefore, IKEA had to further modify T&L operations for tea light candles. These candles are now transported alongside lighter products such as pillows and mattresses in balanced loads. This is achieved through IKEA's cluster supply network (Case study 2.16 in Section 2.3.4.5).

Achieved environmental benefits

Avoiding air freight and reducing transport distances can considerably reduce the environmental impact of T&L activities, and can considerably reduce the overall lifecycle environmental impact of products that can be efficiently produced closer to the point of sale. The specific global warming impact of air-freight is 60 times greater than that of ocean shipping (Section 2.3.4.4).

Increasing packaging density can improve the overall efficiency of T&L operations and lead to reduced T&L traffic, thus reducing the entire range of impacts associated with T&L activities. In the IKEA tea light candle example (Case study 2.15), simple repackaging lead to a potential transport vkm reduction of 30 % for that product.

Appropriate environmental indicator

Improvements in packaging density can be reflected in **weight-based**([21]) final T&L performance indicators listed in Table 2.68 and Table 2.69 (Section 2.3.4.1):

- kg CO2 eq. per tkm
- kg CO2 eq. per tonne delivered.

Environmental performance improvements associated with integrated sourcing decisions involving T&L impact reductions should be expressed as net lifecycle environmental performance improvements for particular products (Section 2.2.6.2). These may be expressed as lifecycle GHG emissions, but should include other environmental indicators where relevant (e.g. water footprint in relation to local water resource pressure). Retailer performance can be expressed as:

- number of product groups where sourcing or packaging has been modified specifically to reduce T&L and lifecycle environmental impact.

A proposed benchmark of excellence is:

- systematic implementation of packaging improvements to maximise density and improve T&L efficiency.

Cross-media effects

It is environmentally preferable to source some products from distant warm climates where they are more efficiently produced (e.g. sugar). Sourcing optimisation must be informed by comprehensive and integrated product assessment (Section 2.2.6.2) to ensure that there are no major cross-media or indirect counter effects, such as pressure on water resources. Social considerations, in particular the creation of quality employment in developing countries (Fairtrade certified products), may conflict with reducing product lifecycle impacts through closer sourcing.

In some cases, increased product density may require additional packaging, or a change in packaging material, which should be balanced against reduced transport pressures using LCA or similar assessment.

Operational data

Product lifecycle impacts should include T&L operations, based on the reporting described in Section 2.3.4.2 and methodologies described in Section 2.2.6.2. Case study 2.15 provides an example of retailer implementation of improved packaging density.

Applicability

This technique applies to all large retailers with private label products.

Economics

Lifecycle costing should be applied to determine net costs. Possible increases in sourcing and packaging costs may be offset by possible reductions in T&L, storage and in-store display and handling costs (Bestlog, 2010).

Driving force for implementation

Increased packaging density reduces T&L and handling costs. Integration of T&L considerations into sourcing helps retailers to identify opportunities for efficient product

([21]) Improved packaging density will not be reflected by volume-based indicators (e.g. kg CO_2 eq./m^3 delivered). This is pertinent to IKEA, where T&L performance is expressed as kg CO_2 per m^3 delivered but improvements in transport efficiency are being achieved through volume minimisation (Case study 2.15). Therefore, the best indicator to reflect improved T&L efficiency associated with modified packaging is MJ or kg CO_2 eq. per tkm transported or per tonne delivered.

lifecycle environmental improvement, and may be regarded as an integral part of environmentally responsible product sourcing policies. The main driving forces for this technique are:

- social and environmental responsibility;
- potential efficiency improvements and cost savings;
- reducing risk associated with energy price volatility;
- reducing risk associated with future increases in road and air-freight taxation;
- product green procurement policy;
- improving image and reputation.

Reference retailers
Coop Switzerland, IKEA.

Reference literature

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2.3.4.4 Shift towards more efficient transport modes

Description

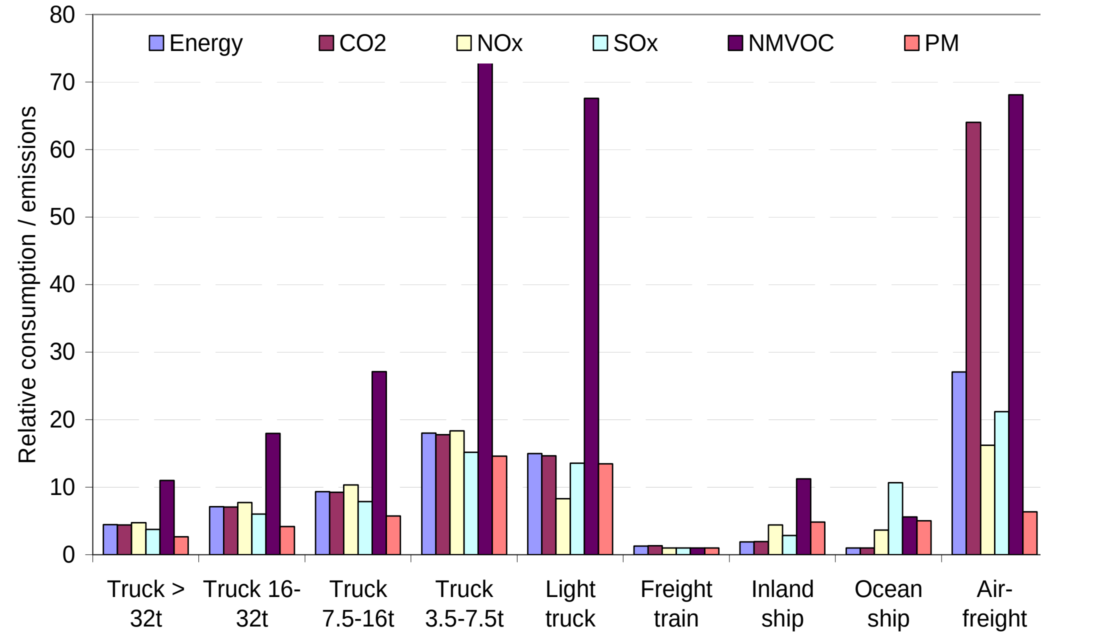
Transport mode is the most important determinant of specific transport efficiency on a per tkm basis. Most environmental impacts arising from goods transport are closely related to energy consumption and energy source, both of which are strongly dependent on mode. Table 2.74 provides an overview of the efficiency, roles and restrictions inherent to different modes of goods transport. Shifting goods transport onto more efficient modes for as much of the transport distance as possible is the primary mechanism by which the environmental impact of T&L operations can be reduced. The possibility to make such shifts may be limited to primary distribution, from supplier DCs to retailer DCs: the first and final kms almost exclusively necessitate road transport. Modal shifts therefore result in intermodal transport, and require optimisation of distribution networks (Section 2.3.4.5) to accommodate multiple modes (e.g. integration into the rail network). Shifting from smaller to larger trucks, including trucks with double-deck trailers, is included in this technique owing to the considerably greater efficiency of large compared with small trucks (see Figure 2.95). Modal shifts can be an important component of product sourcing decisions intended to minimise T&L and product lifecycle environmental impacts (Section 2.3.4.3).

Table 2.74: Various attributes of different modes of goods transport

Mode	g CO_2/tkm (assumptions)	Source	Role and restrictions
Road (truck)	51 (60 % load factor)	NTM (2010)	An essential component of retail goods transport, responsible for the final stage of delivery to stores. High flexibility, relatively low cost, but use of large trucks may be restricted by national and local (e.g. city) regulations.
	109 (25 tonne truck, 57 % load factor and 21 % empty running)	ADEME (2007)	
	62 (overall average)	McK&P	
	72 (>35 tonne truck)	WBCSD/WRI (2004)	
Rail	1.8 (electric trains, France)	ADEME (2007)	The most efficient land-based goods transport, well suited for delivering to distribution centres and potentially fast, but restricted by rail network coverage and route capacity constraints. High costs of infrastructure and loading/unloading to road transport make rail a cost-effective option for longer distances only.
	55 (diesel trains)	ADEME (2007)	
	40 (electric trains average)	WBCSD/WRI (2004)	
	20 (diesel trains)	WBCSD/WRI (2004)	
	26.3 (average, all trains)	Tremove (2010)	
	22 (average for all trains)	McK&P	
Maritime	8.4 (average deep-sea container vessel)	BSR (2010)	Low-cost transport, flexible transport well-suited to carrying large volumes over long distances. Slow, and requires goods unloading and transfer to/from land-based modes at ports.
	5 (large tanker)	DEFRA (2009), NTM (2010)	
	13.5 (small container vessel)	DEFRA (2009)	
	10 (ocean transport)	WBCSD/WRI (2004)	
	35 (short transport)	WBCSD/WRI (2004)	
	14 (average for maritime transport)	EEA (2010)	
Inland waterways	31 (little variation)	McK&P	Low-cost, efficient transport, but restricted by waterway network coverage and capacity.
Air freight	570 (long haul)	WBCSD/WRI (2004)	Fast transport for products with short shelf-life. Restricted to airport hubs. Relatively expensive and highly polluting.
	800 (medium haul)	WBCSD/WRI (2004)	
	1580 (short haul)	WBCSD/WRI (2004)	
	602 (average)	McK&P	

Metrics commonly used to compare the specific efficiency of different transport modes are MJ energy consumed per tkm and kg CO_2 eq. emitted per tkm (e.g. Table 2.74). However, other important environmental pressures vary considerably across modes of goods transport (Figure 2.95). There is a wide variation in specific performance of different modes across a range of environmental pressures when direct and indirect (fuel processing and electricity generation) emissions are considered. The high energy consumption of air freight translates into a carbon footprint over 60 times greater than that of ocean-shipping, when the radiative forcing index of high-altitude emissions is considered. There is also a wide variation in emissions of non-methane volatile organic compounds (NMVOC), with light trucks and aircraft emitting approximately 70 times more than trains per tkm. The environmental performance of trucks is highly dependent on their size, and other factors including:

- loading efficiency
- average age profiles and EURO compliance profiles
- driving patterns (e.g. a higher share of urban driving for smaller trucks).



NB: Air freight CO_2 based on long haul RFI of 2.73.
Source: TREMOVE (2010) and IFEU (2010)

Figure 2.95: Comparative energy consumption and emissions across freight transport modes, expressed as a multiple of the lowest emitting mode on a per tonne-km basis (2010 average from Tremove, 2010 and IFEU, 2010).

The high sulphur content of heavy fuel oil used in marine transport compared with other fuels is somewhat offset by the inherent fuel efficiency of this mode, so that SO_x emissions from marine transport are comparable to road transport, but considerably higher than for rail and inland waterway transport. The overall environmental performance ranking of the transport modes approximates to the energy efficiency ranking, with the exception of ocean ships relative to freight trains, where lower specific energy consumption for ships is more than offset by high specific emissions of SO_x, NO_x and PM. Based on environmental performance, Table 2.75 contains a proposed order of preference for the different transport modes, from most preferred (freight train) to least preferred (air freight).

Table 2.75: Proposed prioritisation ranking of transport modes, based on environmental performance

Ranking	Transport mode	Ranking	Transport mode
1	Freight train	5	Medium truck
2	Ocean ship	6	Small truck
3	Inland waterway	7	Air freight
4	Large truck		

Achieved environmental benefits

Shifting towards more efficient modes can result in a range of environmental benefits, as indicated by Figure 2.95. Table 2.76 provides an overview of some environmental benefits achieved by retailer actions to shift product transport to more efficient modes.

Table 2.76: Some examples of CO_2 savings achieved by modal shifts

Retailer	Measure	Environmental benefits
Carrefour	In 2009, 45 % of imported products destined for hypermarkets in France were transported by rail and river, up from 41.7 % in 2008 (Carrefour, 2010). In Spain, 100 % of products arriving in Barcelona from Asia, and 76 % of all products arriving in Valencia, are shipped by rail to Madrid.	Considerable avoidance of road transport and associated environmental impacts
Casino	In 2009, 39 % of non-EU imports were transported by rail or river (Casino, 2010)	
Coop Switzerland	In 2009, 748 203 tonnes of product were supplied by rail (Coop Switzerland, 2010). The volume of road freight shipments from national distribution centres in Wangen and Pratteln to regional distribution centres fell by 8 %, whilst rail transport increased by 5 %. Rail accounts for over 60 % of long-distance freight transport.	8 % reduction in road transport in one year to 2009
H&M	In 2009, 62 % of the goods shipped from Turkey to Germany (a major sales country) were shipped by rail instead of truck, compared with 22 % in 2008 (H&M, 2010). Between Turkey and Poland, 87 % of goods were shipped by rail in 2009, compared with 10 % in 2008. The percentage of goods shipped from transit to sales countries by rail increased from 44 % in 2008 to 60 % in 2009, saving 705 t CO_2.	9 % reduction in sales-normalised transport CO_2 emissions in 2009 relative to 2008(*)
KF Sweden	In late 2008, Coop began a partnership with Green Cargo, moving goods transport within Sweden from roads to rail (KF, 2010). Coop trains carry truck trailers across Sweden, saving 120 truck consignments per working day between Helsingborg and Umeå. This solution has also increased KF Sweden's ability to strategically control T&L operations.	Savings of 8 000 t CO_2 per year (10 %) expected
Mercadona	Transports 19 000 tonnes goods daily from east coast Spain to southern Spain (Bestlog, 2010). Worked with T&L provider to agree a contract with Spanish rail operator (Renfe) to deliver 8 trains per week from Seville to Tarragona and Seville to Valencia in a round trip transporting non-fresh and non-food goods. Every year, 220 000 tonnes are transported on 416 trains. Mercadona's T&L provider collects goods from train stations for final delivery by truck. In addition to reducing the environmental impact (7.0 % reduction in transport energy), delivery punctuality has improved and goods damage has decreased. Cost savings of EUR 13.1 million have been achieved.	Avoids up to 9 152 truck deliveries and 12 000 tonnes CO_2 per year

Retailer	Measure	Environmental benefits
Migros	Road transport decreased from 32 million km in 2005 to 30 million km in 2009 whilst rail travel increased from 9.4 million km in 2007 to 10.3 million km (186.5 million tkm) in 2009 (Migros, 2010). Migros transports over one million tonnes of freight by rail annually engaging over 400 SBB Cargo wagons full time for Migros.	6 % reduction in road transport over four years.
Tesco	The Tesco train between Daventry and Grangemouth saves 5.12 million km per year and 2424 t CO_2 (Tesco, 2010). Using the Manchester shipping canal to transport wine from Liverpool to Irlam bottling plant saves 263000 road miles and 330 t CO_2 per year. Introducing double-deck trailers for high-trade store deliveries avoided 52000 deliveries in 2009.	Alternative transport modes have saved 12000 t CO_2 eq. per year relative to 2006.
(*) H&M report a 4 % increase in transport CO_2 and a 14 % increase in turnover for 2009 relative to 2008 (H&M, 2010).		

Appropriate environmental indicator

Modes should be compared by assessing total (direct plus indirect) emissions per tkm transported, especially GHG emissions (CO_2 eq. in Table 2.74), but also other emissions (Figure 2.95).

Retailer performance with respect to implementing or using more efficient transport modes is most accurately conveyed through statistics on the percentage of goods transported via such modes. Two proposed indicators are:

- percentage of total product transport (tkm), from first-tier suppliers to stores, accounted for by specified more-efficient modes
- percentage of international product transport (tkm) accounted for by specified more-efficient modes.

Where these indicators cannot be calculated, alternatives are:

- percentage of overland transport between first-tier suppliers and retail distribution centres, by sales value, accounted for by specified more-efficient modes
- percentage of international product transport, by sales value, accounted for by specified more-efficient modes.

A select few retailers (apparently the front-runners) report the percentage of long-distance goods transport made on more efficient (rail and water-based) modes (Table 2.77).

Table 2.77: Performance of front-runner retailers for transporting goods overland via efficient modes (rail and inland waterways)

Retailer	Description	2009 rail/water share
Carrefour	Imported products destined for hypermarkets	45 % (Carrefour, 2010)
Coop Switzerland	Long-distance transport (rail)	60 % (Coop Switzerland, 2010)
H&M	Goods shipped via transit countries (rail)	60 % (H&M, 2010)

Proposed benchmarks of excellence are:

- over 50 % of overland transport between first-tier suppliers and retail distribution centres, according to sales value, is by water/rail (where infrastructure allows)
- over 99 % of overseas transport, according to sales value, is by ship.

Cross-media effects
Intermodal transport may necessitate longer routing distances, but this effect is unlikely to outweigh the substantial environmental benefits possible from shifting the mode of primary transport.

Shifting goods transport to LHVs is only environmentally beneficial if it replaces transport in smaller trucks. There are possible indirect negative effects of shifting towards LHV transport, in particular the indirect displacement of rail transport (see Economics).

Operational data
It is important that the net impact of modal shifts is assessed on a door-to-door basis, accounting for any increases in routing distance, goods transfers, and secondary modal shifts. For example, shifting the primary transport mode from road to rail for a particular product group may necessitate a longer route, transfer of goods from train to truck, and road deliveries from the train depot to the DC or stores. Handling and transfer of goods makes a minor contribution to transport GHG emissions (Blanco and Craig, 2009), calculated at 5 % in a worst case scenario of ship to train transfer using trucks (CN, 2010). The CO_2 reduction associated with intermodal shifts is dominated by:

- energy intensity of the replaced and replacement mode
- carbon-intensity of the power source for the replaced and replacement mode
- load factor differences between the replaced and replacement mode.

There is currently debate over the potential for Longer Heavier Vehicles (LHVs) to reduce the net environmental impact of goods transport in Europe. In a recent European Commission study (EC, 2009), it was estimated that 60 tonne LHVs could be up to 12.5 % more efficient than 44 tonne vehicles per tkm transported. However, potential reductions in road-transport costs associated with LHVs could result in a shift of goods transport away from rail towards road (see Figure 2.96). Based on the prioritisation of transport modes outlined in Table 2.75, shifting goods transport to LHVs is only beneficial if it is from smaller trucks, but in any case is likely to be limited in the short term owing to LHV bans in a number of European countries.

Applicability
All large retailers can take some action to shift from more to less polluting transport modes, at least based on vehicle size. There are opportunities for most large retailers to shift some of their product transport from road to rail or water.

Achieving large-scale shifts in retail goods transport from road to rail and inland waterways will require improvements in national rail infrastructures and greater cross-border coordination by operating companies. For example, the Swiss Federal Railways Company (SBB) is near capacity for freight, so Coop Switzerland achieved a 5 % increase in rail transport in 2009 through improved capacity utilisation (Coop Switzerland, 2010).

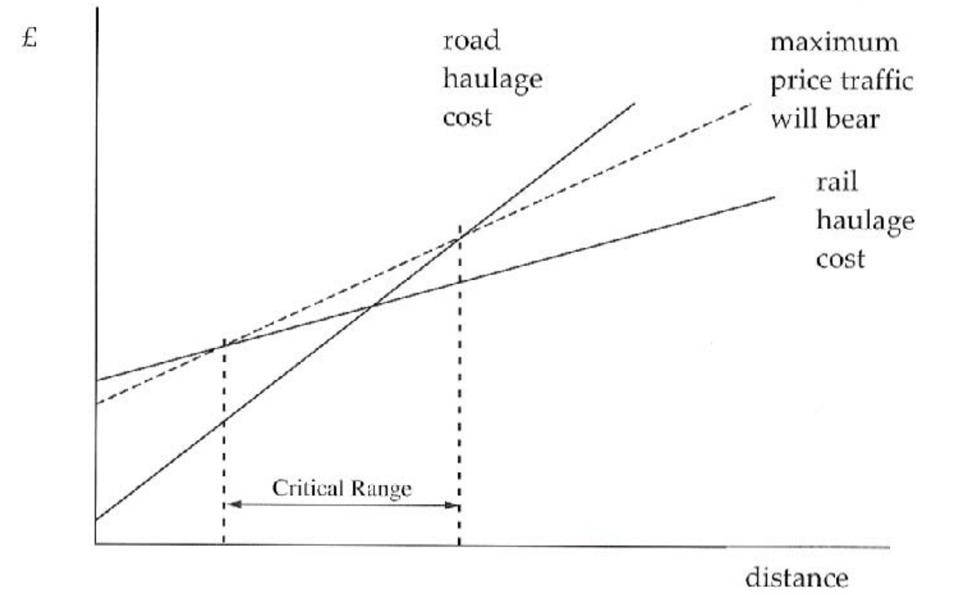
National policy (e.g. road pricing) can have a significant influence on retailers' decisions regarding transport mode. In Switzerland, HGVs have been subject to a statutory charge since 2002.

Economics
Investment in the distribution network necessary to achieve intermodal shifts may be recouped by savings in transport costs. Rail is more likely to offer cost savings compared with road for longer distance transport (Figure 2.96).

Driving force for implementation

The main driving forces for retailers to shift towards environmentally preferable transport modes are:

- social and environmental responsibility;
- potential efficiency improvements and cost savings;
- reducing risk associated with energy price volatility;
- reducing risk associated with future increases in road and air-freight taxation;
- improving image and reputation.



Source: Harris & McIntosh (2003)

Figure 2.96: Comparison of the costs of road and rail transport over increasing distance

Reference retailers

Carrefour, Coop Switzerland, H&M, Migros.

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2.3.4.5 Optimise the distribution network

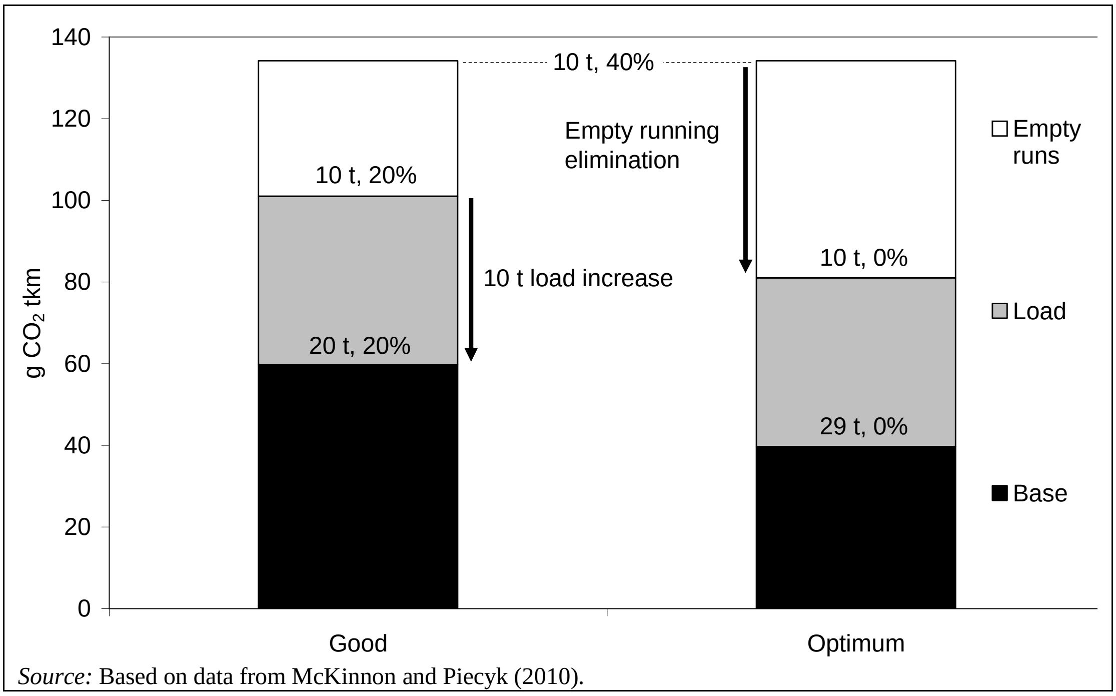
Description

Shifting towards more efficient transport modes is the most effective way to achieve T&L efficiency improvements on a per tkm basis (Section 2.3.4.4), but often requires modification of the distribution network to accommodate modal transfers. Distribution network optimisation can further improve the efficiency of T&L operations by enabling higher rates of vehicle loading and backloading to reduce empty running.

For a given transport mode, load factor and empty running are key determinants of specific energy consumption and GHG emissions (Figure 2.97). If a 44 tonne truck with a 29 tonne net load capacity operates with an average load of 10 tonnes over 60 % of the distance it travels (i.e. 40 % empty running), the specific GHG emissions for transported goods would be 134 g CO_2 tkm^{-1} (Figure 2.97). If that truck operates with an average load of 20 t over 80 % of the distance it travels, specific emissions would be 59.8 g CO_2 tkm^{-1} (55 % lower than the above case). If that truck could be operated continuously at full capacity, specific emissions would amount to just 40 g CO_2 tkm^{-1} (Figure 2.97). The relatively low density of many retail goods restricts the achievable weight-based load efficiency (Lumsden, 2004; Section 2.3.4.3), but there remains considerable scope for improvement – especially when combined with packaging optimisation and load balancing made possible through cluster networks (Case study 2.15 in Section 2.3.4.3 and Case study 2.16). In summary, there are four primary objectives for distribution network optimisation:

- enable use of efficient modes for long-distance routes
- increase load factors
- reduce empty running (increase back-loading)
- reduce vkms.

The latter three objectives are also achieved through more efficient route planning (Section 2.3.4.6).



Source: Based on data from McKinnon and Piecyk (2010).

Figure 2.97: Effect of increasing load and reducing empty running on specific CO_2 emissions for a 44 tonne gross (29 tonne net load) truck

There are a number of approaches to distribution network optimisation that may be implemented separately or in combination. Three of the major approaches are summarised in Table 2.78. The third approach that overlaps with route planning (Section 2.3.4.6), and the most appropriate approach is highly dependent on product-specific factors including the location and how scattered the suppliers are, and product transport requirements (especially cooling requirements and time limits).

Table 2.78: Three major approaches to efficient distribution network design

Approach	Description	Examples
Centralised hub network	Modify distribution network so that it is based on centralised hubs located and designed to accommodate intermodal transfer and load optimisation.	Tesco opened three new DCs in 2007 at Livingston, Lichfield and Goole, to replace six smaller regional DCs. The larger DCs hold a greater range of products and reduce the amount of trunking required between DCs. These changes to the distribution network saved 2.186 million miles and 2 951 tonnes of CO_2 per year.
Consolidated platforms	Arrange consolidation points (strategically located warehouse or nominated supplier) where a group of neighbouring suppliers can deliver goods for forwarding to the retailer in consolidated (optimised) loads.	Carrefour is implementing a consolidated platform strategy where suppliers deliver to a single consolidation warehouse, from which Carrefour arranges goods transport to DCs and stores in optimally-filled trucks (Carrefour, 2010). Five new consolidation warehouses were established in France in 2009, in addition to the two pre-existing ones: Saint Quentin, Agen, Thuit-Hébert, Lieusaint, Soissons. This is similar to IKEA's cluster supply strategy detailed in Case study 2.16.
Direct routing	For some products, it may be possible to coordinate production with demand so that intermediate storage and distribution can be avoided.	In 2009, H&M reduced the number of shipments via their transit warehouse in Hamburg, and instead shipped products directly to sales countries. Between 2008 and 2009, H&M decreased transit volumes shipped by ocean and air by 40 %. Products in Coop Switzerland's 'fresh from the region' range are supplied directly to stores by local producers.

Figure 2.98 is a simple schematic of the centralised hub and consolidated platform concepts, relative to unimproved direct transport between suppliers and retail stores or DCs. Large distribution networks are usually organised around hubs that enable aggregation and disaggregation of products for long-distance and short-distance transport, respectively. The centralised hub concept defines the use of large hubs strategically placed to enable integration into efficient modal networks such as shipping and rail. Although the use of large centralised hubs located at port and rail depots may necessitate additional short-distance feeder transport by road (Figure 2.98), it enables the use of efficient modes for long-distance transport, and load optimisation through product mixing according to density (see Case study 2.15).

Consolidated platform networks may be developed either separately or in combination with centralised hub systems, and are particularly effective where large numbers of suppliers are scattered over a wide area. Consolidated networks are based around a strategically located warehouse, or a designated supplier, where products from a surrounding 'cluster' of suppliers can be consolidated into optimised loads for long-distance transport to retail DCs (Figure 2.98). Consolidated platforms may be referred to as 'supplier clusters' where they are based on a designated supplier (Case study 2.16). Consolidation points may be selected to enable access to the rail network for long-distance transport. Coordination of supplier clusters is dependent on vertical coordination between retailers and suppliers.

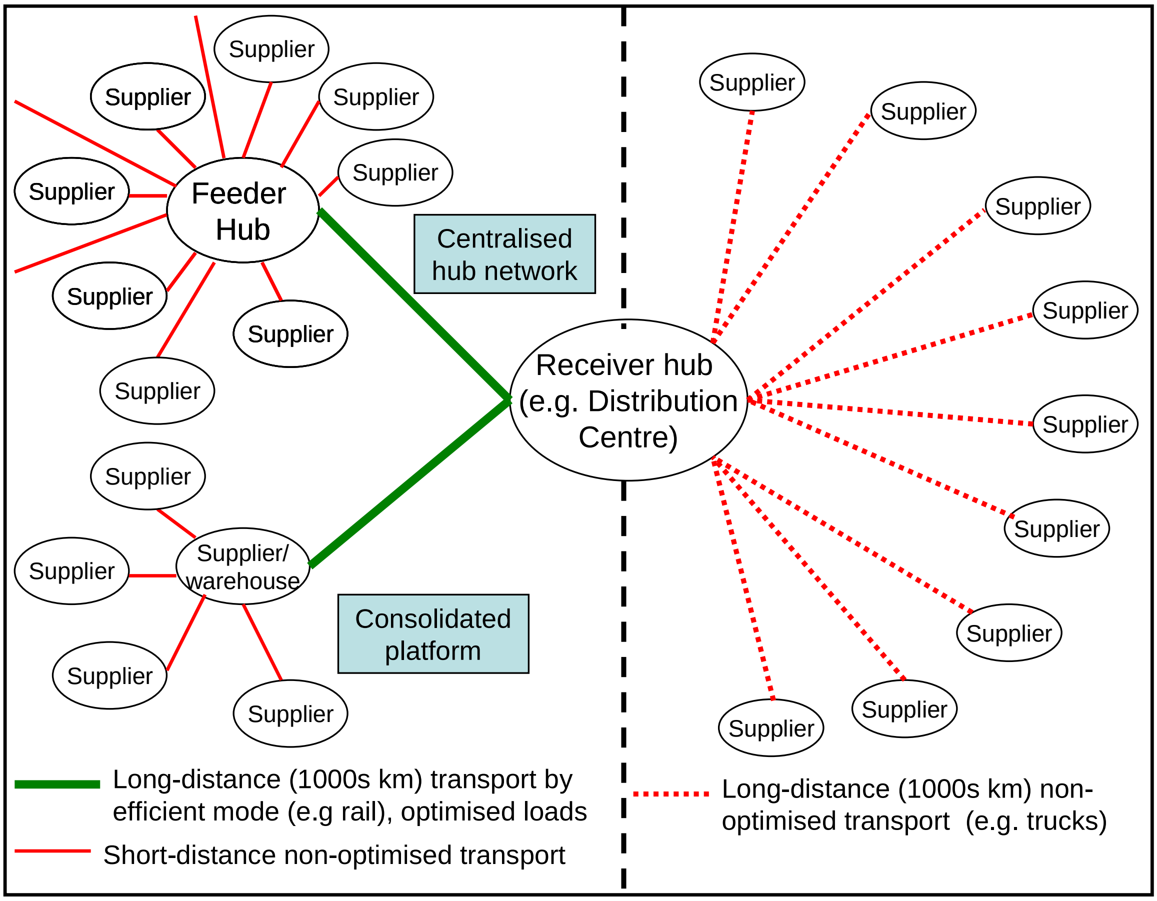


Figure 2.98: Centralised hub and consolidated platform networks (left) require additional short-distance (10s to 100 km) transport, but enable optimised loading and use of efficient modes for long-distance (100s to 1000s km) transport, compared with uncoordinated systems (right)

For some products, efficient logistical planning may enable them to be routed directly to sales outlets without intermediate distribution (often the case for fresh food products) (Table 2.78). In order to accommodate the main measures associated with efficient route planning described in Section 2.3.4.6, the approaches in Table 2.78 should fully integrate the locations of all:

- major suppliers
- waste handling facilities
- stores.

Migros provides a good example of a centralised hub distribution network strategically integrated into the (Swiss) rail network. Migros national DCs not only receive deliveries via rail, but forward them on to the regional Cooperatives via rail (Migros, 2010). In 2009, the Neuendorf DC forwarded all non-food and near-food products to regional Cooperatives in Neuchâtel/Fribourg, Geneva, Vaud and Ticino exclusively via rail. In autumn 2009, the Suhr DC also switched to rail transport for all of its food deliveries to the Geneva Cooperative. Similarly, two thirds of Coop Switzerland's freight transport from their two national distribution centres (in Wangen and Pratteln) is made by rail (Coop Switzerland, 2010).

Case study 2.16: IKEA supplier clusters as an example of distribution network optimisation

Cluster supplier concept
IKEA is reconfiguring its supply chain into coordinated clusters that pool transport to maximise loading efficiency (Bestlog, 2010). According to IKEA's cluster supplier concept, between seven and 24 product suppliers deliver directly to a nearby cluster supplier, who then delivers consolidated orders to IKEA stores in optimised loads. Coordination between retailer and suppliers includes optimisation of packaging in order to maximise loading efficiency (see Case study 2.15).

Implementation in Poland
Poland is IKEA's second largest supplier country, with 80 producers supplying 17 % of IKEA's home furnishing products. In order to implement the cluster supplier concept, IKEA performed the following tasks:

- analysed the geographical distribution of Polish suppliers, and identified a cluster of 28 suppliers within a 50–100 km radius;
- used Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis to identify two project leaders with logistics competences: COM.40 sofa producers and Correct mattress producers;
- initiated cooperation between COM.40, Correct and 26 smaller suppliers within the identified cluster.

The smaller suppliers deliver their products to the two project leader companies' warehouses where they are stocked. IKEA places orders with COM.40 and Correct, who consolidate volumes of different products into optimised delivery loads – based around a critical mass of sofas and mattresses. Twenty-five rail wagons and 60 trucks are prepared every day. The supplier cluster configuration also creates the opportunity to channel products via efficient transport modes: 18 % of shipments from the Polish supplier cluster to IKEA DCs and stores occurred via rail in 2007.

Distribution of costs and benefits
COM.40 and Correct control delivery reliability on behalf of IKEA, who ultimately bear transport costs. However, risks and efficiency gains are shared between COM.40, Correct and IKEA, so that the Polish suppliers are investing in infrastructure to deal with anticipated volume growth. In addition to reduced transport costs, the cluster supplier concept leads to sales benefits (for both IKEA and suppliers) by reducing lead times and improving product availability. Load optimisation, and substitution of road with rail transport, significantly reduces the environmental impact of T&L.

Achieved environmental benefit

Distribution network optimisation is integral to other techniques detailed in this chapter, and the environmental benefits are reflected in overall T&L efficiency improvements achieved by retailers (Table 2.67 in Section 2.3.4.2). In particular, this technique makes a critical contribution towards the environmental benefits associated with modal shifts (Section 2.3.4.4) and route planning (Section 2.3.4.6).

Tesco claim that reduced trunking between DCs associated with the replacement of six regional DCs with three new ones saved 2.2 million miles of road transport and 2951 t CO_2 per year (Table 2.78) (UK DfT, 2007). Meanwhile, preliminary studies by Carrefour indicate that supplier coordination in platform consolidation has achieved CO_2 reductions of 25 % per pallet delivered (Carrefour, 2010).

Appropriate environmental indicator

Intermodal shifts, increased loading efficiency, and reduced empty running associated with distribution network optimisation will be reflected in transport efficiency indicators (Table 2.68 in Section 2.3.4.2):

- percentage transport by different modes
- average percentage load efficiency (volume or mass capacity)
- average percentage empty running (truck km)
- g CO_2 eq./tkm.

The above indicators are important to identify the most appropriate improvement options. The full effect of distribution network optimisation, including a reduction in the overall transport distance, will be reflected in final performance indicators (Table 2.69 in Section 2.3.4.2), in particular:

- kg CO_2 eq. per m^3 delivered product.

The most appropriate indicators of retailer management performance for this technique are:

- the number of consolidation platforms in use
- the number of strategic central hubs in use
- the number of direct transport routes in use
- percentage reduction in T&L GHG emissions through implementation of specified distribution network improvement options
- outsourcing of T&L operations to a third party provider with an optimised distribution network.

Retailers often refer to absolute reductions in GHG emissions attributable to specific improvements (e.g. Table 2.78).

Proposed benchmarks of excellence are the same as for transport mode (Section 2.3.4.4), plus:

- systematic optimisation of distribution networks through implementation of strategic hub locations, consolidated platforms, and direct routing

Cross-media effects

No significant cross media effects are likely to be associated with this technique. Energy use and emissions associated with increased feeder transport by trucks to centralised hubs and consolidation platforms are likely to be small compared with energy and emissions reductions arising from use of optimally-loaded, efficient long-distance transport modes.

Operational data

Intermodal transfers may be restricted, or at least complicated, by varying load unit dimensions (Lumsden, 2004). Standardisation of load unit dimensions would accommodate full inter-modality, and enable the use of modular combinations such as truck trailers. Given that retail transport is often volume-limited, further improvements in weight-based load efficiency may require trailer designs and combinations with greater volume capacity at a given weight capacity. IKEA designs all products to fit in flat packs that in turn fit exactly onto standard pallets (IKEA, 2010).

Applicability

Any large retailer with a distribution network (i.e. distribution centres) can implement this technique. Any third party T&L service provider can implement this technique.

Economics

There are few economic data for implementation of this technique, and the costs of distribution network optimisation will vary considerably across retailers and approaches. For strategic central hubs, capital investment in new distribution centres and intermodal connections will be high. However, retailer examples of reductions in transport distances and GHG emissions attributable to distribution network improvements (Table 2.78) suggest that efficiency improvements are likely to payback any investment costs within an acceptable time.

Coordination of suppliers into consolidation platforms requires little investment, but can realise significant efficient savings, and therefore result in short payback periods. Efficiency dividends may be shared between cooperating parties (Case study 2.16).

Where it does not require a shift towards a less efficient transport mode, or towards lower loading efficiency, implementation of direct transport routes can reduce transport distances and reduce operating costs. Infrastructure requirements are also lower, so that this option may result in immediate cost savings.

Driving force for implementation

The main driving forces for retailers to optimise their distribution networks are the same as for use of environmentally preferable transport modes:

- social and environmental responsibility
- potential efficiency improvements and cost savings
- reducing risk associated with energy price volatility
- reducing risk associated with future increases in road and air-freight taxation
- improving image and reputation.

Reference retailers

Carrefour, H&M, IKEA, Migros.

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2.3.4.6 Optimise route planning, use of telematics and driver training

Description

Road transport is an integral part of retail T&L operations, necessary for transport from suppliers to outgoing DCs and final distribution from incoming DCs to stores. In the context of a particular distribution network (Section 2.3.4.5) with predetermined primary transport modes (Section 2.3.4.3), the efficiency of T&L operations can be further improved by route planning (including use of telematics), more efficient driving techniques, and finally vehicle modification as described in Section 2.3.4.7. The scope for route planning optimisation is somewhat dependent on the distribution network, and overlaps with three of the four objectives for distribution network optimisation described in Section 2.3.4.5:

- reducing overall transport tkm
- increasing load factors
- reducing empty running (increase back-loading).

In addition, driver training and telematics can reduce fuel consumption per km travelled.

The complexity of coordinating T&L operations to ensure punctual store deliveries necessitates the use of specialised vehicle routing software, based on optimisation models, to route and schedule transport activities for large fleets. This software takes into account the multitude of logistical factors that must be considered, including: driver hours-of-service rules, pick up and delivery schedules, vehicle size constraints, vehicle-product compatibility, equipment availability, vehicle-loading dock compatibility, route restrictions and empty mileage. Vehicle routing schedules can reduce the total distance travelled by trucks on multi-drop delivery rounds by between 5 % and 10 % (UK DfT, 2005). Retailers can maximise the benefit of such software by extending the parameters considered beyond transport from DCs to stores, to include:

- transport from suppliers to DCs (integration of upstream transport)
- waste transport (integration of downstream transport)
- traffic avoidance (out-of-hours deliveries).

Table 2.79 provides an overview of the main methods to improve T&L efficiency included in this technique. In addition to increasing load-efficiency and reducing empty running, retailers can extend the daily delivery window, and use telematics and driver training to improve truck fuel efficiency. Case study 2.17 describes a best practice example of driver training to reduce truck fuel consumption, implemented by Migros and extended to third party delivery drivers.

Table 2.79: Some of the main methods applied by retailers route planning

Method	Description	Examples	Environmental benefit
Supplier back-loading	After store delivery, collect goods from nearby suppliers on return journey to DC	In 2009, Sainsbury's fully implemented the Integrated Transport Management System for primary and secondary transport operations (Sainsbury's 2010). For primary operations, empty trucks from Sainsbury's fleet are used to transport products from suppliers to DCs when returning from making store deliveries. In secondary operations, suppliers transport products from DC to store on return journey from DCs.	CO_2 reduced by 6.4 % in one year, and 16 % over 5 yrs, to 0.122 kg CO_2 eq. per case. In 2009, a total of 1 174 046 vehicle kms were avoided for Sainsbury's and supplier fleets.
		Tesco operate a load-sharing arrangement with suppliers similar to Sainsbury's (above). Cooperation with suppliers resulted in 55 432 supplier back-loads to minimise empty running in 2007 (Tesco, 2009). In 2008, 2.6 million road miles were saved. Tesco's delivery fleet did not grow over the three years to 2009, despite significant retail growth.	Saved 3 590 t CO_2 per year in 2008
Reverse packaging	At store, fill truck returning to DC with reusable packaging (e.g. pallets) and (recycling) waste.	Carrefour reduced return journeys by 10 % (Carrefour, 2010), Coop Switzerland, Migros	10 % reduction in empty return journeys
Extended delivery window	Deliveries planned to avoid times of traffic congestion.	Carrefour has installed special delivery areas to accept deliveries outside store opening hours at 39 hypermarkets and 1200 supermarkets/convenience stores (Carrefour, 2010). To facilitate deliveries outside peak traffic, Carrefour operates trucks on consecutive rounds (necessitating a driver shift swap), has installed low-noise handling equipment, and will use 30 'silent' trucks for Paris city-centre deliveries in 2010.	In total, Carrefour reduced downstream transport by 3 %, and associated CO_2 emissions by 7 600 t, in 2009 compared with 2008.
Telematics	Optimise speed and route to avoid traffic based on real-time traffic information from GPS	The retailer Casino saved 8.5 million km in one year by optimising routes with tracking software (Casino, 2008).	Avoided 8 000 t CO_2 emissions
Driver training	Driver training in efficient and safe driving techniques. May be accompanied by incentives.	Migros operates a comprehensive driver training scheme that is being extended to third party drivers (Migros, 2010), and offers incentives for drivers to save fuel (see Case study 2.17).	Migros' Basel Cooperative reduced fuel use by 6 % across their fleet between 2008 and 2009.

Case study 2.17: Migros driver training and incentive scheme to reduce fuel consumption

Background Since its instigation in 2008, Migros' national transport logistics improvement project has led to higher loads per haul and more efficient transport routes (Migros, 2010). In 2009 there was a slight decline in the number of kilometres travelled by lorry, whilst constant renewal of the vehicle fleet in favour of more environmentally friendly lorries (Euro 4 and Euro 5 compliant) has reduced nitrogen oxide emissions by 40 % since 2005. Migros is also increasing the number of gas or hybrid vehicles, and the use of alternative fuels such as biogas from organic waste and biodiesel from recycled vegetable oils. **Driver training** Migros cooperatives regularly hold driver training courses on energy-saving and economic driving. In 2009, 82 % of all drivers attended an ecodrive course. In addition, Migros extended ecodrive courses to 150 **third party drivers** in 2009. Migros Cooperative Basel had one of the highest fuel consumption rates amongst the Migros cooperatives, and in 2008 introduced an incentive scheme to reward drivers for efficient driving. Fuel consumption data are recorded and analysed by the regional transport manager for each driver and vehicle. Migros Coop Basel saved 38 000 l of diesel between 2008 and 2009, with average truck fuel consumption declining from 2.94 km/l (34 l/100 km) to 3.13 km/l (32 l/100km).

Achieved environmental benefit

By reducing the number of vehicle km travelled, and ensuring a higher proportion of these vehicle kms are travelled in free-flowing traffic conditions, optimised routing can significantly reduce fuel consumption and associated emissions of CO_2, SO_x, NO_x, VOC and PM.

Table 2.79 lists reductions in transport distance, fuel consumption and CO_2 emissions achieved by specific retailer actions relevant to this technique. More efficient driving techniques can reduce fuel consumption by up to 10 % (Ricardo, 2010), though a reduction of 6 % was realised in practice by Migros (Table 2.79), and a reduction of 7 % in a trial performed by Tesco (Tesco, 2010).

Telematic systems can reduce fuel consumption and associated emissions by approximately 5 % for long-distance HGV transport and up to 15 % for urban LCV transport (Climate Change Corporation, 2008). Ricardo (2010) estimates that one telematic application with predictive cruise control can reduce fuel consumption by 2 % to 5 %.

Albert Heijn reported a reduction in fuel consumption of 75 % for deliveries to an urban store following the replacement of small trucks making day-time deliveries with large, quiet trucks making night-time deliveries outside peak traffic hours (Case study 2.18 in Section 2.3.4.7).

Appropriate environmental indicator

Increased loading efficiency and reduced empty running associated with routing improvements, and more efficient driving associated with telematics and driver training, will be reflected in transport efficiency indicators (Table 2.68 in Section 2.3.4.2):

- fleet average percentage load efficiency (volume or mass capacity)
- fleet average percentage empty running (truck km)
- fleet average g CO_2 eq. per tkm.

The above indicators are important to identify the most appropriate improvement options. The full effect of improved logistics, telematics and driver training will be reflected in final performance indicators (Table 2.69 in Section 2.3.4.2), in particular:

- kg CO_2 eq. per m3 delivered product.

Retailers often refer to absolute reductions in GHG emissions attributable to specific improvements (e.g. Table 2.79). The most appropriate indicators of retailer management performance for this technique are:

- percentage of drivers continuously trained in efficient driving techniques
- percentage reduction in T&L GHG emissions through implementation of specified options (i.e. back-hauling waste or supplier deliveries, telematics, driver training and incentive schemes, out-of-hour deliveries)
- outsourcing of T&L operations to a third party provider implementing this technique.

Two proposed benchmarks of excellence for this technique are:

- 100 % of drivers being continuously trained in efficient driving or implementation of an efficient driving incentive scheme for drivers
- systematic optimisation of routing through back-hauling waste and supplier deliveries on store-delivery return journeys, use of telematics, and extended delivery windows.

Cross-media effects
The only significant cross-media effect likely to arise from measures described in this technique is elevated emissions of NO_x from engines under lighter loading as a consequence of more efficient driving techniques (EMCT, 2006).

Operational Data
Retailers need to cooperate with suppliers (or with suppliers and T&L providers) in order to integrate upstream transport between suppliers and DCs with transport between DCs and stores. Retailers may also need to facilitate cooperation across suppliers to coordinate loads and back-hauling (i.e. to implement a flexible version of the cluster supplier concept referred to in Section 2.3.4.5).

Fuel savings realised by driver training diminish over time, and it is necessary to continuously train drivers, for example through annual refresher courses. Retailers may also implement a driver benchmarking system to maintain interest and encourage competition in efficient driving. This may be based on basic fuel consumption per truck (Migros: Case study 2.17) or real-time monitoring systems that monitor truck and driver efficiency (e.g. Tesco's 'Fleetboard' system). Drivers for KF Sweden receive part of the fuel savings they achieve through more efficient driving.

Night time delivery may necessitate the use of silent trucks and unloading facilities, depending on the location of the store (Case study 2.18 in Section 2.3.4.7). Casino makes store deliveries between 20:00 and 22:00 in the Greater Paris region using vehicles certified to the Dutch PIEK standard.

Some opportunities to achieve significant efficiency savings through route planning and driving techniques are restricted by legislation. For example, platoon driving, whereby HGVs follow one another closely on motorways to form a train, can be achieved using safety sensors and active safety features. It has the potential to reduce fuel use and CO_2 emissions by 20 % on motorway journeys, but contravenes current road regulations.

Applicability
Applicable to all large retailers.

Economics
Driver training costs between EUR 170 and EUR 340 per driver (Ricardo, 2010). Based on an average fuel cost of EUR 50 000 per year for an average European long-distance truck (Volvo, 2010), a 5 % fuel saving would translate into EUR 2 500 saved in the first year alone.

Software and manpower costs associated with route optimisation are highly variable. For large retailers, these costs are likely to be small compared with routing distance reductions and fuel cost savings. Similarly, telematic system installation costs are likely to be small compared with efficiency improvements and fuel cost savings (see driver training example, above).

Efficient route planning (particularly in coordination with suppliers) can reduce the size of the fleet required, and thus reduce capital investment (see Case study 2.18 in Section 2.3.4.7). Efficiency dividends may be shared between cooperating parties.

Driving force for implementation

The main driving forces for retailers to optimise their distribution networks are the same as for use of environmentally preferable transport modes and distribution network optimisation:

- social and environmental responsibility
- potential efficiency improvements and cost savings
- reducing risk associated with energy price volatility
- reducing risk associated with future increases in road and air freight taxation
- improving image and reputation.

Reference retailers

Carrefour, Migros, Sainsbury's, Tesco.

Reference literature

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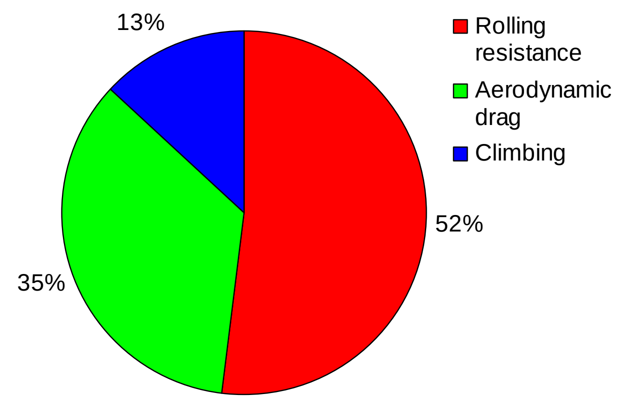
2.3.4.7 Minimise the environmental impact of road vehicles through purchasing decisions and retrofit modifications

Description

Road transport is an integral part of retail T&L operations, necessary for transport from suppliers to outgoing DCs and final distribution from incoming DCs to stores. Whether or not retailers have taken measures to reduce the distance transported by goods (Section 2.3.4.3 and Section 2.3.4.5), to shift to more efficient modes (Section 2.3.4.4), and to optimise routing and driving efficiency (Section 2.2.6.6) a number of measures can be taken to improve the efficiency of trucks. Various features can be specified when purchasing vehicles in order to maximise their operational efficiency, and thus reduce fuel costs and environmental impact. Many features can be retrofitted to existing road vehicles to improve their efficiency. Using larger vehicles, such as trucks with double-deck trailers, is considered as a modal shift, and is included Section 2.3.4.4.

The internal combustion engine is inherently inefficient, and most fuel energy is lost through friction and heat losses. For large 44 tonne HGVs, of the 30 % to 40 % of fuel energy that is converted into motion, half is used to overcome rolling resistance and a third is used to overcome air resistance (Figure 2.99). In the medium term, there is considerable potential for efficiency improvement through use of alternative drive trains, such as electric motors, in particular for smaller delivery vehicles. In the short term, natural gas and biogas may be used instead of diesel in large trucks, with CO_2 savings of 10–15 % and over 60 %, respectively (Table 2.80). Biodiesel made from waste oil can result in similar CO_2 savings to biogas.

There remains considerable debate over the potential for crop-based biofuels (e.g. ethanol from corn and sugarcane, biodiesel from rape seed oil and palm oil) to reduce environmental impact owing to their agricultural land requirements, and impacts associated with high chemical and energy inputs. Most large retailers have suspended their targets for minimum biofuel percentages in fuel blends owing to concern over the sustainability of first-generation crop-based biofuels (e.g. M&S, 2010). If adequate procedures are developed to certify the sustainability of biofuels from different sources, or second generation biofuels are commercialised based on low-input woods and grasses that do not require productive agricultural land, biofuels could make an important contribution to reducing the environmental impact of transport. In the meantime, crop-based biofuels are excluded from this best practice technique.



Source: Ricardo (2010)

Figure 2.99: Energy demand from a 44 t HGV over a typical driving cycle in the UK

Table 2.80 provides an overview of the main measures that can be taken to improve truck (primarily HGV) fuel efficiency. Based on Figure 2.99, reducing aerodynamic drag and rolling resistance are the two primary objectives of many vehicle design features and retrofit modifications. For a 44 t HGV, a 22 % reduction in aerodynamic drag translates into an 8.7 % reduction in fuel consumption, whilst a 10 % reduction in rolling resistance translates into a 5.5 % reduction in fuel consumption (Ricardo, 2010). Improved aerodynamic trailer design and retrofitted aerodynamic modifications can significantly reduce fuel consumption and costs – by up to 10 % for vehicles frequently driven at higher speeds. By 2009, M&S had increased the number of aerodynamic 'teardrop' trailers in their fleet to over 300 (M&S, 2010). Reducing rolling resistance through choice of tyres and correct inflation can achieve similar benefits. Replacing diesel-driven auxiliary power units for trailers with electric units can also result in significant efficiency savings.

New vehicles will be compliant with high EURO emission standards, but when purchasing used vehicles it is important to select the most efficient vehicles that comply with the highest possible EURO standard (preferably EURO 4 or EURO 5). The percentages of EURO 4- and EURO 5-compliant trucks in the transport fleets of some leading retailers are shown in Figure 2.100. The most effective way to improve EURO emission standard compliance is to replace the fleet's oldest trucks (e.g. Coop Switzerland, 2010). Use of selective catalytic reduction in combination with urea additives that react with exhaust gases considerably reduces the NO_x emissions of modern HGVs, to ensure compliance with EURO 4 and 5 standards (Table 2.81).

A number of retailers, including Coop Switzerland and Albert Heijn, are trialling trucks powered by biogas (Albert Heijn, 2010; Coop Switzerland, 2010). Meanwhile, retailers introducing electric vehicles for urban deliveries include M&S and Sainsbury's (M&S, 2010; Sainsbury's, 2010).

Table 2.80: Portfolio of measures to improve truck efficiency and/or reduce environmental impact

Measures	Description	Applica-bility	Cost	Fuel/CO_2 saving
Aerodynamic trailer	'Tear-drop' shaped trailer	Vehicle (trailer) purchasing		10 % (depending on speed)
Aerodynamic fairings	Retrofit add-ons to reduce drag. Greatest effect from cab fairing and collar	Retrofit	EUR 285 – 2000	0.1–6.5 %
Spray-reducing mud flaps	Reduce spray and air resistance	Retrofit	EUR 2 per unit	3.5 %
Low-rolling resistance tires	Similar cost to ordinary tyres, but shorter lifespan. For long-distance routes	Retrofit		Up to 5 %
Single wide-base tyres	Replace double tyres with single wide-base tyre. Also reduces weight, so increases possible payload. Not allowed on trucks over 40 tonnes	Retrofit	NA	2–10 % (depending on number of axles fitted)
Automatic tyre inflation	Automatically inflates tyres according to conditions. Benefit depends on: (i) range of conditions; (ii) existing (manual) monitoring efficiency	Retrofit	EUR 11 500	7–8 % (based on % of trucks with under-inflated tires)
Electric/ alternative fuel bodies	Replaces diesel-driven trailer equipment with electric (or nitrogen-) driven equipment	Vehicle (trailer) purchasing	Up to 15 % additional trailer cost, but lower maintenance	10–20 % of trailer fuel use
Electric vehicles	Best suited to urban driving (less than 160 km per day), and smaller (less than 12 tonne) trucks	Vehicle purchasing	EUR 90000 for a 7.5 tonne vehicle	40 %, depending on electricity source
Mild-hybrid	Stop-start systems and use of braking-energy for battery recharge. Suitable for LGVs and urban driving	Vehicle purchasing	EUR 700 option on some LGVs	6 %, depending on driving cycle
Full-hybrid	Large battery recharged by braking energy, used to power vehicle at times. Expensive and not well developed for trucks.	Vehicle purchasing	NA	20 % urban driving, 7 % long-distance driving
Automated transmission	Mechanical efficiency of manual shifts, with optimised automated changes	Vehicle purchasing	EUR 1100–1700 option	7–10 %
CNG engine	Engine that runs on compressed natural gas.	Vehicle purchasing	20–25 % more expensive than diesel engines	10–15 %
Biogas engine	Engine that runs on biogas (tolerant of contaminants in fuel)	Vehicle purchasing	Additional EUR 30 000–40 000 for HGV, EUR 5 000–6 000 for vans.	Over 60 %

Source: Ricardo (2010).

Achieved environmental benefits

Fuel and CO_2 reductions attributable to various improvement measures are listed in Table 2.80. In particular, use of natural gas and biogas to power HGVs could result in CO_2 savings of 10-15 % and over 60 %, respectively (Ricardo, 2010). For natural gas and biogas powered trucks, emissions of all the major air pollutants should be lower than comparable petrol or diesel engines.

Ricardo (2010) reports fuel consumption reductions of up to 24 % during trials at constant speed for aerodynamic trailers with integrated vehicle aerodynamic systems, and real-world fleet savings of 9 % achieved by DHL and 16.7 % achieved by STD. Aerodynamic trailers used by M&S, developed in 2008/9, reduce fuel consumption by 6 % (M&S, 2010).

Table 2.81 presents the large reductions in emissions associated with higher EURO standards for heavy duty diesel engines used in HGVs, in particular for NO_x and PM.

Table 2.81: Emission limit values for heavy duty diesel engines associated with various EURO standards, expressed per kWh engine output, and year of introduction

Tier	Date	Test	CO	HC	NO_x	PM	Smoke
			g/kWh				m^{-1}
EURO I	1992	ECE R-49	4.5	1.1	8.0	0.36	
EURO II	1998		4.0	1.1	7.0	0.15	
EURO III	2000	ESC + ELR	2.1	0.66	5.0	0.1	0.8
EURO IV	2005		1.5	0.46	3.5	0.02	0.5
EURO V	2013		1.5	0.46	2.0	0.02	0.5
EURO VI	2013		1.5	0.13	0.4	0.01	
NB: Values are for steady state testing (ECE R-49), European Stationary Cycle (ESC) and European Load Response (ELR). From summary data presented in DieselNet (2009).							

Appropriate environmental indicator

Vehicle efficiency is reflected in distance-normalised indicators specified in Table 2.68. Two relevant indicators that can be used to monitor the effect of improved vehicle design are:

- l/100 km (vehicle fuel consumption)
- kg CO2 eq./tkm.

Neither of these indicators isolates the effect of vehicle efficiency improvements from other factors, in particular loading efficiency. Improved loading efficiency will negatively affect the former indicator and significantly positively affect the latter indicator (Figure 2.97 in Section 2.3.4.5). For example, the average specific diesel consumption of 0.0122 l/tkm reported by Coop Switzerland is highly dependent on loading efficiency. The effect of alternative fuel use (biogas, electricity) requires reporting of lifecycle kg CO_2 eq. per km or tkm.

Vehicle performance in terms of air pollution is not measured directly, but can be inferred from vehicle EURO emission standard compliance (Figure 2.100). Figure 2.100 presents data from some leading retailers on the percentage of their fleets complying with EURO 4 and EURO 5 emission standards. Kingfisher's entire fleet complied with at least EURO 4 standards in 2009, but 90 % of Albert Heijn's fleet was compliant with EURO 5 (and PIEK) (see Case study 2.18). Albert Heijn plans for 100 % EURO 5 and PIEK compliance in 2010.

Similarly, the percentage of low-noise vehicles that enable more efficient night-time deliveries, and the percentage of alternatively fuelled vehicles (excluding biodiesel and ethanol owing to sustainability concerns), are useful indicators of improved environmental performance. Application of aerodynamic improvements and fitting of low rolling resistance tyres also indicate improved efficiency. Thus, five indicators for the environmental performance of the delivery fleet are:

- % vehicles within transport fleet compliant with different EURO classes
- % vehicles, trailers and loading equipment compliant with PIEK noise standards, or equivalent standards that enable night-time deliveries with
- % vehicles in transport fleet powered by alternative fuel sources, including natural gas, biogas, or electricity
- % of vehicles within transport fleet fitted with low rolling resistance tyres
- % vehicles and trailers within transport fleet designed or modified to improve aerodynamic performance.

Proposed benchmarks of excellence for this technique are:

- HGV fuel consumption less than 30 l/100 km
- 100 % vehicles at least EURO 5 compliant
- 100 % vehicles, trailers and loading equipment compliant with PIEK noise standards, or equivalent standards that enable night-time deliveries
- operation of alternatively fuelled vehicles (natural gas, biogas, electric)
- 100 % vehicles fitted with low rolling resistant tyres
- 100 % vehicles and trailers designed or modified to improve aerodynamic performance.

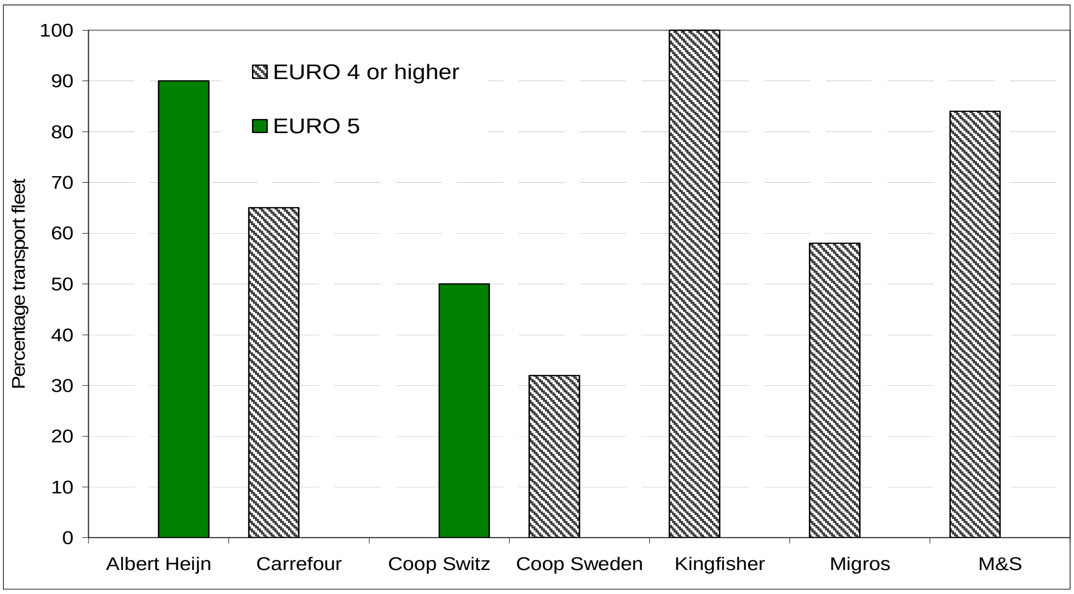


Figure 2.100: The percentage of retailer fleet trucks compliant with EURO 4 and EURO 5 emissions standards

Cross-media effects

There are no significant cross-media effects likely to arise from measures to improve vehicle efficiency.

For electric vehicles and biofuel, the impact of electricity generation and biofuel production should be accounted for and compared with the impact of the supply and combustion of fuel used in conventional vehicles. This may require a full 'well to wheel' LCA for proposed and conventional vehicles/fuels.

Operational data

The actual fuel efficiency and environmental benefits associated with the measures listed in Table 2.80 are highly dependent on vehicle use and operational conditions. For example, aerodynamic improvements will achieve significant fuel savings for vehicles that frequently travel at higher speeds, whilst hybrid and electric vehicles will achieve significant fuel/energy savings for vehicles that spend most of their time in urban areas making frequent stops. Meanwhile, biogas is a promising 'green' fuel for trucks, but widespread use will depend on the development of biogas availability and distribution.

Compressed natural gas, LPG and biogas are considerably less dense fuels than petrol and diesel. Trucks running on these fuels require fuel tanks that are of higher capacity (up to four times higher) than for conventional trucks and that are reinforced to maintain necessary fuel pressurisation. Appropriate specialised refuelling infrastructure is required, at least at truck depots, but also along long-distance transport routes. Similarly, electric delivery vehicles (vans)

will require recharging within vehicle depots, as recharging networks are in the early stages of development.
Case study 2.18 provides insight into one example of vehicle specification that had a significant positive effect on operational efficiency and was rolled out across a retailer's entire fleet – 'silent' running trucks for Albert Heijn.

Case study 2.18: Albert Heijn's investment in silent trucks to improve transport efficiency

The logistics of city deliveries
Albert Heijn stores are predominantly located within densely populated urban areas in The Netherlands. Depending on the specific location, there are restrictions on the size of delivery vehicle allowed within the city centre at specific times, and in all instances standard (non-quiet) deliveries are not allowed before 07:00. Consequently, Albert Heijn must make a high proportion of deliveries to city-centre stores during morning rush hour traffic, with smaller vehicles, thus increasing delivery times and costs.

PIEK standard
The Dutch government introduced the current PIEK standard in 2004. To comply with this standard, products (e.g. trucks, trailers, loading equipment) must emit less than 60 dB(A) at 7.5 metres from the sound source. All handling and delivery equipment must comply with this standard to be deemed suitable for off-hours delivery. This represents a significant improvement over standard equipment. Tail lifts typically emit 83 dB(A), vehicle reversing warning systems 110 dB(A) and refrigeration systems 69–74 dB(A).

Trial
In 2007, Albert Heijn participated in a trial involving 1000 morning (05:00–07:00) and evening (19:00-02:00) deliveries to 10 shops in nine cities over three months (Albert Heijn & PIEK, 2008). There was just one complaint from a resident during the trial. Meanwhile, the results demonstrated two major effects that could significantly improve operating efficiency:
1. Faster journey times owing to less congestion. The average journey time on a 35 km route (Tilburg to Eindhoven) was reduced from 1.5 hours to 0.5 hours, and fuel consumption from 43 to 33 l. A 30 % reduction in costs was achieved.
2. Opportunity to use larger vehicles. In place of three 10 m long rigid trucks used during the day, it was possible to use a single 16.9 m tractor trailer for morning and night time deliveries. Journey time also decreased from 2 hours to 1.3 hours. Consequently, average fuel consumption over the 75 km trial journey decreased from 74.25 l to 24.75 l and total costs decreased by 75 %.

Implementation
Based on the 2007 trial, Albert Heijn estimated that investment in silent equipment increases capital costs by 15 %, but reduces overall cost by more than 20 %. Since the trial, Albert Heijn have been expanding their use of PIEK-compliant trucks in off-hours deliveries. In 2009, 90 % of Albert Heijn's delivery trucks were PIEK-compliant, with a target for 100 % PIEK compliance in 2010.

By extending the delivery window and increasing allowable size in city centres, upgrading to 'silent' trucks facilitates modal shifts (Section 2.3.4.4) and optimised route planning (Section 2.3.4.6).

Applicability
All retailers, suppliers and T&L providers operating trucks can specify vehicle design features, or retrofit modifications, to improve vehicle efficiency. Purchasing HGVs capable of running on CNG and biogas can result in large emission savings at acceptable costs, but may be restricted by refuelling infrastructure available within different member states. Similarly, the purchase of electric delivery vehicles is highly dependent on available recharging infrastructure.
The greatest benefits associated with silent trucks are realised where the legislative restrictions on standard trucks are greatest. Retailers with a high percentage of stores in built-up residential areas, especially city centre locations, are therefore likely to benefit most from silent trucks. Such retailers also have the greatest opportunity to achieve benefits from the use of hybrid and electric vehicles.

Economics

As indicated in Table 2.80 vehicle modifications can result in substantial fuel and cost savings. The payback periods for most of the retrofit investment costs specified in Table 2.80 are favourable, often shorter than two years based on conservative estimates of potential fuel savings and average European truck operations.

For some of the vehicle purchasing options, especially alternatively powered vehicles, the payback periods are highly dependent on national fuel taxation and road tolling policies - in particular taxation on gas-based fuels relative to petrol and diesel.

However, as indicated in Case study 2.18, investment in low-noise transport and loading equipment increased capital costs by 15 %, but reduced overall transport costs by more than 20 %.

Driving force for implementation

The driving forces for this technique are:

- social and environmental responsibility
- potential efficiency improvements
- reducing risk associated with energy price volatility
- reducing risk associated with future increases in road and air-freight taxation
- improving image and reputation.

Reference retailers

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2.4 Best environmental management practice concerning waste

2.4.1 Chapter Structure

This section provides information to retailers concerning their waste management. The aim is focused on those management activities under direct control of the retail company, although some issues covered by the description are also referring to indirect aspects. An introduction about waste management and the related European legislation is provided in Section 2.4.2 where an overview on the commitments of retailers in waste and packaging materials management is also included. The scope is explained in Section 2.4.3. This section also reflects the types and amount of generated wastes with a special focus on food waste production. Section 2.4.4 mentions the most important drivers detected for the improvement of waste management.

Section 2.4.5 provides the rationale for the sequence of the described techniques, based on the waste hierarchy according to the waste Directive. The reduction and minimisation of food waste is described in Section 2.4.6.1. Best practices on the integration of waste management in retailer activities, using, for instance, reverse logistics and local or regional partnerships, are described in Section 2.4.6.2. Return systems from customers are described in Section 2.4.6.3 and the treatment of food waste by anaerobic fermentation is described in Section 2.4.6.4.

2.4.2 Chapter Introduction

Retailers have to comply with a number of directives, regulations and other mandatory structures. In view of more restrictive and demanding environmental legislation, increasing costs may be expected leading to a need to go for best management and proactive schemes (Pitt, 2005). On top of that, given the cost of waste management, there is a strong business case to reduce wastes. There would be a better business performance if less waste is generated, leading to an increased competitiveness. Additional benefits are derived from improved management and control of retailers operations and improved corporate image. As well, especially for SMEs, the local aspects of waste management should make a good chance to improve corporate reputation, not only to customers but also to public authorities. Disposal of wastes (e.g. landfill and incineration) will have higher costs and more restrictive requirements of compliance, so best environmental options (i.e., the hierarchy prioritisation according to waste Directive) become the best business option.

Retailers are, directly or indirectly, participating in the generation of a huge amount of wastes generated by households, by themselves or by their suppliers. The action taken by retailers to prevent and treat waste is essential, but also their role in the supply chain and their direct contact to customers is really important and influential. As well, Pitt, 2005, identified two areas where retailers can be helped to achieve their waste reduction, reuse or recycling objectives: the economics of waste management facilities, controlled by private or public funding and the public awareness and education, which have influence on their employees, managers and customers. For the latter, retailers should play an active role.

In the case of small enterprises, strategic partnerships and the establishment of common approaches have lead to decreased waste management costs (Tryantafyllou et al., 2010). This is usually the case for small enterprises belonging to the same commercial centre, same street, same economic activity, etc. Setting up a common waste management structure is easily achievable and produces economical benefits. For the best implementation of these schemes, the implication of all actors (tenants, owners, distributors, suppliers, local authorities, etc.) is highly relevant as it can increase recycling and reuse rates, minimise landfilling and reduce costs.

Retailers are waste producers, waste holders and, in some cases, they can act as dealers or brokers. They have to fulfil a number of European Directives which the Member States had to implement:

- Directive 2008/98/EC on waste and repealing certain Directives.
- Decision 2000/532/EC establishing a list of hazardous wastes.
- Directive 2002/96/EC on waste electrical and electronic equipment.
- Regulation 1774/2002 laying down health rules concerning animal by-products not intended for human consumption.
- Directive 94/62/EC on packaging and packaging waste and the amendment of Directive 2004/12/EC.
- Other Directives and initiatives relevant for retailers: Directive 1999.31/EC on landfill of waste, Directive 2000/76/EC on waste incineration, Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators, the Thematic Strategy on the Prevention and Recycling of waste, etc.

The **Directive 2008/98/EC on waste** defines 'waste' as any substance or object the holder discards or intends or is required to discard; and 'waste management' is the collection, transport, recovery and disposal of waste, including the supervision of these operations and actions of dealers or brokers. This directive also defines the hierarchy of waste management. Priority should be given, sequentially, to prevention, preparing for re-use, recycling, other recovery (e.g. energy recovery) and disposal:

- **prevention**: measures taken before a substance, material or product has become a waste (e.g. improved preservation, monitoring, etc.)
- **preparing for re-use**: all operations of checking, cleaning or repairing by which products become re-usable (e.g. cleaning and repairing operations).
- **re-use**: any operation by which products or components that are not waste are used again for the same purpose for which they were conceived (e.g. re-use of plastic boxes, pallets and other packaging). This operation is not covered in the waste Directive but it is relevant for the waste management of retailers.
- **recycling**: waste is reprocessed into products or materials, which purpose is the same or other than the original product. Processing of organic material is considered under this term but not energy recovery and production of fuels or backfilling (e.g. one-way glass bottles).
- **recovery**: any operation which results is to replace other materials by waste serving for a useful purpose, or waste being prepared to fulfil a function (e.g. composting, anaerobic fermentation, etc.)
- **disposal**: any operation which is not recovery, even if the operation is associated with the recovery of energy.

This hierarchy should be applied to waste management to achieve the best overall environmental performance.

The Directive uses the concept of extended producer's responsibility. Producer of the product is any natural or legal person who professionally develops, manufactures, treats, sells or imports products. Measures concerning extended producer responsibility may be implemented by Member States, for example, the acceptance of returned products and of the waste after the use of those products, subsequent management and financial responsibility for that and obligations to provide publicly available information on the extent which the product is re-usable.

As well, the original waste producer or other holder should carry out the treatment of waste, or it is performed by a dealer or public or private waste collector. Nevertheless, the general rule is that the responsibility for carrying out a complete recovery or disposal operation shall not be discharged from the original producer. It can be shared or delegated only at exceptional cases.

With respect to waste prevention, the European Commission lays the emphasis on following objectives:

- foster durable, reusable and recyclable products
- change current consumption patterns
- waste prevention and decoupling objectives based on best available practices

For re-use and recycling, the Directive prescribes following targets for 2020:

- the fraction of waste prepared for re-use and recycling (at least paper, metal, plastic, glass form households and other origins) should be increased to 50% by weight
- the fraction of waste prepared for re-use, recycling and other material recovery of non-hazardous construction and demolition waste should be increase to 70% by weight.

According to Article 29, Member States shall establish national waste prevention programmes. It also provides examples of waste prevention (Annex IV of the Directive). Some examples of the proposed measures, to be implemented by Member States and relevant for retailers, are summarised below:

- The promotion of eco-design
- The provision of information on waste prevention techniques.
- The use of voluntary agreements, consumer/producer panels or sectoral negotiations in order to set their own waste prevention plans or objectives or correct wasteful products or packaging.
- The promotion of creditable environmental management system, including EMAS and ISO 140001.
- The promotion of creditable eco-labels.
- Incentives for clean purchases
- Agreement with industry, such as the use of product panels such as those being carried out within the framework of Integrated Product Policies or with retailers on the availability of waste prevention information and products with a lower environmental impact.

Directive 2002/96/EC on waste electrical and electronic equipment (WEEE) aims, as a first priority, the prevention of waste electrical and electronic equipment and its reuse, recycling and other recovery formats. The objective is to reduce the amount of waste and to improve the performance of all operators involved in the life cycle of electrical and electronic equipment.

One of the main concerns of the WEEE management is the content of hazardous substances in these wastes. The introduction of producer responsibility is the mean to encourage design techniques taking into account or facilitate repairing, reuse, dismantling, recycling and recovery. Retailers are involved directly in the life cycle of such equipment and in the management of WEEE, irrespective of the selling technique, including distance or electronic (online) selling. Separate collection is one requisite of this Directive. The role of retailers is defined as distributor, as they supply the equipment to the customers who are going to use it. But, as well, the role of some retailers can be considered as 'producer', as they sell electronic equipment under their own brand. The target for the collection rate in the original formulation of the Directive is 4 kg per capita and year, but this value seems to be not enough, as a huge amount of WEEE are generated and illegal trade of WEEE to third countries continues. The new target proposed by the Commission is the 65% of the average weight of electrical and electronic equipment placed on the market over the two previous years in each Member State and increasing recycling rates for all the WEEE categories by 5%.

As distributor, the retailer is the responsible for ensuring that waste can be returned free of charge by the customer when supplying a new product. As producers, retailers can set up take-back systems from private households and they should set up systems to treat WEEE with the best available technique. The list of products to be managed under this Directive is shown in Annex I-B under the following categories:

- Large household appliances: refrigerators, freezers, washing machines, microwaves, stoves, radiators, etc.
- Small households' appliances: vacuum cleaners, toasters, fryers, irons, etc.
- IT and telecommunication equipments: personal computers, printers, laptops, etc.
- Consumer equipment: radio, television, cameras, musical instruments, etc.
- Lighting equipment: fluorescent lamps, luminaries except from households, etc.
- Electric and electronic tools: saws, drills, sewing machines, etc.
- Toys, leisure and sports equipment: electric trains, video game consoles, etc.
- Medical devices: radiotherapy equipment, cardiology, dialysis, etc.
- Monitoring and control instruments: smoke detectors, heating regulators, etc.
- Automatic dispensers: hot drinks, money, etc.

Directive 94/62/EC on packaging and packaging waste covers all packaging materials and wastes placed on the market. The first priority in this aspect should be the prevention of packaging waste and, as additional fundamentals, reuse and recycling and other forms of recovery. Hence, it also aims to reduce the final disposal of packaging wastes. Article 6, setting targets for recovery rates for packaging wastes, was amended by directive 2004/12/EC. These targets are:

- 55 – 80 % rate of recycling of packaging waste
- 60 % recycling for glass in packaging waste
- 60 % recycling for paper and board
- 50 % recycling for metals
- 22.5 % recycling for plastics (accounting only for the fraction recycled back in plastic)
- 15 % recycling for wood.

Regulation 1774/2002 laying down the rules concerning animal by-products not intended for human consumption establish that certain animal by-products should be collected separately and according to the rules of this regulation. Catering wastes (foodstuffs and meat or fish coming from food retailers) are not considered unless it is destined to animal consumption; it is used for biogas or for composting or it comes from transport operating internationally. Retailers should collect this fraction of waste foodstuff if the final treatment for this waste fraction is the fermentation to obtain biogas or compost. Else, disposal of this kind of waste is not recommended as it would be contrary to the priority lists proposed by the waste directive.

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2.4.3 Scope of this Chapter

In this chapter, waste management is considered as a direct environmental aspect of retailers' activities, i.e. those aspects under direct control of the retailer. Waste generation is unavoidable at stores, especially those generated because of transport activities. The influence of retailers in the waste management of the supply chain is covered by Section 2.2. As well, the influence of retailers on consumers' behaviour, especially for waste prevention, is covered by Section 2.7.

According to the statistics published by Eurostat and the study made for SME and the environment in Europe (Constantinos et al., 2010), European retailers contribute to 1.5 % of total waste generation in Europe and about 20 % of the waste generation in the services sectors

(Nace Codes from G to U). The relative importance can be observed in Figure 2.101 for the generation of non-hazardous wastes in Europe.

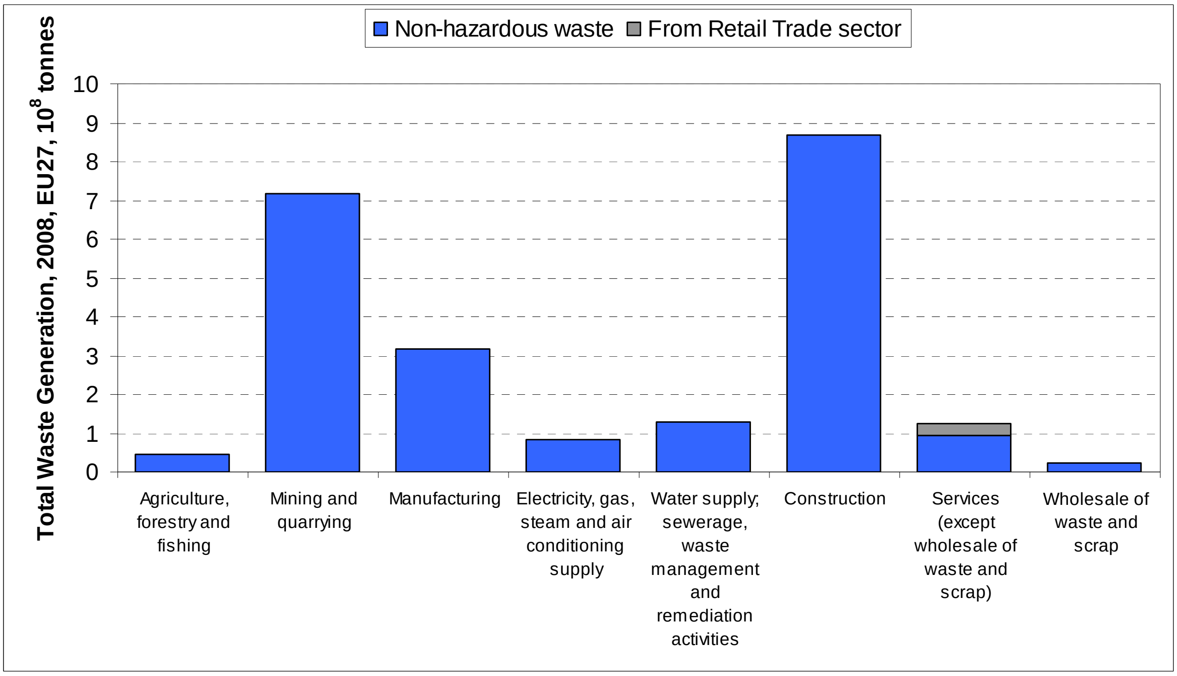

Figure 2.101: Non-Hazardous Wastes Generation in Europe for several sectors.

Although the contribution of retailers' activities to waste generation is not as important as for other sectors, retailers' waste management seems to be very relevant because of:

- the great amount of packaging materials,
- the great influence of retailers to households and to consumer behaviour,
- the role of retailers in food waste management and in animal by-products generation.

The disclosure of waste types can vary when assessing different retailers, but also waste generation and type of wastes can significantly vary among different stores of the same retailers. Figure 2.102 shows the average waste generation of several sampled retailers and stores and the distribution per type of waste. Values shown in Figure 2.102 were collected from Retailers Sustainability Reports, EMAS environmental statements or information provided for the elaboration of this document. Comparability among values is not assured, as the monitoring methodologies vary from on retailer to another. Absolute values, ranging from 40 to 160 kg of waste per m^2 of sales area, should be taken as a rough estimation of the specific waste generation of retailers. Nevertheless, the heterogeneity of the values presented in Figure 2.102 reveals that, almost for every retailer, there are three main waste types:

- Organic waste, which can usually be processed for anaerobic fermentation or composting. These wastes can be assumed as one third of the total (only for food retailer activities). The quantities generated by the non food stores are low. The difference can be assumed as the organic waste generation performed by distribution centres or other retailer activities. As well, the generation of food waste varies depending on many circumstances: local aspects, rate of refrigerated products, sales format, etc.
- Packaging waste, which is usually conducted to recovery or recycling processes. As well, re-use of materials is becoming more important to reduce waste generation. As shown in Figure 2.102, packaging waste usually corresponds to paper, cardboard, plastic, wood and metal materials. Glass is not a significant fraction of total waste generation unless the retailer is controlling a take-back system for glass.

- Other fraction assumable as municipal solid waste. Non-recovered wastes are included within this category. They are, usually, disposed off in landfills or incinerated.

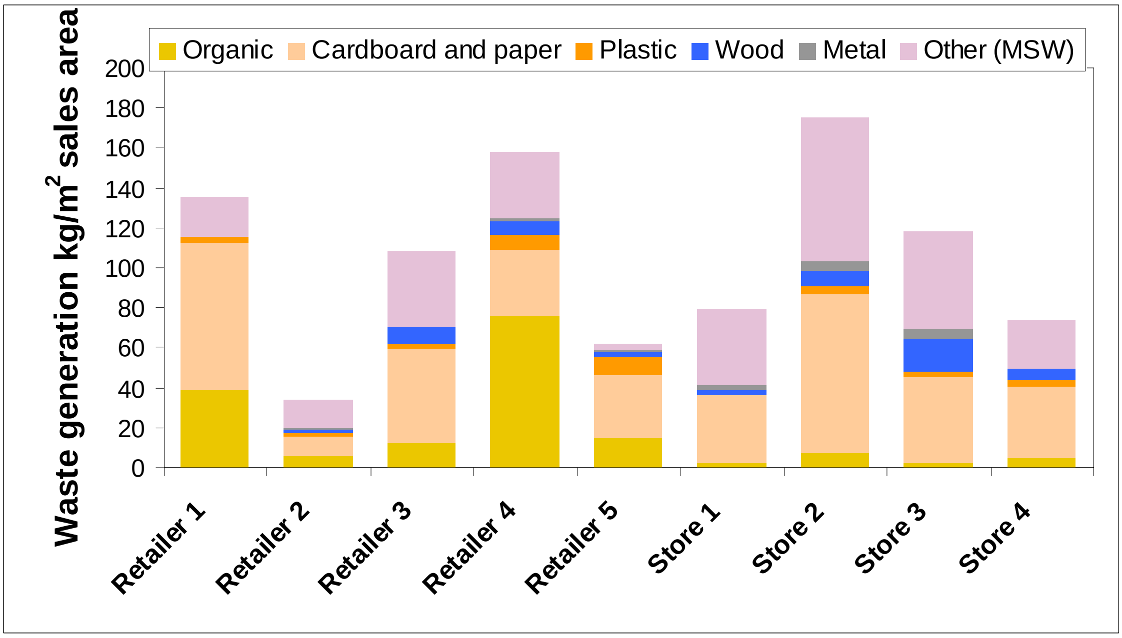

Figure 2.102: Wastes generation per category for different retailers and sampled stores.

The final destination of wastes managed by retailer depends on the nature of the waste, on the management capabilities of the retailer, on the type of facilities of third parties to treat wastes and the load capacity of these waste treatment facilities. As shown in the introduction of this chapter, section 2.4.2, existing legislation and the commitment of the sector are to reduce waste and to re-use, recycle, or recover more, minimizing the amount of waste disposed off in landfills but also in incineration plants. Figure 2.103 shows the average waste treatment distribution of two important food-retailers in Europe. As observed, retailer 1 is disposing off almost 42% of total waste generated, while retailer 2 is disposing 15% of wastes in incineration plants and is not landfilling any waste, which is a big progress. Retailer 1 is composting or fermenting about 17% of wastes (corresponding to the food waste fraction), and retailer 2, about 28 %. The accounting for recycled materials does not usually differentiate re-used materials. This rate is increasing among retailers all over Europe and the amount of wastes sent to landfill is being reduced, although the general trend is to increase the overall amount of wastes. Once a waste should be disposed off, preferred options should be incineration plants under the IPPC Directive with energy recovery, as they represent best practice for unavoidable waste.

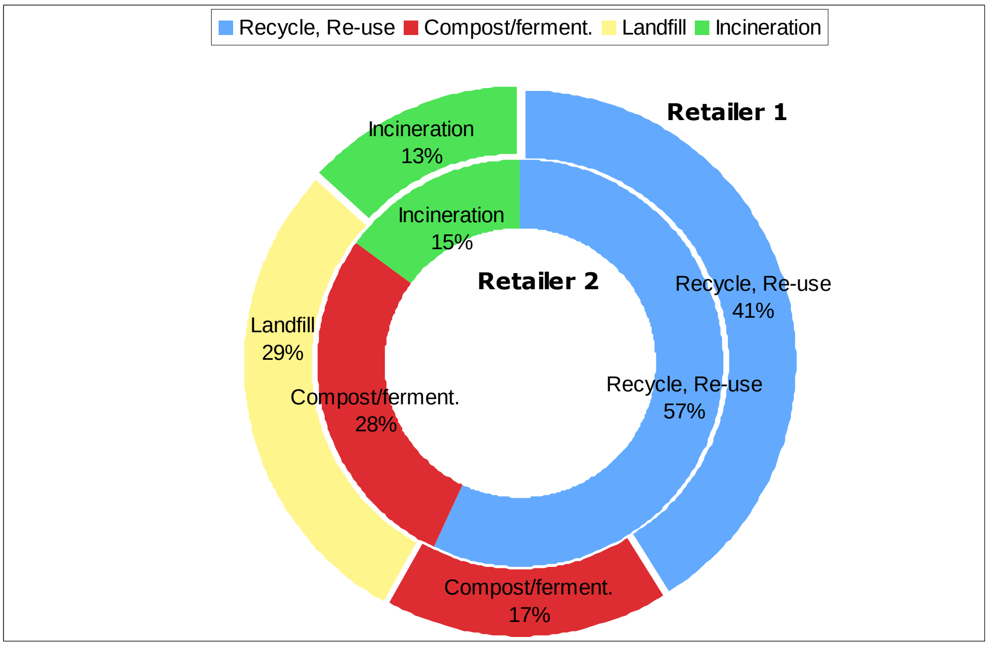

Figure 2.103: Disclosure per type of waste treatment for two European retailers

A high recycling rate does not necessarily mean a good waste management system. Best performers should give priority to waste prevention and, then, achieve the best re-use and recycling rates and the minimized disposal on landfills. Figure 2.104 shows the performance of several European retailers, assessed as the relation between recycling rate and specific waste generation (per unit of sales area and year) and the bubble size indicating the sales per m^2, which may represent the difference between sales format.

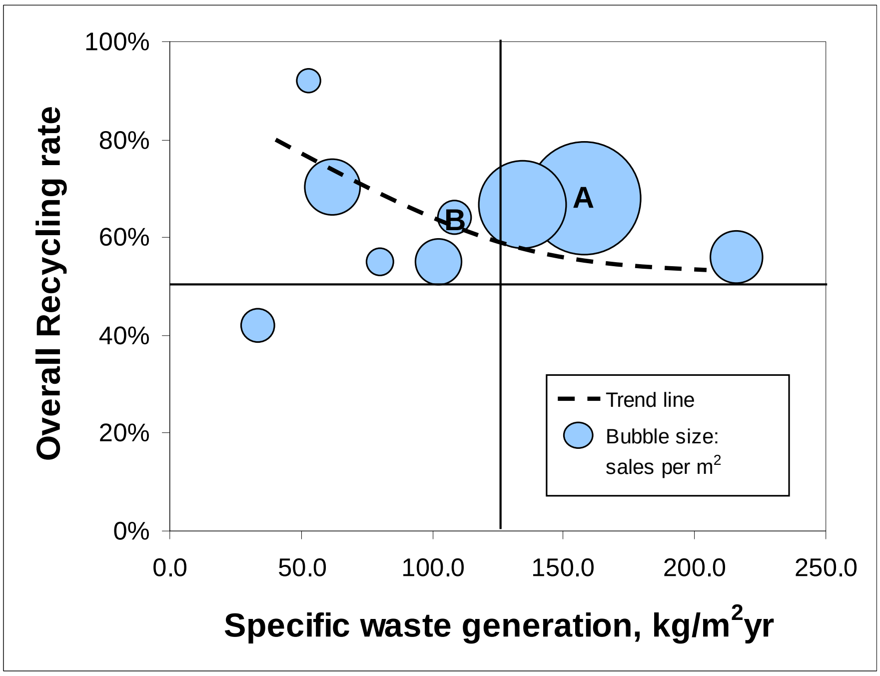

Figure 2.104: Recycling rates vs. specific waste generation for several European retailers.

As shown in the Figure, best retailers are achieving high recycling rates at relatively low specific waste generation. Nevertheless, different sales formats lead to different amount of sales per unit of area. The two examples of retailer A and B shown in Figure 2.104 represent two different sales formats: retailer A has higher turnover per m^2, which may be the reason of high specific waste generation (more than 150 kg/m^{2}yr). Retailer B is generating more than 100 kg/m^{2}yr with less sales per m^2. In order to increase the comparability among retailers, the generation of waste per EUR million of turnover is evaluated in Figure 2.105. As shown, retailer A is generating half of the wastes generated by retailer B. Therefore, a high turnover per m^2 may have a higher specific waste generation but with a really high performance in waste management. The trend shows that high recycling rates are achieved, usually, in retailer producing less waste per turnover. So, integrating prevention measures, to reduce waste generation, with best waste management practice, to increase recycling rate, would produce best results, also from the economic point of view.

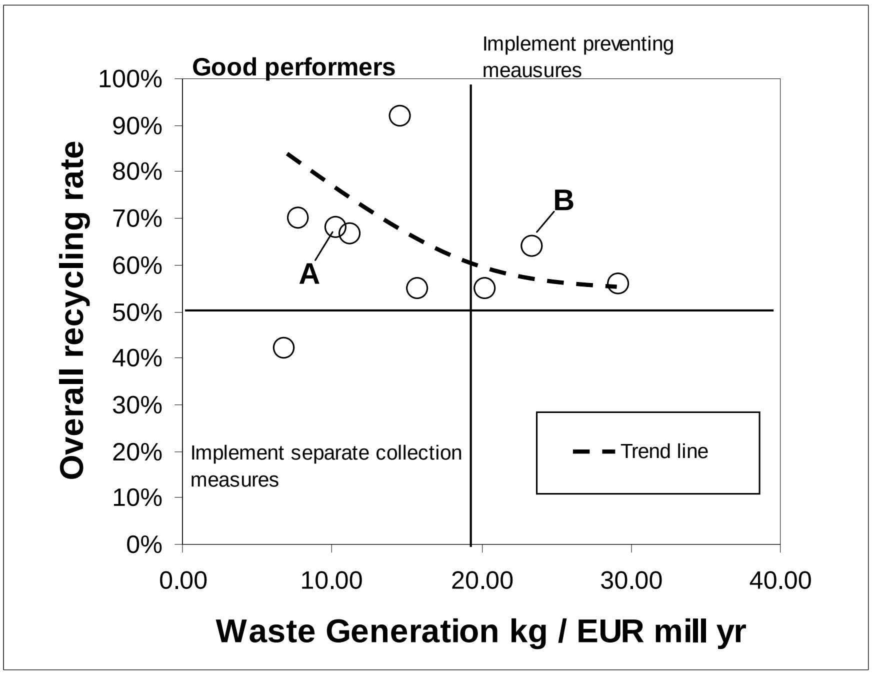

Figure 2.105: Overall recycling rate vs. Waste generation per EUR million turnover

The generation of hazardous wastes from retailers' activities is of minor relevance. The amount of wastes generated depends on many factors, essentially on the store activities on waste management. As an example, Figure 2.106 shows the distribution of hazardous wastes generated in two similar stores of the same retailer and at the same region. Actually, store 1 is generating about 2-3 kg/m^{2}yr and store 2 about 13 kg/m^{2}yr. Store 2 has a garage and a fuel station, while store 1 has a fuel station but no garage.

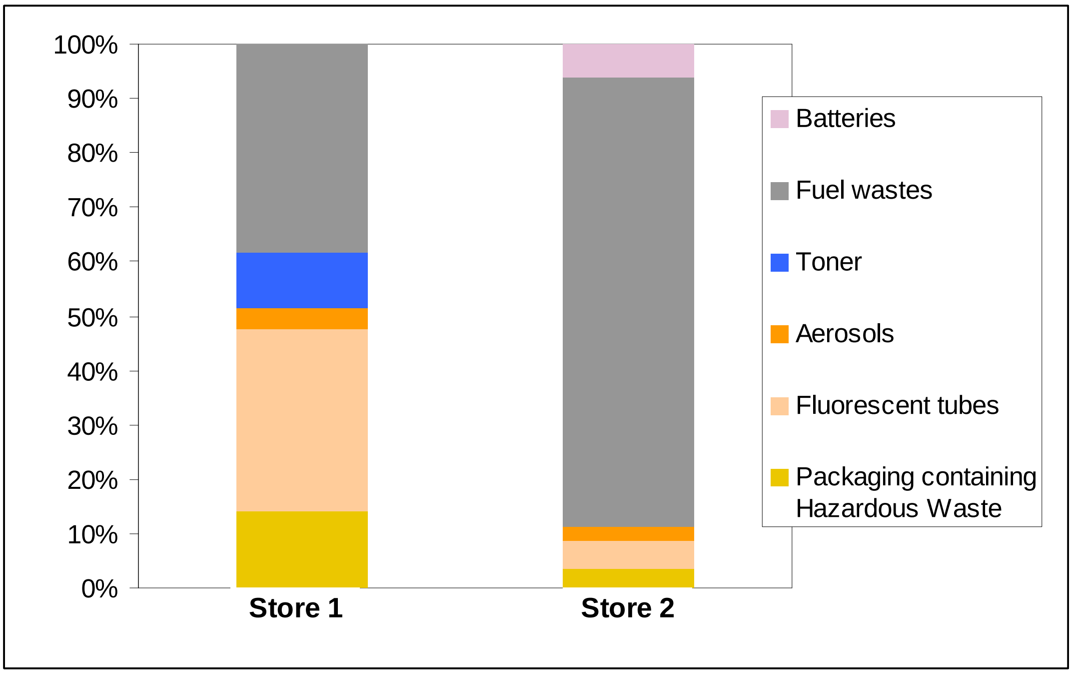

Figure 2.106: Hazardous wastes generated in two different stores from the same retailer

Retailers should declare as a separate fraction of hazardous waste the amount of waste electric and electronic equipment (WEEE), which should be collected separately in accordance to Directive 2002/96/EC. The stores of the example shown in Figure 2.106 manage WEEE differently: store 1 is collecting about 5 time less electric and electronic wastes than store 2, while both stores have similar sales area and sales format.

For food retailers, it is quite important to control the organic waste fraction coming from animal by-products, regulated under the regulation 1774/2002, and the rest of food wastes, coming from outdated or damaged food products. A study on food waste at European level (BioIS, 2010) states that around 25% of purchased food is discarded at households. Retailers generate about 4% of food waste, 14% come from food services and catering, 39% from manufacturing industries and 43% from households. Although the study is made on estimations of available data, it reveals the huge amount of waste food in Europe, where the contribution of retailers is about 7 to 9 kg per capita and year from a total of about 180 kg/m^2. Spain Ministry published the White Paper on animal by products on 2007. The analysis on the origin and generation of animal by-products estimated the flows values for by-product category 3 (according to regulation 1774/2002). With this estimation, in combination to average consumption and food waste production patterns, a mass balance was drafted as shown in Figure 2.107.

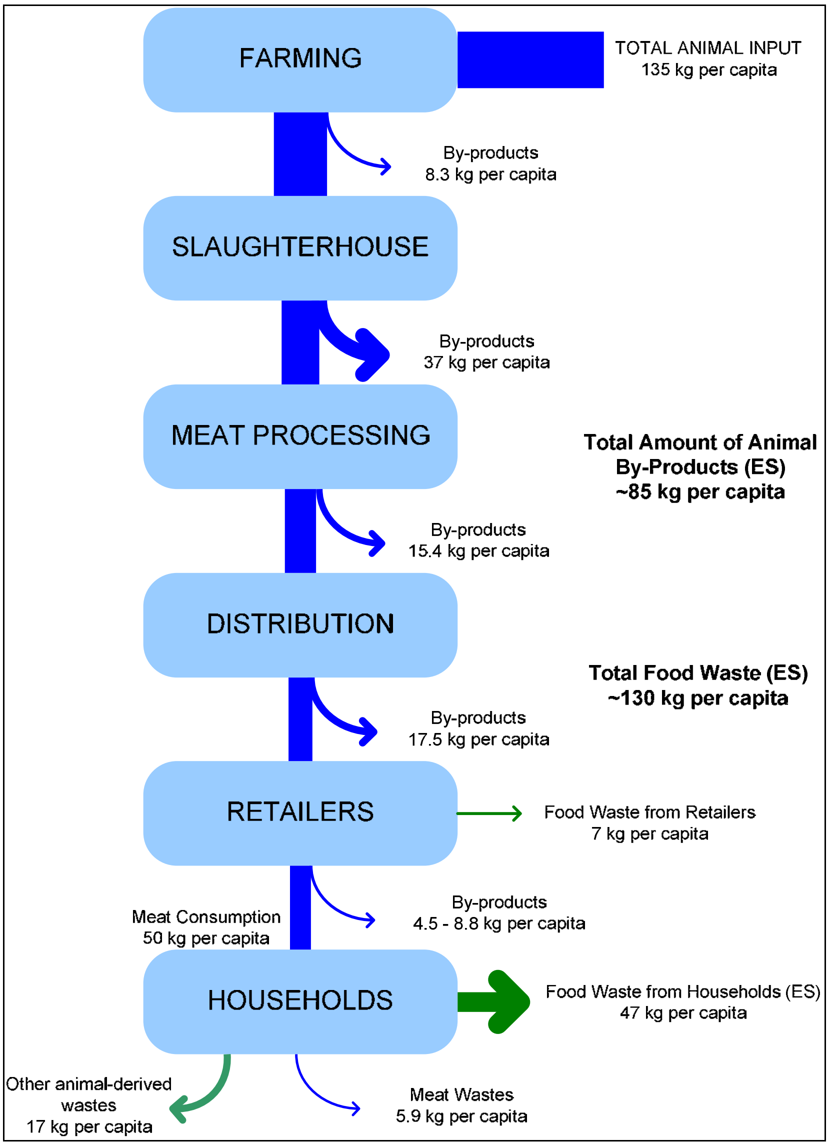

Figure 2.107: Animal by-products and food waste flows in Spain

Values shown in Figure 2.107 are estimations that should be taken with caution, as many limitations on the referenced studies were observed. Nevertheless, it is noticed that retailers' generation food waste is not relevant if compared to other actors within the chain. Retailers can act in three different directions: influencing food suppliers to minimize wastes (e.g. through application of demanding standards), preventing in-house food waste generation and influencing customers to reduce food waste generated at households, e.g. through responsible public campaigns.

The role of retailers in the implementation of these directives is highly important. Waste management is a direct impact: retailers are producers of a high amount of wastes, mainly from packaging materials. As well, waste management made by suppliers can be influenced (see section 2.2) and retailers' influence on consumers is also relevant (see section 2.7). At European level, the commitment shown by retailers to improve their environmental management of wastes is part of the objectives of the Retail Forum([22]), which is considered to represent a significant contribution to the implementation of the EU Action Plan on Sustainable Consumption and Production and Sustainable Industrial Policy (COM, 2008).

([22]) http://ec.europa.eu/environment/industry/retail/index_en.htm

As explained in section 2.1.2, The Retail Forum is a multi-stakeholder platform. It was developed with the aim of exchanging best practices on sustainability and to identify opportunities and barriers of the achievement of sustainable consumption and production. In the framework of the Retail Forum, the Retailers' Environmental Action Programme (REAP) was launched and some mechanisms were provided to enhance the dialogue with the European Commission and other relevant stakeholders. It also makes available the commitments and actions of retailers in Europe. The REAP commitments database is located at the Commission webpage ([23]). The list of commitments for energy efficiency was shown in Table 2.1. Retailers' commitments for waste management are shown in Table 2.82.

([23]) http://ec.europa.eu/environment/industry/retail/reap/index_en.html

Table 2.82: Examples from REAP commitments about waste management

Retailer	Category	Target description	Keywords
Asda Wal*Mart	What we sell	Reduce food packaging by 30% by end 2009 versus 2005.	food, packaging, waste management
FCD	What we sell	Further reduce the production of packaging waste by at least 10% by 2009.	packaging, waste management
FCD	What we sell	Encourage the use of recycled materials in packaging (especially for retailer branded products), reach 75% of recycled materials for glass and cardboard paper.	packaging, waste management
Tesco	What we sell	Reduce unnecessary product packaging.	packaging, waste management
APED	How we sell	Encourage correct solid waste management in stores.	waste management, waste recycling & prevention
Asda Wal*Mart	How we sell	Send zero store waste to landfill by end 2010 for store operations.	waste management, waste recycling & prevention
Asda Wal*Mart	How we sell	Zero waste to landfill by end 2010 for all store construction waste.	waste management, waste recycling & prevention
Auchan	How we sell	Improve waste management and reduce the environmental footprint of its stores.	waste management, waste recycling & prevention
CEC	How we sell	Obtain that companies know the environmental impacts of the construction materials used when renovating and decorating and take these into consideration for future renovations.	sustainable construction/buildings, waste management
Colruyt	How we sell	Keep on maximising recycling efforts and use of organic waste for bio-methanation.	waste management, waste recycling & prevention
Coop Norway	How we sell	Develop model for increased recycling and improved waste management practices in DCs and outlets.	waste management, waste recycling & prevention
IKEA	How we sell	Exploitation of 90% of waste by recycling and/or energy recovery at stores and warehouses.	waste management, waste recycling & prevention
Kingfisher	How we sell	Achieve a 50% reduction in tonnes of store waste disposed per £ of retail sales by 2011/12 against the 2006/07 baseline.	waste management, waste recycling & prevention
Kooperativa Förbundet	How we sell	Increase the amount of recycled waste from stores and warehouses	packaging, waste recycling & prevention

Retailer	Category	Target description	Keywords
Kooperativa Förbundet	How we sell	Decrease the physical destruction of goods (food waste etc), in terms of sale value, by 10% to 2010.	waste management, waste recycling & prevention
Marks & Spencers	How we sell	No waste to landfill from M&S operations as well as from M&S store construction programmes in the UK and Ireland.	waste management
Mercadona	How we sell	Recover and recycle all the carton, plastic and porexpan (plastic boxes that are used to transport fish) waste generated in supermarkets and warehouses.	packaging, waste management
S Group	How we sell	To decrease grocery trade's losses by waste reduction	waste management, waste recycling & prevention
The Co-operative Group	How we sell	Reduction of the landfilled waste	waste management, waste recycling & prevention
Delhaize Group	Communication	Encourage recycling behaviour of customers of Alfa-Beta by installing recycling facilities at 28 of its stores	waste management, waste recycling & prevention
ANCC/Coop Italia	What we sell	Decrease packing waste production by the "3R" strategy	packaging, waste recycling & prevention
Auchan	What we sell	Increase ecodesign on Auchan branded products.	packaging, product ecodesign
Coop Norway	What we sell	Environmentally friendly product packaging	packaging, waste recycling & prevention
El Corte Inglés	What we sell	Implement bio-degradable bags in certain areas of El Corte Ingles' activities and, for general use in every store department, different types of reusable bags.	bags, packaging
Leroy Merlin, Spain	What we sell	Sell in the near future reusable and biodegradable plastic bags to encourage our customers to stop using disposable plastic bags.	bags, packaging
Lidl	What we sell	Annual reduction of CO_2 of 8.800 tons by using shopping bags consisting of recycling material.	bags, packaging
S Group	What we sell	Environmentally friendly product packing	packaging, waste recycling & prevention
The Co-operative Group	What we sell	Design-out packaging waste growth and deliver absolute reductions in packaging waste	packaging, waste management

Retailer	Category	Target description	Keywords
The Co-operative Group	What we sell	Use a wide range of bags for life and pilot compostable bags in certain areas	bags, packaging
Asda Wal*Mart	How we sell	Reduce environmental impact of carrier bags by 50%.	bags, packaging
C&A	How we sell	Sell corporate Bio Cotton bags.	bags, packaging
Carrefour	How we sell	Eliminate the use of free disposable checkout bags and promote the use of reusable carrier bags.	bags
Delhaize Group	How we sell	Ban of all plastic non reusable carrier bags at check outs in Belgium supermarkets and strong promotion of reusable alternatives.	bags, packaging
El Corte Inglés	Communication	Campaign for reusing and recycling of bags, in order to increase percentage of recycled items coming from yellow container-banks (for light-weight containers).	bags, packaging
Marks & Spencers	Communication	Reduce bag use by 33%.	bags, packaging

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2.4.4 Drivers of retailer waste minimisation (prevention, re-use, recycling and other recovery operations)

The development of integrated waste management policies within the business structure has important benefits for the company. Waste prevention has a direct positive impact on costs: less waste means less expenditure for treatment or collection/re-use/recycling systems or disposal and, also, less waste means higher efficiency on resource management, which can produce important cost-savings for the company.

As explained above, retailers have to respect a number of regulations and waste-related legislation. The extended producer responsibility also influences their activity and they should have implemented mechanisms to manage wastes affected by this issue. Re-use of secondary and tertiary packaging materials can reduce drastically the waste generated from packaging. As well, disposal costs are becoming higher so waste minimization would be more attractive from the economic point of view.

Main drivers leading retailers to implement integrated waste management in their companies are:

- Reduce costs lead to improved competitiveness.
- Generated knowledge and expertise. They would also help to improve insight into waste generation aspects.
- Synergies with other management systems would be established.
- Decision-making process would be improved.
- Better response to existing or future regulations through anticipated actions.
- Better preparation for waste treatment fees increases
- Better public image and reputation

2.4.5 Techniques portfolio

In this section, the approach to present best environmental management practices is explained. Some of them are not single techniques, but they summarize the best available practices for the management of wastes for all the aspects of a retailer. The organization of the described techniques has been made according to the prioritization of waste management as laid down in the Waste Framework Directive:

- prevention: waste prevention techniques are described in section 2.4.6.1. Main focus is the avoidance of food waste generation through management practices.
- prevention, preparing for-reuse, reuse, recycling, recovery, etc: an overview of best performance of integrated waste management is given, as described in section 2.4.6.2. This section describes best performers management practices, focused on retailers activities at stores and the logistic issue.
- recycling: customer return systems are described. Many schemes already exist in Europe and one example is given through PET and PE bottles take-back systems in section 2.4.6.3.
- recovery: food waste recovery as biogas and/or compost is an extended operation among best performers in Europe. Technical description is given in section 2.4.6.4.
- disposal: as landfill or incineration of wastes should be minimised in Europe, no best practice dealing with these options are provided. Minimisation of disposed waste is a consequence of the application of best practices in waste management priorities.

The information provided in this chapter has been collected through different mechanisms:

- Information provided directly by retailers. Relevant European retailers have provided an important amount of information to develop this document. Some of the provided data were confidential and the information can be presented in an anonymous manner.
- Information about retailers' initiatives publicly available. For example, joint initiatives as the Retail Forum or companies´ sustainability and financial reports were used.
- Relevant existing or ongoing studies in each knowledge topic and publicly available literature.
- Own research. Important conclusions were derived from EC own research activities.

The relation between retailers' activities and described techniques are summarized in Figure 2.108, where a simplified flow chart of wastes among different processes (at retailers or directly connected to them) are shown. Waste streams directly managed or indirectly influenced by retailers are also presented. Grey dashed boxes are representing the area of activity affected by the described practices (called technique 1, 2, etc. in the plot).

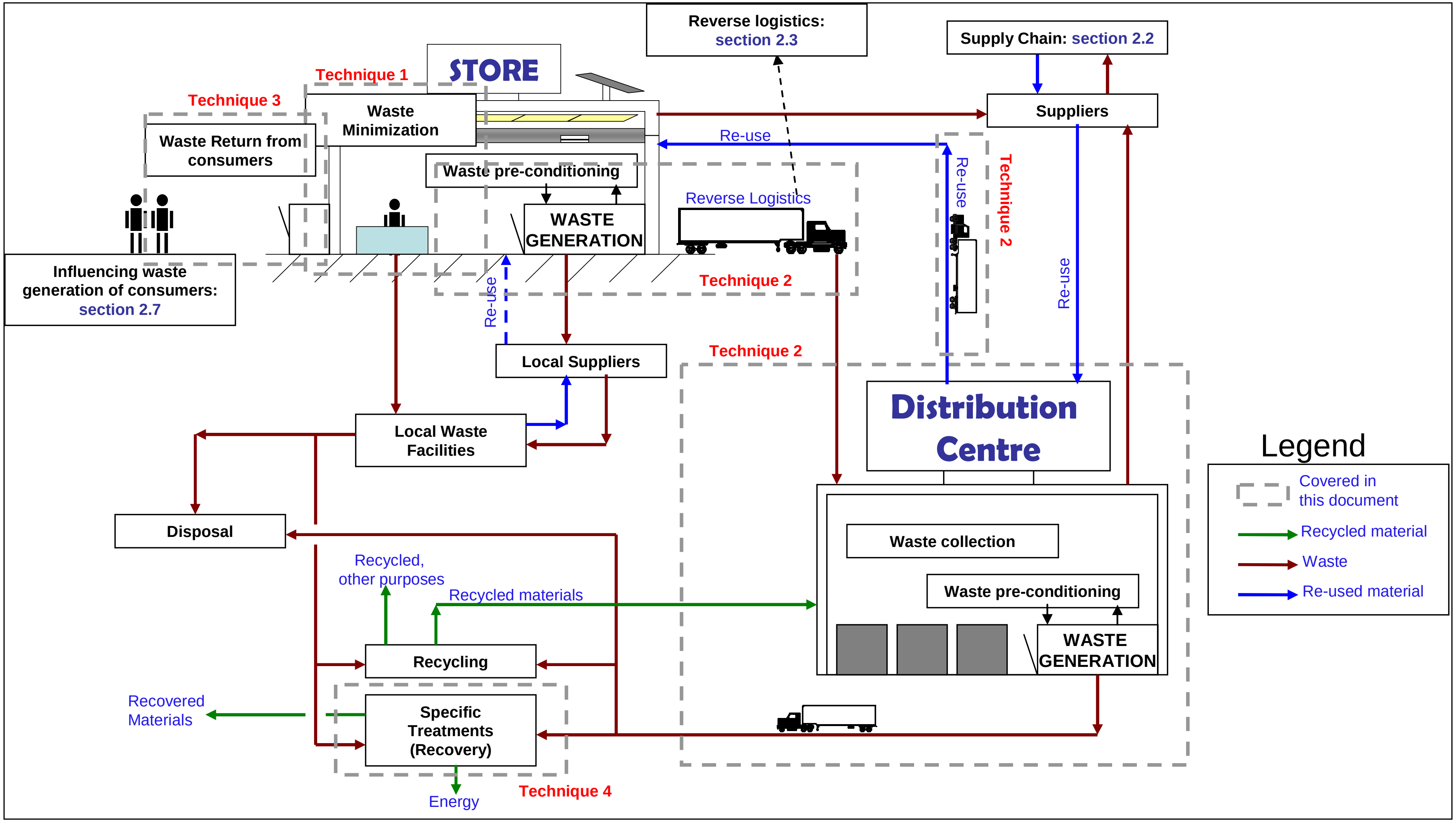


Figure 2.108: Simplified waste flow chart of retailer activities.

2.4.6 Best environmental management practices

2.4.6.1 Food waste minimization (prevention and recovery)

Description

The amount of waste generated by retailers is significant and relevant for the environmental impact of retailers. For non-food retailers, wastes are usually coming from packaging materials, as paper, cardboard or plastic, while the other most important fraction is municipal solid waste (MSW) for disposal. Food retailers are producing three main types of wastes, with a varying distribution as a function of different sales concepts and management schemes: organic or food waste, packaging materials (plastic, paper, cardboard, metal, glass, etc.) and the remaining fraction is usually considered as MSW for disposal but with a non-negligible part composed of hazardous wastes.

The aim of this section of the document is to describe best practices carried out by food retailers in minimisation of waste. The effort already made by retailers on preventing the use of packaging materials and their reuse and recycling is huge. As seen in Figure 2.104, the rate of waste recycling for packaging materials is higher than 60% for most of the analyzed examples.

There is an important concern about food waste generation. In the UK, 115 kg of food waste is thrown away by households, from which 70 kg were avoidable (WRAP, 2008). As indicated above, a report from BioIS, published in 2010, estimates that in the UE, an average of food wastes 180 kg per capita an year, from which 4% are generated by retailers (BioIS, 2010). According to the figures of this report, the retailers are generating 1 kg of food waste per each 10 kg generated at households. The environmental consequences of the generation of food waste are relevant, but the ethical implications of avoidable waste are very serious: in the UK, one third (by weight) of the purchased food is thrown away, the 61% of the total food waste is perfectly avoidable and other 20% is potentially avoidable. This example from the UK has also a very important economical impact: EUR 565 is lost per household and year or more than EUR 200 per capita per year.

Regarding food waste, retailers should prevent the generation of food waste at stores and distribution centres, but should also take the chance to influence their supply chain and to help customers to consume foodstuff with a minimum generation of avoidable food waste.

One of the concerns is how to define food waste. From a technical point of view, it would not be waste till it overpasses its use-by date. For foodstuff that fits to human consumption, not saleable food or surplus food are preferred terms. This fraction of foodstuff is produced within retailers operation because of several reasons: mislabelling, order cancelation, end-of-line runs, out-of-date promotions, damaged or incorrect packaging seasonal ordering, over ordering, new product testing, manufacturer errors, insufficient shelf life, unpredictable events (weather changes, incorrect quality), transit damaging, etc. An important fraction of this surplus or not-saleable food would become food waste under the responsibility of retailers.

Table 2.83 shows a set of example actions to be implemented by retailers (in their operations or by influencing others) to minimise food waste generation in all the elements of the product chain, from producers to consumers. In the table, there is an indication of the techniques already covered by this document. Nevertheless, only a few are covered by this section, as many others are already covered in other sections or are out of the scope. The attention in this section was focused on the prioritization of food waste management, food conditions control (temperature and humidity) and the correct management of refrigerated or frozen food. Next described practice, in section 2.4.6.2, explains how to integrate several waste management techniques that also influence food waste management, as monitoring, establishment of local partnerships or joint initiatives with supplies, other retailers, municipalities, consumers, etc., and the training needs of staff.

Table 2.83: Set of example actions taken by retailers to prevent food waste in whole product chain (from suppliers to consumers)

Who?	What?	How retailers can influence/act?
Suppliers / contractors	Minimise food waste by maximizing quality and green sourcing	Setting minimum criteria for the quality of food or demanding the fulfilment of standards (section 2.2) Controlling strictly temperature and humidity of sensitive foodstuff (this section) Checking and/or monitoring waste generation (section 2.4.6.2) Helping to set a list of priorities on food waste management and implementing the means for each alternative (this section) Establishing joint or partnership initiatives with local or regional suppliers (section 2.4.6.2) …
Distribution centres	Minimising food waste by best monitoring and management	Controlling strictly temperature and humidity of sensitive foodstuff (this section) Monitoring sell-by, use-by dates and food waste generation (section 2.4.6.2) Setting priorities to food waste management and implementing the means in joint or individual initiatives (this section) Increasing the rate of refrigerated food taking into account energy efficiency issues (this section) Increasing the rate of better-preserved food or foodstuff with less chance to become waste (this section) Returning low quality products (section 2.4.6.2) …
Stores	Minimising food waste by fitting orders to consumption	Ordering just-in-time and purchasing plans (out of scope) Controlling strictly temperature and humidity of sensitive foodstuff (this section) Returning low quality products (section 2.4.6.2) Monitoring sell-by, use-by dates and food waste generation (section 2.4.6.2) Setting up priorities to food waste management and implementing the means in joint or individual management practices (this section) Increasing the rate of refrigerated food taking into account energy efficiency issues (this section) Increasing the rate of better-preserved food or foodstuff with less chance to become waste (this section) Training staff for avoiding food waste generation (section 2.4.6.2) …

Who?	What?	How retailers can influence/act?
Customers	Minimising food waste by informing customers	Providing reliable information at product/store about the environmental performance of products with labels including also food waste generation (section 2.7) Providing reliable information at product/store about the best food conservation (section 2.7) Training staff to help customers in food preservation (section 2.4.6.2) Advertising responsibly (section 2.7) …

Setting up a list of priorities

Retailers should set a list of priorities in the management of food waste. Figure 2.109 shows an example of list of priorities (Alexander et al., 2008 and US EPA, 2006) Retailers should decide the best ways to prevent food waste generation.

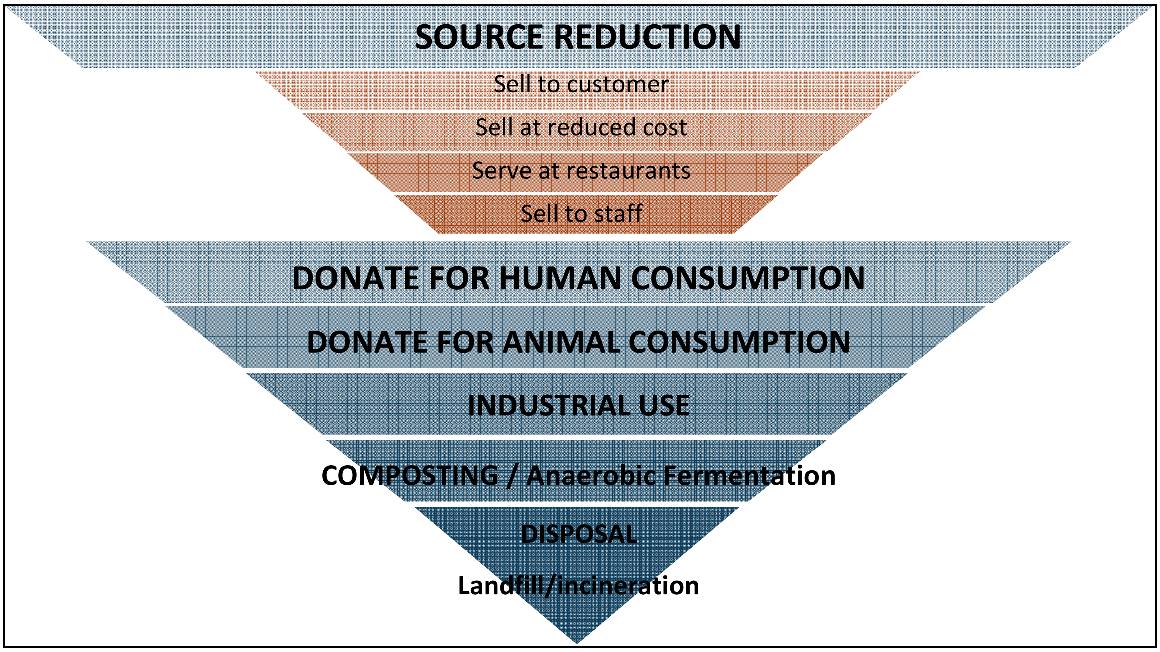


Figure 2.109: Example of food waste management priorities for retailers

As shown in the figure, the priority should be to sell to customer before the sell-by date. If this is not possible or wastes are generated by product damaging, a variety of options are opened, as selling at reduced cost, serve at restaurants, sell to staff, etc. These options seem to be standard for food products exceeding their sell-by date. It is highly recommended that retailers focus on the logistic aspect, trying to fit orders to consumer purchases instead of using other mechanisms. Reduced costs of foodstuff can be associated to low quality food (especially for food with damages and fresh food). As well, quality issues at restaurants can make the use of food exceeding the sell-by date difficult. Retailers using these mechanisms to manage foodstuff, should assure that a real food waste reduction is being achieved. Re-allocating food waste should be avoided: for instance, when selling to staff, a minimum quality should be required in order to avoid generation of the same food waste quantity at staff households. As well, the use of cost compensation mechanisms (to balance, for instance, thefts) should take into account food waste generation.

Donation is, sometimes, a conflicting aspect of foodstuff exceeding the sell-by date but not the use-by date. Many retailers donate food to NGOs and charitable organisations and this is performed usually at local level. So, it is a concern of store managers. Technically, food not exceeding the use-by date is not waste and should not be treated as such. The preferred term would be surplus food. If it is not saleable, one of the most important routes for these products is donation. Then, production of food waste would be avoided and the image of retailer can be enhanced due to its participation in food banks schemes at local level and can change the status of a retailer store at community level. There are retailers proud of this donation scheme, like Sainsbury in the UK, collaborating with FareShare and others in providing surplus food, and COOP in Switzerland reports their efforts in food donation to several Swiss NGOs, as Schweizer Tafel and 'Tischlein deck dich'. Mechanisms for donation are diverse and food banks are usually established at local level by public or private initiatives.

Nevertheless, organisational tensions can arise at retailers donating food. Alexander et al., 2008, summarize these tensions in three arguments against food donation from retailers:

- donation moves oppositely to profit maximisation
- donation relaxes food waste prevention
- donation makes brand image less controllable.

These aspects, argued by some retailers, are not totally accurate, as best management practices would often produce opposite results. The just-in-time or fit-to-purpose deliveries are convenient schemes for avoiding food waste. Nevertheless, there would be always surplus food, as unpredictable events and market volatility are taking place. So, any food store will have a certain generation of non-saleable foodstuff per year. This fraction would become food waste if no means are implemented to avoid its production: return to suppliers is possible for some products (milk and dairy products) but for many others it would not be possible. Food waste management costs are relatively high (close to EUR 100 per ton). Then, food donation can be a reliable mechanism to prevent waste but also to improve waste management economy. Then, charitable organisations would benefit from integrated food waste prevention policies, as they become an important element on the management of unavoidable surplus products. So, there is not any bad donation, but inadequate management. Brand image control is out of the scope of this document. Sustainability reports from some retailers use food donation as an example of their social responsibility. An important number of retailers are providing surplus food to charitable organisations, but many do not report it or do not want to use this activity as an example of responsibility. An argument for that is, mainly, that uncontrolled disposal of branded products would affect the image aspects regarding to quality, freshness and reliability. Some retailers are establishing strong rules to the use of their products by charitable organisations, in order to avoid inappropriate disposal (Alexander et al., 2008). As well, legal aspects of food donation may be not properly covered by retailers and by NGOs and charitable organisations (Sciencia et al., 2010).

Donation for animal consumption should be done if food is no more suitable for human consumption. Then, two kinds of donations are detected: those for animal sanctuaries and those for animals in farms, with the objective of food production (meat, milk, etc.). For both cases, minimum quality requirements should be accomplished. Figure 2.110 shows bread leftovers used to feed cattle.

Figure 2.110: Bread leftovers used for cattle feeding

The rest of priorities are focused on treatments for food waste, so they have an associated cost for the waste producer (in this case, retailers). Examples of industrial uses are, for instance, biofuels production or anaerobic fermentation to produce biogas. Composting and, preferably, anaerobic fermentation would close the organic material cycle by creating a nutrient amendment for soils. The very last option should be disposal of food waste (landfill or incineration).

Improving product preservation

In a study assessing North American stores (Nunes et al., 2009), poor temperature control of fresh and refrigerated food was found to be the major cause (55%) to produce food waste or not-saleable waste, while expire date products or waste products account for the rest. Following this study, fresh food is usually not managed properly regarding to temperature and relative humidity control. This aspect is really important for fruits and vegetable: they should be preserved in a temperature allowing preservation but also avoiding chilling injury. As well, relative humidity should be high (around 90%) but not much higher as it can drive faster decomposition, while water losses from 3 to 6% can affect drastically the appearance of fruits and vegetables and reduce the sales due to less weight per piece.

Incorrect temperature and humidity management may occur all over the supply chain, from the producer to the consumer and with an important role from retailers. Best temperature and humidity control can reduce the amount of food waste up to 55% in retailers, but also well preserved food increases sales and reduces food waste generation at households.

The influence of food preservation is significant concerning the environmental impact of products, especially regarding to food waste generation, at retailers and at households. The improvement of food preservation will allow reducing the overall environmental impact through less food waste generation but, also, all the environmental impact associated to the life cycle of food products (Weidema et al., 2008). The mechanisms to reduce the rate of food generation are usually demanding a higher amount of electricity: refrigeration, vacuum packaging, etc. Refrigerated food is the preservation technology that would fit best preservation needs in order to eliminate food wastes. Reducing temperature for meat conservation to 0 or 2ºC and increasing the purchases of refrigerated food would help to prevent food waste generation at households but:

- The consumer behaviour is affecting significantly this issue, as food handling at households could not be optimal and the cold chain can be interrupted. As well, consumer demands higher amounts of fresh food. So, the educational role of retailers is influencing this aspect.
- Refrigerators and other domestic appliances do not work at temperatures from 0 to 2ºC, except for some brands including fresh food conservation storages (usually for meat and vegetables).

- Better food preservation is one mechanism to avoid wastes in households, but not the only one. Better purchases planning and behavioural changes are needed.

Achieved environmental benefit

Best practitioners generate less than 10 kg of food waste per m^2 of sales area and year. The environmental benefit of reducing food waste is significant, as it is affecting direct and indirect aspects of food retailers. First, the environmental impact of food waste management is avoided, as its storage, treatment and/or disposal. This would have a direct economic impact, as treatment costs are avoided and, in case of selling, purchasing costs are saved.

Secondly, all the indirect impact derived from product life cycle is avoided: raw materials, land use, fossil energy, carbon footprint, etc. For example, (Weidema et al., 2008), report 28 kg of equivalent CO_2 per kg of beef consumed. This means that a retailer reducing 3 kg of meat waste per m^2 of sales area and year would reduce the carbon footprint of the food chain by 85 kg of CO_2 per m^2. This reduction is really relevant if compared to direct and indirect CO_2 emissions of refrigeration systems at supermarkets, which is about 150-200 kg of CO_2 per m^2. The same calculation can be done for non-renewable energy use in beef life cycle: 77 kWh of primary energy per m^2 and year can be avoided per kg of avoided beef waste. For perishable food, a balance between impact of new preservation mechanisms (e.g. more refrigerated products) and the relative benefit should be accomplished. Am extension of the shelf life of refrigerated meat, fruit or vegetables at households would produce a significant reduction of food waste and a significant reduction of the environmental impact (even if electricity consumption balance is accounted for short shelf-life extensions).

Appropriate environmental indicator

The most appropriate indicator for managing wastes is weight, which can be given in a 'density' format, as the specific annual waste generation in kg per m^2 (sales area). Total waste generation should be also controlled. For instance, for retailers managing a number of stores, waste generation in kg per store and year can be an indicator to control wastes, although the size of the store is not being taken into account. For food waste, the amount of waste generated per turnover unit (for instance, in EUR million) is also a good indicator, which allow to assess waste impact on the company economics (see Figure 2.104 and Figure 2.105).

The most sensitive aspect is the waste monitoring system, which has to be integrated in the usual inventory of aspects to be monitored at the environmental management system. This system should differentiate among different type of wastes. A recommended category would be food waste, which can be defined in subcategories (e.g., per product group). The scope of food waste category should be the foodstuff managed as waste at stores (avoidable, unavoidable, animal by-products, compostable, disposed, etc.). All those non-saleable items not treated as food waste and intended for human or animal consumption (for instance, donations) should not be monitored as waste.

For accounting the area of waste generation, sales area is preferable for stores. No correction on time accounting is recommended, even though opening hours vary across Europe.

Cross-media effects

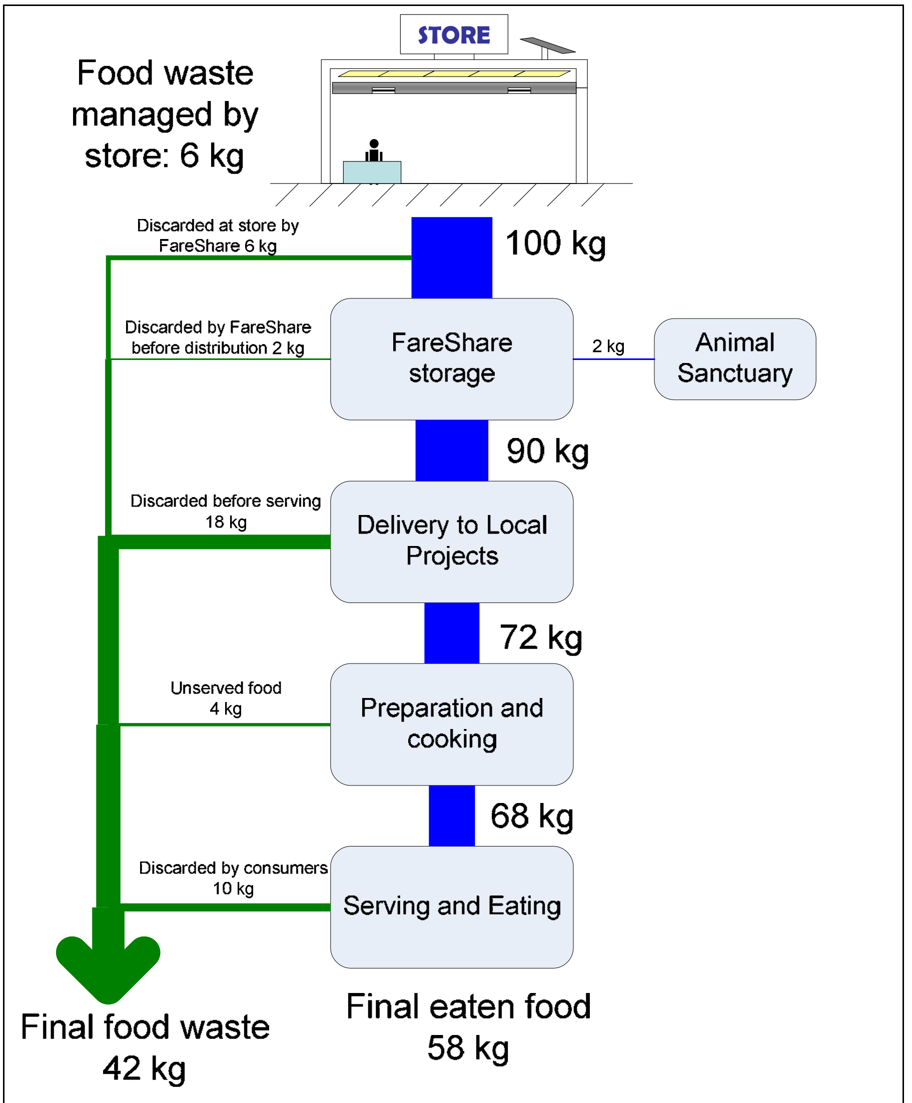
Less food waste at stores has a direct impact on retailer economy, as there are less economic losses. Less food waste has also a direct impact on the environmental performance of the retailers: less energy would be consumed per product transits and less energy per product would be consumed at stores. Brand image damage would be avoided through less inappropriate disposal.

If preservation technologies implementation is promoted, there would be higher consumption of electricity due to refrigeration or other associated processes. The extra consumption would be lower than the avoided impact of the product life cycle although it depends on the expected extension of the shelf life of the product.

Operational data

As already mentioned above, surplus food is unavoidable as an important influence of unpredictable events are influencing its generation. In-house prevention mechanisms through improved logistics, improved inventory control, staff training, etc., are common practices in retailers not only to avoid food waste but also to control their activities.

When surplus food can not be sold, retailers may choose not to treat them as wastes yet by different mechanisms that they can prioritize. One important practice in this priority list is food donation for human consumption. Figure 2.111 shows a flow chart of the food donation case study of a retailer in the UK (Alexander et al., 2008). As observed, food donation avoids direct management of 94 kg per 100 kg of food donated. Nevertheless, donation food chain is still generating about 42 kg of food wastes, which are not under direct responsibility of retailers. Globally, food waste generation is reduced by 58%. Nevertheless, all non-saleable food can not be donated, due to health risks derived of products exceeding their use-by date. Store managers should watch for the best achievable quality of food donations.

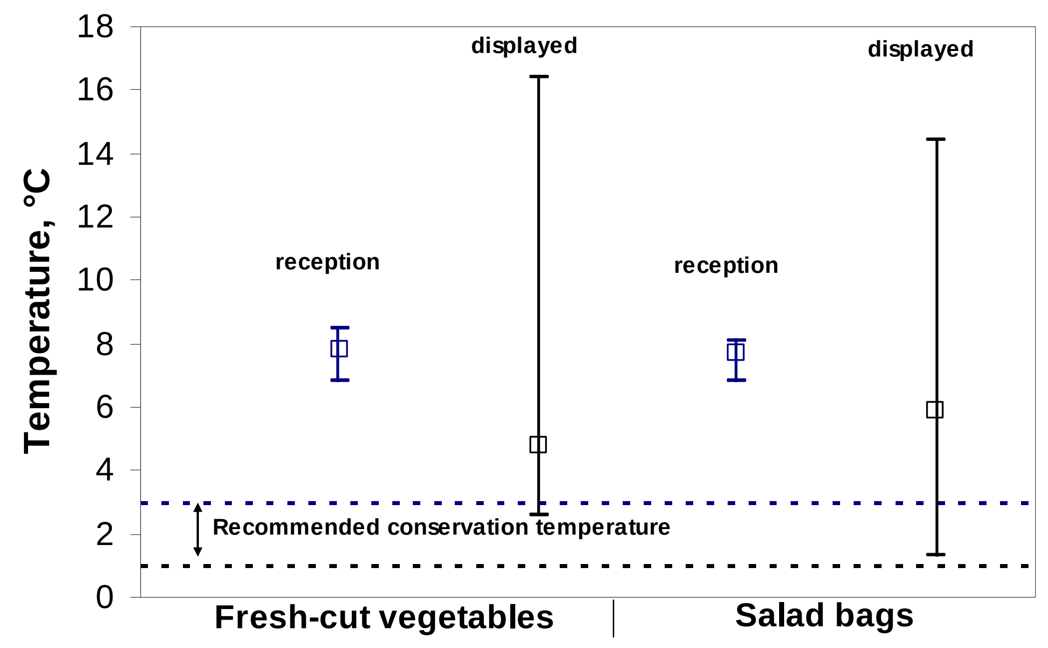


Source: Alexander et al., 2008

Figure 2.111: Flow chart of a food donation case study

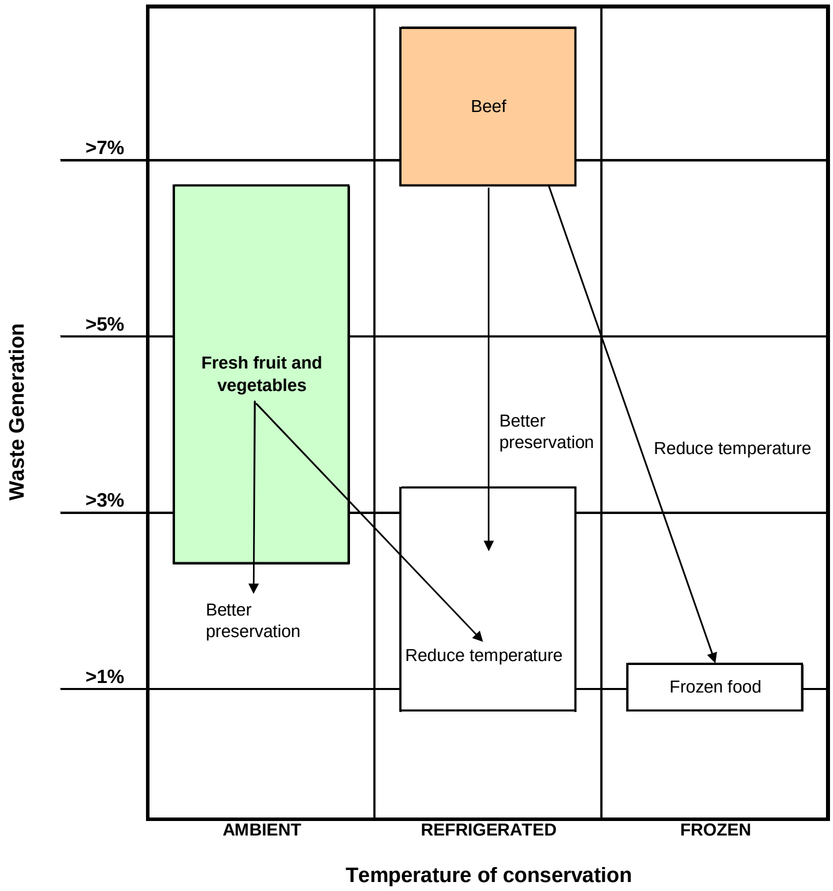
Temperature management is very important in order to minimize food waste. Nunes et al., 2009, provides an important number of examples of badly performed temperature control for fresh fruit and vegetables. Figure 2.112 shows the low, high and average values of fresh-cut vegetables and salad bags at their reception and at their display at stores.

As shown, recommended practice with fresh-cut vegetables and salad bags is to refrigerate to temperatures of 1-3 °C to achieve a better preservation, not only to avoid food waste generation but also to reduce health risks and to preserve their properties. Retailers tend to offer these products as fresh, not as chilled products. Then, these products are received at temperature over recommended value and, then, retailers offer them in a variety of conditions, since fresh products, at ambient temperature, to refrigerated and packed products, as it can be shown in Figure 2.112). Following the study of Nunes et al., 2009, more than 55% of the food waste generated at stores is caused by bad temperature control. In this study, there is not a deeper research on how the food waste generation rate is affected by temperature conditions at stores' display. About generation rate, Mena et al., 2010, performed a survey in several stores in UK and Spain and they draw the chart shown in Figure 2.113 (only fresh fruit, vegetables and beef are shown).



Source: Nunes et al., 2009 and own elaboration

Figure 2.112: Temperature at reception and shelf display for fresh products



Source: Mena et al., 2010 and own elaboration

Figure 2.113: Rate of waste generation of fresh fruit and vegetables in retailers and potential improvements through better preservation and reduced temperature

As shown in Figure 2.113, the generation of food waste can be avoided through reducing the temperature of presentation at store. As well, better packaging (vacuum and others) can be an effective way to reduce food waste without changing preservation temperature. These practices have two opposite effects: the increase of energy consumption due to larger needs of refrigeration and the trend of customer to purchase fresh food (packed food and refrigerated food are excluded from the consumer view of fresh food).

Applicability

All food retailers can apply described management practices to avoid food waste generation.

Economics

Costs reduction through food waste management is evident. Food waste treatment varies, but can be higher than EUR 100 per ton plus the value of the non-saleable food to be considered as a waste. WRAP study at UK estimates the value of food waste as EUR 1760 per ton. Then, the economic impact of food waste generated at retailers would be significant. A standard supermarket of 1000 m^2, generating 10 kg per m^2 per year of food waste, is producing ten tons per year of food waste, i.e., almost EUR 19000 per year. If the food is donated, EUR 1000 could be saved and more than 10 persons could have been fed the whole year (taking into account the food waste generation rate of the donation scheme shown in Figure 2.111).

Driving force for implementation

Food waste minimization has a direct positive impact on costs and environment. The reduction of waste generation would avoid the impact of food environmental footprint, which is very important, and the impact from its treatment. Important costs savings would be produced through less losses and less waste sent to treatment. As well, better reputation and better response to existing or future regulations are also relevant drivers.

Reference retailers

Many retailers are providing surplus food to donation schemes. This issue is frequently managed locally. Retailers do not provide much information on the food they donate, even if they are advertised by charitable organizations.

Sainsbury, in the UK, is applying food donation since 1998. More than 800 stores are providing surplus food to local projects and also to FareShare. According to Sainsbury Corporate Responsibilty Report 2010, they reduce waste sent to landfill, build stronger relationships with local charities and get a better understanding of some of the issues in their community. Coop, in Switzerland, reports that they donate more than 1000 tones per year to Schweizer Tafel and Tischlein deck dich to around 500 social institutions.

About food preservation, there are many examples on retailers implementing better conservation routes. For instance, Lidl offers meat and meat products at a temperature of 3C. Swiss Coop, for instance, is offering meat at 1-2 °C only in covered cabinets to reduce the risks of variable temperature.

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2.4.6.2 Integration of waste management in retailers activities

Description

The integration of waste management in retailers' activities is a standard practice across all retailers in Europe but with different levels of implementation. It is already covered by environmental management systems (EMAS, ISO or other individual management systems). Retailers are mainly focused on the management of the packaging material, as there is an increase interest on the recycling or re-use of packaging materials because it causes important costs savings and reduces substantially waste generation. The recycling rate is high (see Figure 2.104). Nevertheless, specific waste generation is also high, and the impact of waste management is environmentally and economically relevant.

Among many different common standard practices, some of these have been identified as outstanding management techniques for wastes. In the list below, distinction between in-house practices (at stores) and retailers' activities (e.g., from stores to facilities, distribution centres or suppliers) has been done:

In-house management practices:

- segregated collection and specific treatment for re-use: compacting, briquetting for paper and plastic wastes, refrigeration of food wastes, etc.
- monitoring of waste production
- preparation for re-use of packaging materials, as pallets and plastic boxes for suppliers, distribution centres, showcases at stores and home delivery
- staff training.

Retailer management practices:

- monitoring of wastes generated by stores per category and per final destination
- implementation of reverse logistics for the management of packaging materials (to be re-used or recycled), WEEE and other wastes (as hazardous wastes) to suppliers, treatment facilities and/or distribution centres
- establishment of local and/or regional partnerships for the management of wastes
- communication to consumers of responsible management of waste at households (section 2.7).

<u>In-house management practices</u>

The best management practice and the first priority of retailers should be waste reduction through prevention. In section 2.4.6.1, there are described some practices regarding to food waste prevention, which can be also applied to any kind of product and for any kind of material, as, for example, packaging. Strict control of inventory, control of sell-by dates, fitting orders to consumer demands are example of these practices. For packaging materials, re-use is the most important practice to reduce packaging wastes. Plastic boxes, pallets and other systems should be re-used as far as possible to avoid waste generation.

Waste collection, separation, sorting and other operations at store level are influencing the generation of wastes. Examples of mechanisms to achieve high environmental performance in these operations are:

Supply chain and local suppliers' involvement: generation of packaging wastes depends on how the product is delivered to the store and/or to the distribution centre: then, the returning of reusable packaging materials to the supplier should be implemented. As well, the weight of packaging materials, their recyclability and their re-integration in the supply chain should be also regarded as a supplier concern to which the retailer may contribute.

Facilities and enhanced management capacity: through the implementation of facilities at stores to manage wastes with the correct capacity would avoid inadequate disposal practices. Allocating staff resources to waste management is also quite important for this issue.

Staff training and awareness should be appropriate. Managers should consider 'less waste' as a source of 'more profit' in addition to 'better environment'. Employees should not regard waste collection and sorting as a secondary (even avoidable) task. An aware, well trained employee would also help to establish better communication channels with customers.

Table 2.84 shows some pictures taken during technical visits made for the development of this document. As already explained in the introduction section, the sector is performing well and the recycling rate is relatively high. Although some good and bad examples can be identified through the pictures, the purpose of the table is only to show examples of current management practice.

Table 2.84: Example pictures of some waste management practices at European stores

Picture	Comment
	Non-segregated food waste in municipal solid waste (MSW) bins. Packaging material also disposed in these bins.
	Unsorted plastic packaging material disposed in MSW bins.
	Outdoor waste sorting: pallets and plastic boxes, plastics and paper and cardboard.
	Indoor waste sorting: categorized and covered bins for several kinds of materials. The one covered with a black bag is considered as MSW.

	Compacted paperboard wastes
	Refrigerated food wastes: a small fraction of cold rooms employed for this purpose avoids healthy problems and improve the recovery of this waste fraction.

Reverse logistics

The implementation of new directives, as the one for WEEE and the directive on packaging and packaging materials (see section 2.4.2) stimulated actors in the sector to develop take-back systems and reverse logistics for the better management of wastes (Cherret et al., 2009). There is an increasing complexity in normal and reverse logistic operations. The integration within the supply chain is essential for the achievement of high recovery rates, as re-use or recycling of materials may have impacts on different stages of the supply chain. For example, recycling of materials would affect the consumption of resources, but some operations affecting preparation for re-use, as refurbishments, cleanings, repairing, etc., could make the re-used product to enter at different stages.

Two main organisational systems are identified: centralized and decentralized systems. In the centralized reverse logistics, one organisation is responsible for all the operations: collection, inspection, disposition or redistribution, while the decentralized system means that every store would be the 'gatekeeper' in charge of product inspection, testing, redistribution, etc. According to (Cherret et al., 2009) and (Tryantafyllou and Cherret, 2010), four physical networks are identified in the current practice:

- Integrated outbound and returns network: a retailer use its own fleet or logistic providers to return wastes from stores to a regional distribution centre. This system fits to the need of retailers with a high frequency of delivery (e.g., food retailer with an important number of stores).
- Non-integrated outbound and returns network: a third party is taking wastes to a third location, but the retailer is in charge of gatekeeper activities (inspection and testing).
- Third-party returns management: a third party is undertaking all the activities and no expertise on inspection and testing is needed at retailers
- Return to suppliers: return of products directly to suppliers has higher costs and higher impact due to transport. Nevertheless, it is regarded as a solution for some retailers managing a low volume of high added value of products.

Many big retailers with an important number of stores and regional distribution centres manage their wastes using reverse logistics. Table 2.86 shows some examples taken from technical visits to distribution centres, which manage waste generated at stores.

Table 2.85: Example pictures of some waste management practices at distribution centres of retailers in Europe

Picture	Comment
	Waste and packaging truck delivery from a store to the distribution centre.
	Waste delivery from distribution centre to treatment facilities by train. Pallets and other packaging materials return to suppliers also by train.
	Metal waste sorting container.
	Collected and separated appliances (washing machines, fridges, etc.). Each item is labelled with the origin of the waste.

	These covers are used when a refrigerated food waste is being transported back by a non-refrigerated truck.
	Plastic boxes reused at store to pack new deliveries.
	Wood and other wastes for incineration. The wastes with the black covers coming from the stores are not manipulated in the distribution centre. This is the fraction assumable as MSW fraction for disposal.
	Paper and cardboard sorting and compression at a distribution centre.
	Sorting of wastes from stores at a distribution centres. In the picture, showcases and cabinets.

	The trucks coming from the stores are also used to deliver mail to/from the distribution centre.

Establishment of local partnerships
For SMEs, concerning stores at commercial centres, at the same street or within the same economic activity, it would be of great advantage to form joint partnerships, even integrated with domestic waste collection systems, to reduce the amount of landfilled or incinerated wastes. Coordination of this can be made through local public administrations or by private initiatives. This issue can be really important for hazardous waste, where retailers produce a low quantity (but non negligible), with expensive management costs. The benefit is dual: less costs derived from waste management and better environmental performance, as these systems increase collection and recovery rates.

Monitoring
A main principle of environmental management is "you cannot manage what you cannot measure". Retailers should implement a standardized monitoring practice, controlling the amount of wastes generated. A procedure for accounting wastes should be established to harmonize the environmental accounting. A waste audit should be performed during environmental performance audits, although it can also be recommended to maintain a periodic register which allow retailers defining targets and setting benchmarks, while it also allows retailer to redefine environmental policies or implement facilities for uncovered needs. Store managers and staff should be directly involved in the monitoring and registration system. Retailers should define waste categories, for example: food waste and by-products, paper and cardboard, plastic packaging, metal, WEEE, hazardous wastes, fraction presumed to be municipal solid waste, etc. As well, the destination of each waste type should be, at least, monitored: reused, recycled, composted, fermented, incinerated, landfilled, etc.

Achieved environmental benefit
An average retailer can generate more than 30 kg of packaging wastes per m^2 of sales are and year. Less wastes production would reduce the impact of the final disposal or treatment of wastes, but also avoid the embodied environmental impact of the materials being lost as wastes. Table 2.86 shows the embodied energy of some classical waste materials (paper, PET and non-ferrous metals), which is the energy consumed to produce one kilogram of the material. If the waste material is landfilled, the overall energy consumption of its life cycle would be higher than if it is recycled, as this last option subtracts the amount corresponding to the avoided material production.

The same is done for the associated CO_2 emissions of landfilled and recycled wastes. In Table 2.86, it is also shown the amount of energy and CO_2 which can be avoided per m^2 of sales area if the waste material recycling rate passes from 40% to 70%. It is noticeable the great amount of energy that could be avoided by increasing the recycling rate: in the example shown in the table below, around 65 kWh/m^2 could be saved, which is very relevant if compared to the energy consumption of the refrigeration system (around 300 kWh/m^2) or to the HVAC system (around 100 kWh/m^2). The numbers of specific energy consumption per kg of material and specific CO_2 emissions per kg of material were taken from Browne et al., 2009, which correspond to a global average. The case of Table 2.86 is an example: for the calculation of more accurate figures at stores, retailer and local circumstances should be assessed.

Table 2.86: Embodied energy consumption and associated emissions of usual waste materials

	Total Embodied Energy of Landfilled waste	Total Embodied Energy of recycled material	CO_2 emissions of landfilled waste	CO_2 emissions recycled waste	Example of waste generated at a retailer store	CO_2 emissions avoided at 70% recycling,	Embodied energy avoided at 70% recycling
	kWh/kg_w	kWh/kg_w	$kgCO_2$ eq $/kg_w$	$kgCO_2$ eq $/kg_w$	kg_w/m^2	$kgCO_2$ eq $/m^2$	kWh/m^2
Paper and Cardboard	12	7.9	0.735	0.49	40	**2.9**	**49**
Plastic (PET)	16	9.1	1.02	0.56	3	**0.4**	**6.7**
Metal	25	4.5	1.1	0.28	1.5	**0.4**	**9.2**

N.B. Starting point: 40% of recycling rate for each material.
Source: Browne et al., 2009 and own elaboration

Appropriate environmental indicator
The most appropriate indicator for managing wastes is weight, which can be given in a 'density' format, as the specific waste generation in kg per m^2 (sales area). Total waste generation should be also controlled. For instance, for retailers managing a number of stores, waste generation in kg per store and year can be an indicator to control wastes, although the size of the store is not being taken into account. For food waste, the amount of waste generated per turnover unit (for instance, in EUR million) is also a good indicator, which allow to assess waste impact on the company economics.

For compacting and briquetting operations it would be very useful to control the density of wastes (kg/m^3) and/or measure the amount of wastes generated in volume units (especially for low density waste fractions). It would be also related to the efficiency of the transport mode (see section 2.3.4.7)

The most sensitive aspect is the waste monitoring system, which has to be integrated in the usual inventory of aspects to be monitored at the environmental management system. This system should differentiate among different type of wastes, which can be also defined per subcategory or e.g. per product group.

For accounting the area of waste generation, sales area is preferable for stores, with corrections as function of height where appropriate. No correction on time accounting is recommended, even though opening hours vary across Europe.

Cross-media effects
Waste management interacts with other management structures, as transport and logistics, supply chain and relation with suppliers, relation with consumers, image and reputation etc. Nevertheless, the improvement in waste management would not reduce the performance of any other activity and can improve business performance.

Operational data
Triantafyllou and Cherret (2009) proposed the flowchart shown in Figure 2.114. These authors assessed one commercial centre by means of surveys. They characterized a total waste flow of 725 m^3 per week generated by a commercial centre in Southampton, UK. More than a half was cardboard, which is collected in bales once per month and sent to a recycling facility 265 km far. The fraction assumable as MSW was about 31% (227 m^3) and was managed by a third-party logistics company. These wastes are collected weekly (or fortnightly, depending on the yard) and shipped to a local energy facility, 12.3 km far. Plastic wastes are 8% of the total and are shipped to a recycling facility 275 km far and mixed paper (office paper) accounted for 5% of the total and is shipped once per month to the same facility as for cardboard, 265 km far. The

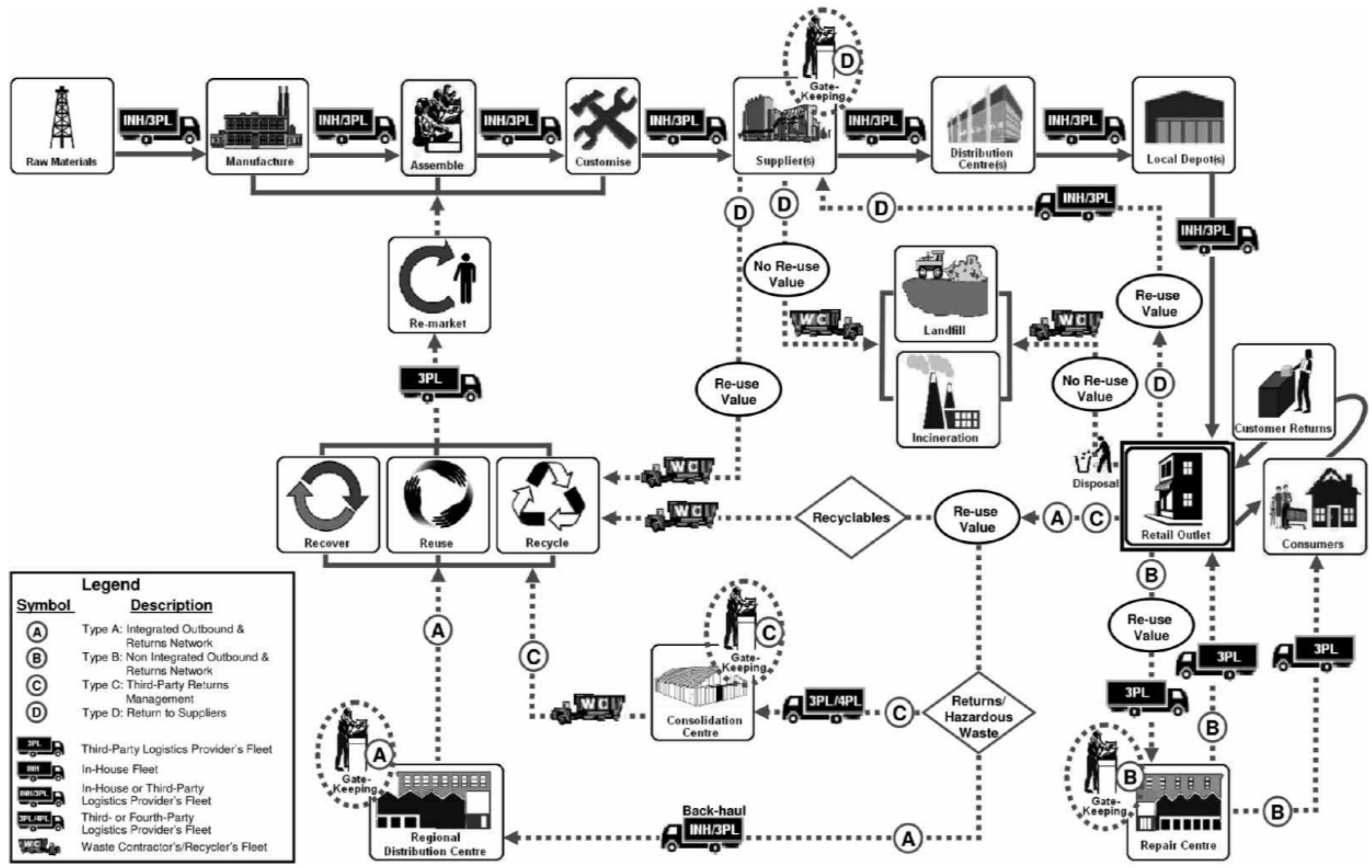
shopping centre hazardous wastes are 0.1 % of the total, consisting of WEEE, fluorescent tubes, cooking oil and clinical wastes.

The distance covered by shipped wastes may be also an indirect concern for retailers, as the accumulated distance from treatment facility to other points of the supply chain or to other treatments are usually long for wastes. (Triantafyllou and Cherret, 2009), detected shipments longer than 2000 km (to Sweden) for components of fluorescent lamps and more than 8000 km for some metals (delivered to China). Shipments of wastes have an unquestioned environmental impact, even if high recovery rates are achieved. As an example, the data of exported waste from the Irish National Waste Report from the Environmental Protection Agency in 2009 and the amount of tonne km are shown in Table 2.87.

Table 2.87: Tonnes of exported wastes from Ireland in 2009 and total estimated tkm (tonne km)

Country	**Average Distance (km)**	**Paper and Cardboard (tonnes)**	**Glass (tonnes)**	**Metals (tonnes)**	**Plastic (tonnes)**	**Organic (tonnes)**	**Total (10^6 tkm)**
UK	287	146250	74642	38433	29298	5478	84
China	10135	109234					1100
Belgium	856	86516			10217		83
Holland	925	15718	32345	4042		134	48
Asia	9120	40360		240	9474		457
Unknown	-	48820		10	781		Unknown
India	7910	26725		356			214
Europe	1885	22988			148		44
Spain and Portugal	1476			13608			20
France	1059	7488		788			9
Germany	1266	88			25	30	0.2
Pakistan	6610	76		50			0.83
Total	-	504243	106988	57527	49943	5642	**2070**

As shown, total impact of exported waste is really high. Taking into account the most environmentally friendly transport modes (see Table 2.74); the total generation of CO_2 is higher than 28 kg of CO_2 per exported tonne.



Source: Tryantafyllou and Cherret, 2010

Figure 2.114: Flowchart for recovery of materials and wastes and their re-incorporation in the supply chain

Applicability
The described techniques are applicable to any retailer. Some of the described techniques are suitable to retailers managing an important number of stores and distribution centres.

Economics
Prevention and minimization of waste generation has a direct economic benefit, as no disposal or treatment cost would be derived from a non-existing waste. The allocation of resources to the effective reduction of waste would be economically justified.

No data are available for waste management through reverse logistics, but, apart from the environmental benefit, bulk transportation back to distribution centres would allow the reduction of the treatment cost if it is compared to the costs negotiated at local or store level. For retailer producing electrical and electronic equipment, the role as a gatekeeper (testing, inspection and potential reuse) would have higher costs than usual bulk transportation (Walther et al., 2010). Bulk transportation would cost about EUR 13 per ton, while transportation with conservation devices (e.g. with protective boxes) would cost more than EUR 36 per ton, although some return from sold reusable equipment can be highly beneficial for the company.

About the costs of joint initiatives for wastes management among stores and supermarkets, one example comes from the US: a joint partnership, established to manage wastes, called Supermarket Recycling Program Certification (US EPA, 2006) achieved recycling rates of 60-75% (average of 65.9%) and costs savings ranging from EUR 2300 to EUR 15000 per store (average of EUR 3300). The assumed costs for food waste disposal were up to EUR 77 per tonne.

Driving force for implementation
Waste minimisation has a direct positive impact on costs and environment. The reduction of waste generation would avoid the impact of products environmental footprint, which is very relevant from a life cycle perspective. Important costs savings, better management structures, better knowledge would be produced through improved waste management. As well, better reputation and better response to existing or future regulations are also relevant drivers.

Reference retailers
For the development of the document, a Spanish retailer provided some information of their activities (Mercadona, 2009). They generate about 300 kg of board waste per store per day, which is compacted at the store and transported back to the distribution centre where a hydraulic press produces 700 kg bale with the appropriate dimensions to be transported to a paper mill. For this packaging material, 1 kg of waste paper and cardboard would produce 2.2 new boxes. Expanded polystyrene boxes are returned to distribution centres where they are briquetted and sent to a recycling plant. The group managed about 1100 tonnes of recycled expanded polystyrene. Reusable plastic boxes for fruit and vegetables and pallets for other purposes are used in the Mercadona group. They use reverse logistics for wastes management.

Global players, like Carrefour, are also implementing a number of preventing measures. As seen in section 2.5, Carrefour commitment to reduce paper thickness has lead to less paper consumption but also to less paper waste.

Rewe group, in Germany, has achieved a recovery rate of 84%, taking into account packaging material recycling and food waste treatment (composting and anaerobic fermentation). Rewe also implemented some techniques to avoid packaging wastes at households by using multi-use and mass packing (e.g. bulk deposits for vegetable oil).

Some retailers in Europe, as Zara (Inditex) or C&A, have integrated exhaustive monitoring systems to control the waste generated at stores. Some recycling good practices have been identified among these retailers, as alarm tags recycling and clothes hangers re-use and recycling.

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2.4.6.3 Return systems for PET and PE bottles and for used products

Description

This technique refers to how certain products such as polyethylene terephthalate (PET) beverage bottles, polyethylene (PE) milk bottles, carbon dioxide cartridges, batteries, electrical equipment (TV sets, personal computers, microwave ovens, kitchen mixers, headsets, remote controls, CD players etc.) fluorescent tubes, energy-efficient lamps and light fixtures can be returned by the consumers free of charge to the retailer who makes sure that these used products are recycled in an environmentally-friendly way. The retailer organises the required containments and logistic. With regard to logistics, the mentioned used products are first transported back to the distribution centres, using empty trucks which delivered goods to the store (see Section 2.3.4.6) where they are sorted and sent to processing facilities for recycling or reuse.

Achieved environmental benefits

Concerning PET beverage bottles, every kg of recycled PET reused in new bottles avoids about 3 kg of greenhouse gases. Furthermore, the collection and reuse of PET and other one-way beverage packaging contributes to reduced littering.

With respect to electrical equipment, valuable raw materials such as plastics, glass and heavy metals (iron, copper, zinc, lead, mercury, cadmium) can be recovered and reused.
For the recycling of batteries, the nickel-cadmium rechargeable batteries and lead batteries are separated. The residual batteries undergo a pyrolysis process and the iron manganese, zinc and zinc oxide is recovered. Thus, raw materials extraction is avoided and the environment is spared from emissions of these pollutants.

Appropriate environmental indicator

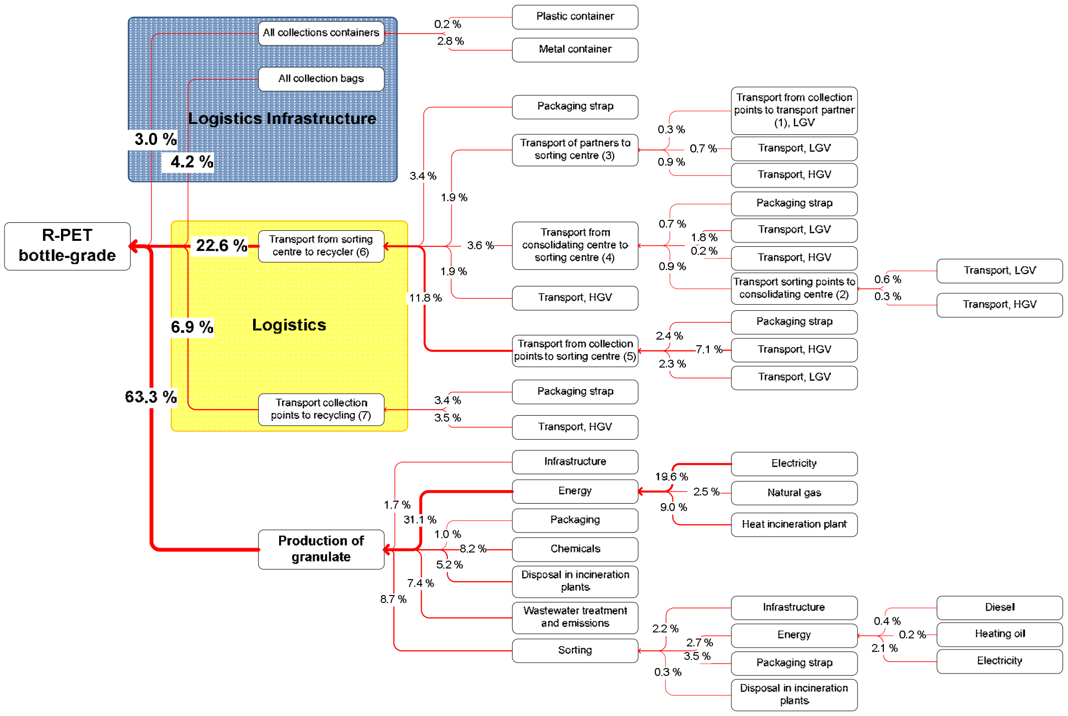
Especially for the recycling of PET and PE bottles, the recycling rate is a useful indicator; this means the percentage of the quantity of sold bottles compared to the quantity returned.

For non-obligatory return systems that do not charge a deposit, a recycling rate of 80 % can be considered a benchmark. For the obligatory return and deposit systems, a recycling rate of 95 % can be considered a benchmark.

For batteries, electrical equipment, fluorescent tubes, energy-efficient lamps and light fixtures which can be stored for a very long time in the consumers' homes, there may not be a direct relationship with the quantity of the product sold in subsequent years. Consequently the absolute quantity per year can be used in order to compare year by year. Notwithstanding this statistical problem, Switzerland reaches an exceptional recycling rate of 70 % for batteries.

Cross-media effects

The collection and transport of the used products and the recovery processes require energy and may result in various emissions. However, the additional energy consumption and emissions involved are clearly lower compared with the production from new raw materials. Concerning PET recycling, a detailed life cycle assessment showed that logistics activities contribute about 37 % to the overall environmental impact whereas the production of PET granulate contributes about 63 % (Figure 2.115) PET recycling is also significantly more environmentally-friendly than the incineration of the PET bottles in municipal waste incineration plants with waste heat recovery (Dinkel, 2008).



Source: Dinkel, 2008.

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

Figure 2.115: Environmental impact of the production of bottle-grade PET-flakes from recycled PET bottles

Operational data

Concerning the recycling of PET bottles, an example is provided by approximately 600 Migros and 800 Coop stores in Switzerland for 2009. Approximately one third of all recycled PET bottles (in 2009, almost 1.2 billion PET bottles equating to 37 500 tonnes of PET) were collected from these stores and transported to collection stations. There, the bottles are compacted to 250 kg packages in order to minimise the energy consumption (and costs) for transport to the plant where new PET bottles are produced. However, only a percentage of the recycled PET bottles can be used for the production of new bottles (in 2009, about 34 % of the collected material was reused to produce new bottles (closed loop). However, it is expected that this rate can be increased to 50 – 60 % in the future. The return rate of PET bottles among Migros customers is about 90 %. Lower quality material is used for other products such as fabrics, electrical devices, etc. The PET Recycling System in Switzerland is very efficient with short distance transport and recycling in Switzerland (94 % of all collected material). Thus, the loop is almost closed within one country.

In total, in Switzerland, retailers operate about 7000 collection points for PET. An example of these collection points is shown in Figure 2.116. In addition, in offices, schools, petrol stations, railway stations, hospitals, hotels, sports clubs, etc., there are another 23 000 collection points.

Figure 2.116: Part of the return system in a Migros store, including PET bottles

Furthermore, at Migros stores, in 2009, about 8000 tonnes of PE milk bottles, batteries, electrical equipment, fluorescent tubes, energy-efficient lamps and light fixtures were collected and subsequently processed. In Migros' Do-it & Garden stores, customers can also bring back products such as old varnishes, solvents, cleansers, biocides, preservers and pesticides.

In Germany, due to the obligatory deposit and return system for one-way beverage packaging (Germany, 2008), every retailer takes back PET, glass and other type of non-refillable bottles. However, the percentage of refillable beverage packaging is high (Table 2.88), in contrast to many European states where refillable packaging is rarely used.

Table 2.88: Percentages of refillable and ecologically acceptable one-way beverage packaging in Germany

Type of Beverage	2004	2005	2006	2007	2008
Beer including shandies	87.8 %	88.6%	87.1%	85.2%	85%
Mineral water	68.2 %	61.4%	53.0%	47.3%	45.4%
Soft drinks	63.0%	55.0%	49.3%	42.8%	38.4%
Alcopops	25.7%	24.7%	31.8%	23.1%	21.2%
All beverages	71.1%	65.7%	59.8%	54.6%	51.8%
Percentage of refillable packaging	66.3%	61.3%	55.6%	51.2%	48.8%
Percentage of ecologically acceptable one-way packaging	4.9%	4.4%	4.2%	3.4%	3.1%
Source: UBA, 2010.					

Figure 2.117 shows two facilities that take back all kinds of bottles. The bottles have a code which is recognised by the machine and the deposit of 15–25 cents/bottle is reimbursed.

NB: German example seen on the left and Dutch example on the right.

Figure 2.117: Machines for returning beverage bottles

As a consequence of the obligatory German deposit and return system, the recycling rates for PET bottles are very high (around 95 %). In general, in 2007, the reuse and recycling rates of packaging in Germany was follows (UBA, 2009):

- Glass: 83.7 %
- Plastics: 95.3 % (42.7 % reuse and recycling, 52.6 % thermal recovery including incineration with waste heat recovery)
- Paper/paper board: 98.4 % (80.2 % reuse and recycling, 18.26 % thermal recovery including incineration with waste heat recovery).

In the Netherlands, there is also an obligatory deposit and return system (see machine Figure 2.117)

Applicability
In principle, all retailers can introduce such return systems.

Economics
In Switzerland, the retailers have to pay 1.3 cent per PET bottle as a contribution to run the PET recycling system. Comparatively, these costs are considered to be very low.

Concerning the obligatory deposit and return systems, there is no bottle-specific cost figure available. The machines for taking back the bottles are expensive (in the order of EUR 30 000) and need considerable maintenance.

Driving force for implementation
In Switzerland, the ordinance concerning beverage packaging from 5 July 2000 (CH, 2000) prescribes the minimum recycling rate for beverage packaging consisting of glass, PET or aluminium (75 %). Furthermore, all retail stores have to take back non-refillable packaging. However, Switzerland has not introduced an obligatory deposit system for beverage packaging.

Due to the high awareness of consumers and high-profile awareness campaigns, the recycling rates are high (e.g. 81 % for PET bottles in 2009).

On the contrary, Germany and the Netherlands have introduced an obligatory deposit and return system (Germany, 2008) which obliges all retailers to charge a fee on one-way beverage packaging and to take back the one-way packaging. Such regulations are in line with European legislation (COM, 2009).

Reference retailers
Concerning beverage packaging, all retailers in Switzerland, Germany and the Netherlands may be regarded as reference retailers. 600 Migros stores concerning carbon dioxide cartridges, batteries, electrical equipment (TV sets, personal computers, microwave ovens, kitchen mixers, headsets, remote controls, CD players etc.) fluorescent tubes, energy-efficient lamps and light fixtures.

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2.4.6.4 Anaerobic fermentation of food waste

Description

The food waste from retailers is co-processed with other organic waste such as green waste. A typical plant is illustrated in Figure 2.118. The green and food wastes are delivered by trucks and discharged to a bunker from where they are fed with a crane to a conveyor. Before shredding the waste to pieces of less than 500 mm, any metal pieces are removed. Usually, the waste contains less than 3 % undesired components. The shredded waste is then mixed with the aqueous phase from the anaerobic fermentation process, stored in the feed tank, and subsequently pumped to the fermenter. The solid content in the fermenter is about 25 %. The fermentation process lasts 14-20 days, the temperature is 55–60 °C (thermophilic conditions). The methane content of the formed biogas is about 58 % (rest CO_2, H_20, H_2S and other trace gases). The produced biogas is stored in a tank and is further processed (mainly the removal of water, carbon dioxide and H_2S). The biogas is incinerated in a gas motor (combined heat and power plant). The produced electricity is fed to the public grid and the heat is used for heating the fermenter. The fermentation liquor is slowly moved by a horizontal paddle system. Part of the fermented mass is dewatered in a screw press and part of it is stored as 'liquid fertiliser'. For the dewatered compost, there is a post-composting process that lasts for about three weeks, prior to delivery to customers. For application on agricultural land, post-composting is not necessary. The compost complies with standards required for its application as a fertilier for agricultural fields.

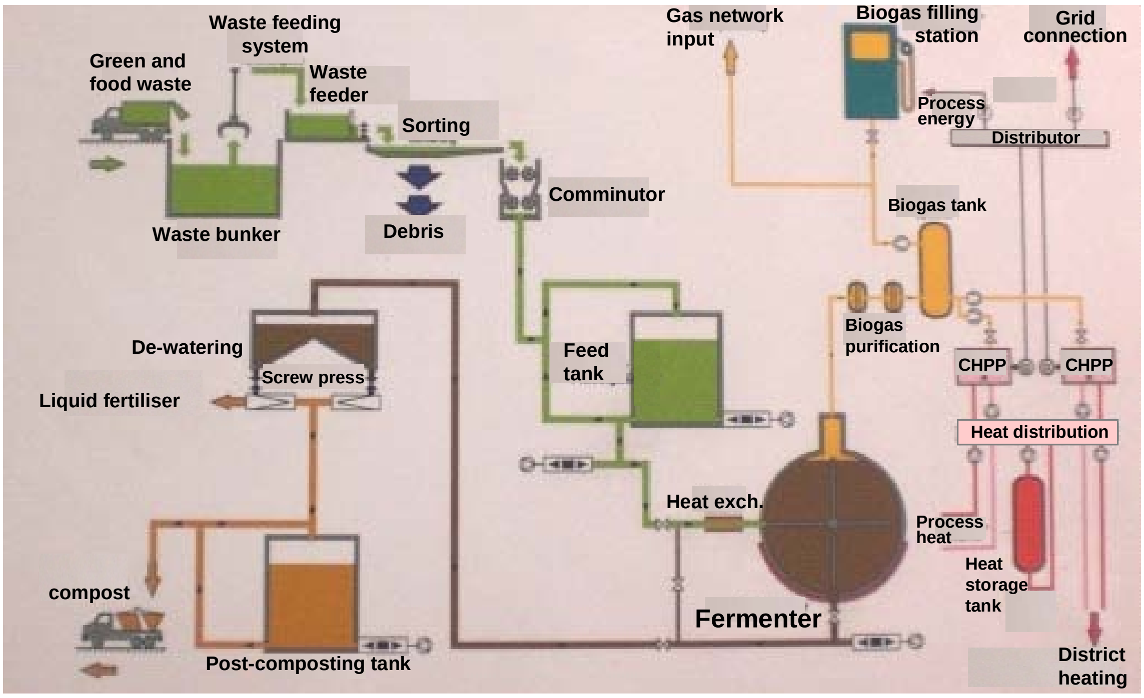
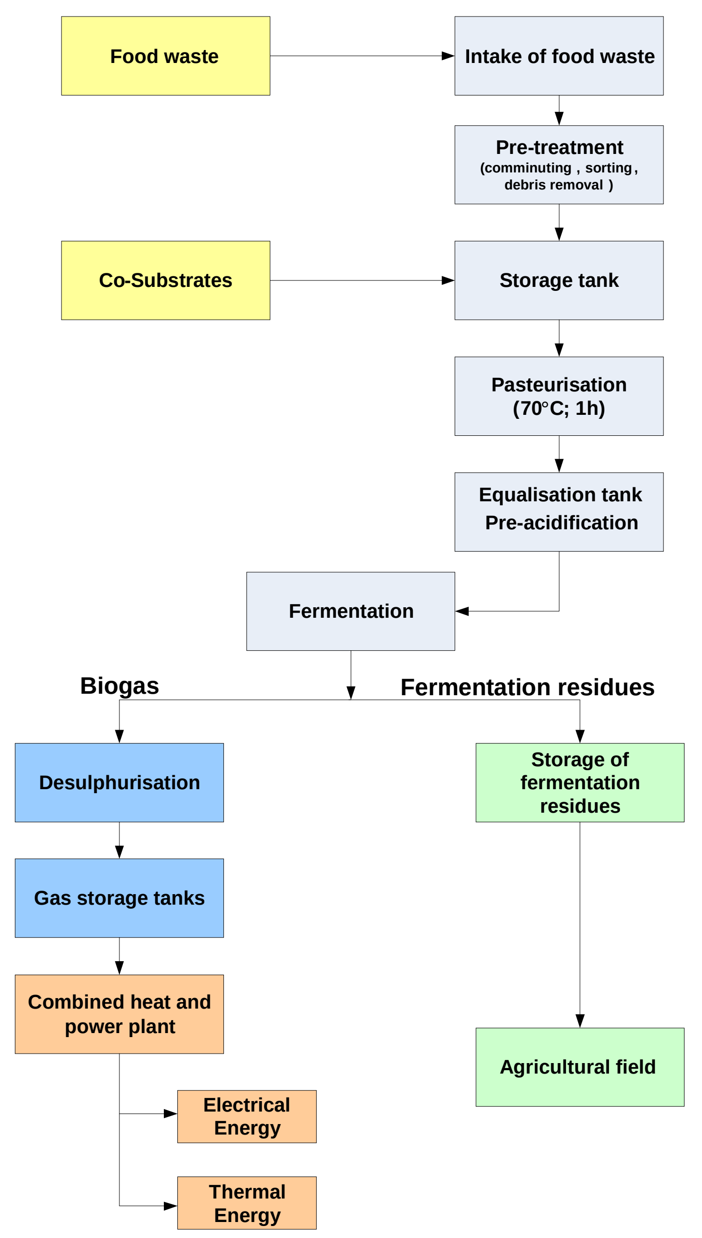


Figure 2.118: Flow chart of the biogas plant in CH-Otelfingen, processing food and green waste

As an example, the Swiss retailers Migros and Coop process about 20 000 tonnes of food waste (from stores as well as from their food production plants) in biogas plants as described above. In 2010, Migros was operating 11 and Coop 6 trucks fuelled with biogas.

As a further example, the flow chart of biogas plants operated by Refood is illustrated in Figure 2.119. Compared to the plant in Figure 2.119, there are two additional steps. After comminuting to an average particle size of 12 mm, plastic, metals, paper and glass from packaging are separated by means of centrifugation. This separated fraction is incinerated in a municipal waste incineration plant. Furthermore, this plant has a pasteurisation step in order to inactivate pathogen microorganisms as prescribed in EC 2002.



Source: ReFood, 2008.

Figure 2.119: Flow chart for the biogas plants operated by ReFood in Germany

Achieved environmental benefits

The food waste is disposed of in an environmentally-friendly manner, i.e. no disposal in landfill (avoiding emissions to soil, water and air) and recovery of biogas for the production of process heat and electricity (combined heat and power). The formed biogas is equal to 70 l of petrol for 1 tonne processed waste. The current estimation of food waste quantity from retailers in the EU-27 is about 4.5 million tonnes (EC Food waste study, 2010). Consequently, the increasing fermentation of the food waste, also from retailers, has a significant environmental benefit.

Appropriate environmental indicator

With respect to retailers, an appropriate environmental indicator is the percentage of food waste which is disposed of in biogas plants or is incinerated. The benchmark concerned is to avoid any landfilling and to completely dispose of food waste in the mentioned facilities.

Cross-media effects

In the plant described in Figure, there is no waste water generated for discharge. However, in the plant illustrated in Figure 2.120 plastics, metals, paper and glass, originating form packaging material, are separated to be disposed off in a municipal waste incineration plant.

The air from all the buildings is evacuated and the waste gas is treated in a biofilter. The waste gas from the combined heat and power plant is discharged via a stack (see Figure 2.120).

Figure 2.120: View of the biogas plant in CH-Otelfingen and the stack to emit the waste gas from the combined heat and power plant

Operational data

The biogas plant in Otelfingen, Switzerland, went into operation in 1996. In 2008, there were the following inputs and outputs from the plant in Otelfingen (see Table 2.89).

Table 2.89: Input/output of the biogas plant in CH-Otelfingen for one year

Input			**Output**	
Green wastes, especially from municipalities	10 500 tonnes		Raw biogas	Approx. 9 GWh
Organic wastes, especially from food manufacturing industries	3 300 tonnes		Fermentation liquor from the screw press	8 200 tonnes
			Solid compost	3 300 tonnes

Source: Axpo, 2010

With respect to pollutants, reference is given to the environmental declaration for the plant in Otelfingen (Axpo, 2010). The pant in Otelfingen is operated by three people who work during day-time. Overnight, the plant runs automatically and is equipped with an advanced alarm system that identifies the type of problem to the designated on-call employee via sms messaging.

The fermenter in Otelfingen has a volume of 900 m^3. Other fermenters in Switzerland have volumes between 280 and 1600 m^3. Today, the standard is 1600 m^3.

The plant is Otelfingen does not have an automated unpackaging facility for packed food waste from retailers. Furthermore, there is no facility to sanitise meat and meat products. Newer plants have facilities for automated unpackaging and sanitising.

The plant in Figure 2.120 processes food waste from retailers (packed and unpacked food waste such as vegetables, meat, fish, sausage, bread, milk, yogurts, etc.) but also from bars, restaurants, hotels, catering companies, canteens, hospital kitchens, food trade companies, butcher shops and food manufacturing industries. It can also process packed food waste and has a pasteurisation step in order to inactivate pathogen microorganisms.

Applicability

This technique is applicable for all retailers.

Economics

In Switzerland, retailers have to pay for the disposal of food waste in a biogas plant – about 70 EUR/t plus transportation costs (depending on the distance) of between 15 and 45 EUR/t. For comparison, the costs for incineration (including transport) are between 110 and 150 EUR/t.

In Switzerland, the operators of biogas plants receive 11 cents/kWh of produced electricity fed to the public grid. In case, other organisations buy credits for certified ecoelectricity, the operator may receive another 6.5 cents/kWh.

In Germany, retailers have to pay an annual fee per container provided by the disposal company. One store may have different containers which may be emptied more than once per week. The prices depend on the individual circumstances. Concrete numbers are not available.

Driving force for implementation

In Switzerland, the main driving forces are the environmental benefit to close the material cycle and to avoid pollution of soil, groundwater and air when disposing of the food waste to landfill as well as the regulation to avoid the disposal of food waste to landfills were the major driving forces. In addition to that, in the EU, new health rules concerning animal by-products (EC, 2002) appeared as a very supportive factor to establish further biogas plants for food waste.

Reference retailers

Migros and Coop in Switzerland, and German retailers.

Reference literature

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2.5 Reduced consumption and use of more environmentally-friendly paper for commercial publications

Description

Many retailers use considerable amounts of paper for issuing commercial publications (leaflets, catalogues, etc.). There are a number of measures to reduce the environmental impact of these commercial publications, such as

- the reduction of the grammage of the paper (specific weight in gr/m2);
- use of more environmentally-friendly paper (use of paper certified according to PEFC or FSC (see Section 2.2.6.4) and increasing the use of supercalendered paper instead of coated paper);
- requiring printing shops to go for environmentally-friendly production techniques and EMAS or ISO 14001 certification;
- optimising the catalogue sizes (can only be done at country level as it depends on the printing equipment).

Achieved environmental benefits

The reduction of the grammage of the paper for commercial publications results in reduced CO_2 emissions and water consumption. For instance, the reduction of paper grammage at Carrefour from 54.2 gr/m^2 in 2005 to 49.4 gr/m^2 in 2008 was associated with a reduction of CO_2 emissions of 22 500 tonnes and with a reduction in water consumption of 470 000 m^3. Furthermore, the substitution of coated paper by mainly supercalendered paper required fewer chemical additives such as talc, glue, kaolin, binding agents, etc.

The careful selection of printing shops that consider environmental aspects contributes to minimised emissions during the printing processes.

The use of certified paper contributes to sustainable forestry.

Appropriate environmental indicator

With respect to paper used for commercial publications, appropriate environmental indicators are:

- the percentage of certified paper (see Section 2.2.6.6); a benchmark could be 100 %
- the grammage of paper used; a benchmark could be a grammage of less than 49 gr/m2
- the percentage of coated paper; a benchmark could be less than 10 %
- the percentage of printing shops which are certified according to EMAS or ISO 14001; a benchmark could be 100 %.

Cross-media effects

There are no relevant cross-media effects.

Operational data

Table 2.90 shows the data for Carrefour who invested and is still investing significant effort to reduce the environmental impact of commercial publications. The average grammage was reduced by 8.8 % from 2005 to 2009. Due to market expansion, absolute paper consumption in tonnes per year only decreased by 2.4 % in the mentioned period.

Table 2.90: Development of paper grammage, area of used paper, paper consumption and percentages of used paper grades at Carrefour from 2005 – 2009

Method	Unit	2005	2006	2007	2008	2009	Difference 2009 vs 2005
Use of certified(*) and recycled paper	%				73	80	
Average grammage	gr/m^2	54.2	53.2	50.8	50.1	49.4	-8.8 %
Area of used paper	km^2	4002			3882	4289	7.2 %
paper consumption	tonnes	217 100			194 380	211 861	-2.4 %
Newsprint	%	15			28	35	
Supercalender paper	%	54			66	57	
Coated paper	%	32			5	8	
(*) PEFC (Programme for the Endorsement of Forest Certification) or FSC (Forest Steward Council).							

Applicability
This technique is applicable to all retailers.

Economics
In the case of Carrefour (see the numbers in Table 2.90), the costs for the paper decreased from 2005 to 2008 by 14.3 % (EUR 151 000 to 130 000).

Driving force for implementation
The main drivers were an awareness to reduce the environmental impact of the consumption of paper for commercial publications, and cost reduction.

Reference retailers
Carrefour.

Reference literature

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2.6 Rainwater collection and reuse to the ground at retail supermarket from roofs and parking areas

Description

Rainwater from the roofs of retailer stores can be collected in an underground tank (Figure 2.121) and can be reused for floor cleaning, flushing the toilets and watering green areas around the building. It can also be used as cooling water for transcritical CO_2 refrigeration plants on hot summer days.

The rainwater from the roofs, and also from the parking area, can also be infiltrated to the ground on the premises of the retailer or to adjacent land.

Figure 2.121: Rainwater collection tank (100 m^3) at the Tengelmann 'Klimamarkt' in Muelheim an der Ruhr, Germany

Infiltration is the most effective means of controlling rainwater runoff since it reduces the volume discharged to receiving waters and associated negative impacts. Infiltration is also an important mechanism for pollutant control. As runoff infiltrates into the ground, particulates and contaminants such as metals and nutrients are removed by filtration through the soil, and dissolved constituents are removed by adsorption. Infiltration systems are designed to capture a volume of rainwater and infiltrate this water into the ground over a period of several hours or even days. Rainwater from parking areas is more polluted than from roofs (assuming there are no significant areas that consist of copper or zinc sheets) and thus it has to pass a biologically active soil layer of at least 30 cm.

Different types of systems can be employed which retain water safely on site, including: pervious pavements (e.g. permeable car parks), infiltration basins, vegetated swales, ponds and wetlands and green roofs. In the case of retailers, an infiltration trench is one of the favourable options. An infiltration trench (Figure 2.122) is a long, narrow gravel-filled trench designed to infiltrate rainwater into the ground. Runoff is stored in the voids between the gravel and infiltrates through the bottom and into the soil matrix. Infiltration trenches typically capture a small amount of runoff and therefore may be designed to capture the first flush of a runoff event. They are frequently used in combination with other measures such as a detention basin to control peak hydraulic loads. Infiltration trenches efficiently remove suspended solids, particulates, bacteria, organics and soluble nutrients.

Figure 2.122: Trench for the infiltration of rainwater of the parking area of a supermarket

Achieved environmental benefits

Rainwater infiltration gives rise to several benefits in relation to water quality, biodiversity and vegetation. The main benefits are:

- reduction of the amount of rainwater discharged into the sewer system
- recirculation of water back to the natural water cycle (groundwater recharge).

The combination of rainwater harvesting and rainwater infiltration offers technical benefits and exerts positive effects on the environment and the local water balance. A hydraulic load reduction can minimise hydraulic peak loads in the sewer network significantly.

In addition, infiltration of rainwater over a long period can increase and/or stabilise the groundwater reserves.

The main benefits on an individual level are the complete uncoupling from the public sewer. Construction costs will be also reduced if rainwater harvesting and rainwater infiltration systems are planned together in addition to a reduction in the waste water fees.

Appropriate environmental indicator

The percentage of a retailer's stores which have a system for the collection and reuse of rainwater, and the percentage of stores having rainwater infiltration could be used as environmental indicators.

Cross-media effects

The biologically active soil layer of the infiltration trenches where inorganic and organic contaminants are removed may have to be replaced after one or two decades of operation and may be disposed of on to landfill.

Operational data

Rainwater from roofs covered with metal sheets (copper or zinc) may not be infiltrated or has to be treated specifically. Due to the contamination of rainwater from parking areas, the rainwater concerned has to pass a biologically active soil layer of at least 30 cm.

Applicability

Several preconditions are required for the planning and success of infiltration measures. These are given below:

- Groundwater conditions: the distance to the groundwater and variations in the groundwater levels should be known before any planning is made. It is recommended that the distance to groundwater be at least 1–1.5 m.
- Soil type and conditions: the effective porosity and permeability of the soil will influence the infiltration process.
- Infiltration rates should be within 1×10^{-3} and 1×10^{-6} m/s. In addition, the bedrock should not be at less than 1.2 m below the infiltration surface
- Vegetative cover: the topsoil layer covered with vegetation (30 cm) will positively influence the infiltration process. During infiltration, rainwater is absorbed by plant roots and is returned back partly to the atmosphere via evaporation/transpiration. In addition, the soil-vegetation complex functions as a filter, which reduces surface clogging of the soil.
- Distance to buildings: based on the local conditions, it is recommended that a distance to buildings of at least 6 m should be held in order to avoid any negative impacts on the building foundation.

The infiltration rate defines the amount of water that is infiltrated into the ground. Soil permeability and flow conditions particularly limit the amount of rainwater that can be soaked into the ground. A soil hydraulic conductivity in the range of 10^{-6} to 10^{-3} m/s is generally considered appropriate to achieve reasonable infiltration rates. For long-term infiltration, a fall-off due to gradual clogging of the soil must be taken into account. Table 2.91 shows the infiltration capacity of different soils.

Table 2.91: Rainwater infiltration capacity of different soils (below the biologically active soil layer)

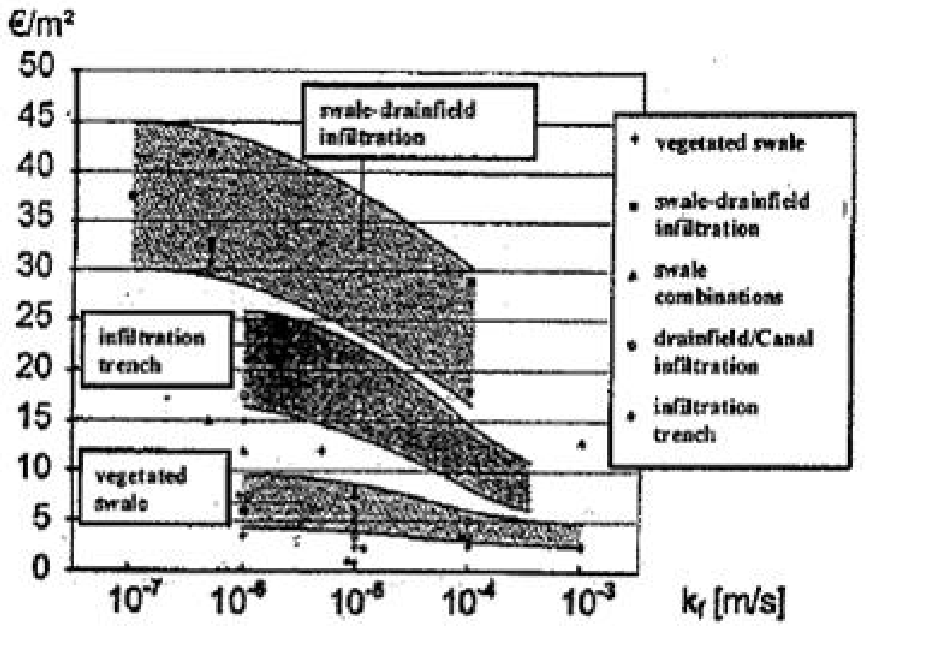
Soil type	Hydraulic conductivity K (m/s)
Gravel	$10^{-3} – 10^{-1}$
Sand	$10^{-5} – 10^{-2}$
Silt	$10^{-9} – 10^{-5}$
Clay (saturated)	$< 10^{-9}$

Economics

Structural measures to achieve rainwater infiltration are generally cost-intensive. The planning process for decentralised concepts is rather costly since many factors have to be taken into account.

The costs for an infiltration technology mainly depend on the type of technology and the proper design. Figure 2.123 shows the dependency of the construction costs from the soil infiltration coefficient (K_f), as is the case in Germany. The cost/m² corresponds to the relevant area, which drains into the infiltration structure, for example, a vegetated swale, and not to the whole area of the swale.

As an example, if a 1 000 m² surface collection area with a runoff coefficient of 30 % is connected to the infiltration system, the system has to be designed based on the amount of rainwater collected from a surface area of only 300 m². With a cost of EUR 10/m² (Figure 2.123) the construction of a vegetated swale with a 1 000 m² surface area will entail total capital costs of about EUR 3 000.



Source: Londong, 1999 (modified)

Figure 2.123: Costs of infiltration techniques depending on the infiltration coefficient (Kf) in Germany

Driving force for implementation

The main drivers are the awareness of retailers to save water and to reduce the hydraulic load of the sewer system but also local requirements due to hydraulic limitations of the sewer systems and/or flood protection programmes.

Reference retailers

Some stores of IKEA and LIDL have rainwater infiltration. At one Tengelmann store and one Rewe store, the rainwater from the roof is collected and reused for floor cleaning, flushing the toilets and watering the building's green area (REWE) or as cooling water for a transcritical CO_2 refrigeration plants at hot summer days (Tengelmann).

Reference literature

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2.7 Influencing consumer environmental behaviour

2.7.1 Introduction

Retailers may influence the environmental behaviour of consumers through several active or passive procedures. Active mechanisms would imply that the retailer is, for instance, offering only best performing products, limits parking lots and promotes the use of public transport, remove the use of free non-degradable plastic bags, etc. Passive mechanisms leave the choice to consumers but retailer should provide enough environmental information as, for instance, environmental labels and rating systems.

For both mechanisms, best practices have been identified and the 'emblem' of how retailers can influence positively the environmental behaviour of consumers is the example of plastic bags, described in section 2.7.2. In this introduction section, some indications and recommendations on communication to consumers are provided.

Environmental performance of products and companies is a recurrent topic in advertising, but usually treated in a discontinuous, not-well structured and sometimes superficial manner, where the main objective is to increase sales or improve image without real scientific evidence on environmental claims (OCU, 2010). Consumer perception of environmental issues is dominated by private companies' messages instead of public administrations and, therefore, responsible advertising is needed. Consumers association have detected that environmental issues included in advertising are focused from a sustainability perspective, including social and economical aspects instead of being focused in a simple exposition of good environmental practices. As well, misleading environmental advertising leads to the perception that purchasing sustainable products is the best way to improve the environment, while they make the consumer to forget about changing habits and reducing consumption, which have a higher improvement potential. These are the conclusions of several consumers associations (from Spain, Portugal, Italy and Belgium), which developed an analysis of existing advertising practices. These associations made several recommendations about using environmental claims in advertising (OCU, 2010):

- Honesty: claims should be based on scientific evidence and the environmental information should be available to the consumer.
- Precision: environmental claims should not mislead about the environmental impacts of a product and should not hide any information. For instance, environmental claims focused on only one stage of the life cycle of the product should be properly defined. It is usual to see products claimed as recyclable but only a fraction of the product is recyclable.
- Usefulness: claims should be clear, concise and easy to understand. More information does not imply better information and better background for comparison.

Retailers are playing an essential role, as they are the link between producers and consumers. Consumers should have the best environmental information, not only to assist their purchasing but also to make consumers play an active role in the improvement of the environment. A good example is the Guide for Responsible Consumption, published by Carrefour Spain, which addresses the habits of consumption of customers at households. The main topics are energy, water, food, materials, transport and wastes. The final recommendation of the document is to reduce consumption, re-use products and recycle (Carrefour Spain, 2009). A free translation of the text is below:

'…we should be aware that consumption has economic, social and environmental impacts and the path to a sustainable consumption needs fewer natural resources, less pollution and fare working conditions in manufacturing countries.

Reduce consumption *is essential to reduce waste generation and energy consumption. It is not consisting on suddenly abandon all consumption goods, but it would be a question of an appropriate and fare use of existing resources to satisfy our needs and improve our life quality without conditioning the future.*

Reuse products*, buy good quality products and repair them. Lend out or donate when products are not needed. If products are reused, then it would not be necessary to produce large amounts of them and manufactures would improve durability and sustainability of their products.*

Recycle materials *without any further use. Then, pollution would be avoided and wastes are reincorporated into a new product cycle.*

With these measures, you are not only protecting the environment, but you can also save money from your family finances.'

References

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2.7.2 The example of plastic bags

Description

The environmental objective of reducing the use of disposable bags has to focus on the opportunity of changing consumer behaviour. When compared to retailers' environmental aspects, the potential impact of a disposable plastic bag is low in relative terms. A disposable polyethylene (PE) plastic bag is responsible for 20–40 grams of CO_2 (it depends on the bag characteristics) in its life cycle (Carrefour, 2004; Bousted, 2007), while the load of the bag (packaging materials of products and the product itself) and the transportation of the bag may have much higher associated emissions (see Chapter 2.3). Nevertheless, plastic bags have been pointed as the emblem of perceived 'throwaway' consumer culture and have become a focus of attention for government, business and community activists to change consumer behaviour (Ritch et al., 2009). In addition, the environmental rationale for banning or restricting plastic bags has to be based on the waste management policy, as the recycling rate of plastic bags is low. Plastic wastes account for more than 90 % of floating litter in the ocean. In addition, significantly affects marine life and has relevant impacts derived from its life cycle as energy consumption, greenhouse gas emissions, ecotoxicity and waste generation. Plastic bags disposed off on landfills have very large breakdown times, about a hundred years for polyethylene bags.

The role of retailers is very significant and their cooperation with governments is essential to implement sustainable consumption policies – ideally integrated with an overall waste management policy defined at the national, regional and local levels. As known, the impact of end-of-life steps of a product can be highly influenced by retailers but strongly depends on consumer behaviour (see section 2.2.3 and Figure 2.64). In accordance with several studies (Carrefour, 2004; Bousted, 2007), plastic bags should not be substituted by other disposable bags, as the environmental benefit is relatively low or the impact can even be worse. The reusable bag is considered the most environmentally friendly solution: the life cycle study performed by Carrefour, 2004, shows that the reusable PE bag is more environmentally-friendly than the conventional single-use PE bag if it is used more than 5 times (on average).

There are several policy instruments to address the reduction of plastic bag use and the influence on consumers (Ritch et al., 2009).

- Regulation: where plastics bags are forbidden or their use is highly restricted.
- Green market: all the instruments are used: there is a regulation relevant for retailers, in terms of levies or fees to the consumers. In addition, the organization should provide enough information on the benefits of reusable compared to one-way bags.
- Voluntary: it is based on information provided by the retailer. No regulation backs up the initiative and the consumer considers it to be reusable.

Although many retailers initiated voluntary policies, currently most of the initiatives can be catalogued as 'Green Market' policies, where the cooperation of many actors involving retailers, consumers' associations and local and national governments is essential (Covenry et al., 2007). The regulation approach (direct banning of single-use bags) is not seen as beneficial as it is not contributing to generating a sustainable consumption and consumer awareness framework.

Retailers should use their influence on the consumer on a voluntary basis to reduce plastic bags consumption. The consumer policy principles (Ritch et al., 2009) of access, choice, information and representation are key aspects to be used by retailers and help to avoid the implementation of more restrictive regulations. Some examples of plastic bags reduction are explained under 'Operational data'.

Achieved environmental benefits

From the environmental point of view, the use of plastic bags made of PE has less environmental impact than other disposable checkout bags, such as paper bags and some types of biodegradable bags. The achievement of environmental benefits should be through the substitution of single-use plastic bags by reusable bags, for example, PE reusable bags (Carrefour, 2004; Boustead 2007).

The environmental benefit will depend on the number of uses of the reusable bags. Following the results from life cycle assessment of single use bags compared to reusable bags performed by Carrefour, 2004, the most environmentally-friendly option is the PE reusable bag if it is used more than 4–5 times. The quantifiable reduction of impacts, if the bag is used 20 times, is enormous: 10 times less energy, 4–5 times less water, 10–15 times less GWP, etc. These achievable benefits are only applicable to the boundaries of the study performed by Carrefour, 2004. For other dissimilar scenarios, specific assessment is highly recommended.

The policy impact of such measures is also high. In Ireland, the implementation of the levy on plastics bags produced a reduction of 94 % of plastic bags consumption. Plastic bag litter fell from 5 % in 2002 of total litter to 0.2 % in 2004. Non-measurable benefits from plastic bags policy are also important. The shift of consumer behaviour and consumption patterns would introduce substantial changes in the long-term and would help the implementation of more responsible and sustainable economies (Ritch et al., 2009)

Appropriate environmental indicator

The end of life of plastic bags should be considered as an indirect aspect of retailers, which is highly influenced by them. Nevertheless, the impact of plastic bag disposal can be controlled by a direct aspect, such as the issuing of plastic bags at checkouts. The specific number of delivered plastic bags (bags per square metre and year) is an appropriate indicator to be controlled by the retailer and can be considered of common acceptance by the sector. The number of free disposable bags is also a useful indicator, as free checkout bags are more likely to become litter (Carrefour 2009, M&S, 2009).

Cross-media effects

The main cross-media effect of reducing the amount of delivered plastic bags is the influence on consumer behaviour. Increasing environmental awareness would also help in the implementation of other green initiatives as an augment of the sales of environmentally friendly products, etc. The success in the implementation of reusable bags and other policy initiatives would enlarge the scope of the influence of retailers and would facilitate the identification of retailers as catalyst for environmental policies.

Operational data

In this section, several case studies are described, which would help to understand the role of retailers in the policies concerning plastic bags: the Irish levy as an example of the influence of regulatory policies, Carrefour Spain as example of cooperation and M&S as an example of voluntary measures.

- The Irish government introduced a levy of EUR 0.15 per plastic bag in March 2002. The usage of plastic bags felt drastically and consumer behaviour changed substantially towards plastic bags (Convery et al., 2009). Consumption of single-use bags was reduced by 94 %. Householders feel the measure was positive for the environment and started to feel guilty when they forgot their own reusable bag. Retailers reported a positive impact in terms of acceptance and implementation and the economic costs for them were not important. Indeed, costs savings can be produced for some retailers, due to the avoidance of bags purchasing.
- One of the new commitments of the Spanish Integrated National Plant for Wastes is the reduction of single-use bags by 50 % and the use of non-biodegradable plastic by 70 % (MMARM, 2008). Financial and regulatory mechanisms are foreseen, but also raise awareness through public campaigns. The expected outcome of this plan is a regulation banning free disposable bags. Carrefour Spain helped the implementation of this policy through the removal of plastic bags in all Spanish stores. An important public campaign was performed to increase the awareness of customers and to facilitate the transition, Carrefour provided free reusable bags to customers (Carrefour, 2009).

- Marks & Spencer introduced a 5 pence charge on the use of plastic single-use bags for food consumers (M&S, 2009). They reduced the consumption of plastic bags by 62 % from 2007. M&S joined the WRAP (Waste and Resources Action Programme) on their Love Food, Hate Waste campaign and donated profits from carrier bag charge to help charity partner Groundwork to build new parks and play areas.

Applicability
No limitation on the applicability of this measure is foreseen. Local and regional factors may influence the implementation procedure but not the final result.

Economics
(Convery et al., 2007) made an assessment of several retailers implementing the levy in Ireland. The costs associated with the implementation of restricted use of plastic bags may have a positive impact for the retailer, as costs savings are produced due to less bags purchasing. Some additional costs are foreseen for the retailer. An Irish retailer spent more than EUR 2 million on the purchase of bags. The implementation of the regulation cost about EUR 100 000 and the extra costs attributable to levy (shoplifting and trolley theft) were about EUR 65 000. With a bag reduction of 95 %, savings of EUR 1.93 million were achieved.

Driving force for implementation
The most important driving forces for retailers to reduce the offer of plastic bags are improved reputation and public image, better customer response to other initiatives, increased environmental awareness, better communication with local/regional governments and better response to existing or future regulations.

Reference retailers
As previously mentioned, Carrefour and Marks & Spencer are examples for the substitution and reduction of plastic bags. Many retailers have implemented similar measures in Europe.

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3 EMERGING TECHNIQUES/APPROACHES

Here, the term 'emerging techniques' is understood according to the draft Industrial Emissions Directive (IED, 2010). There, the definition of emerging technique is 'a novel technique for an industrial activity that, if commercially developed, could provide either a higher general level of protection of the environment or at least the same level of protection of the environment and higher cost savings than existing best available techniques'. As soon as a technically feasible and economically viable technique has been implemented on an industrial scale, it can be considered as best management practice. If the conditions for the implementation are representative of the whole or a major part of the sector, even a few applications of a technique could be sufficient to draw the 'best management practice' conclusion.

However, the boundary between best management practice and emerging techniques is sometimes not readily identifiable because the economic viability of many operations in the retail trade sector is influenced by important but difficult to quantify image and reputational aspects, in addition to basic payback calculations. Some techniques described as best practice might be more accurately defined as emerging techniques according to conventional industrial payback calculations, but are commercially viable, at least for some retailers, owing to their marketing value (improved image or reputation). A good example is the implementation of renewable energy sources on-site, which is highly dependent on the provision of subsidies to be economically feasible, but can be preferred over more efficient low-visibility solutions such as improving the building envelope. Similarly, the promotion of high visibility 'ecoproducts' that account for a small proportion of sales may be favoured over selection of all products according to minimum environmental criteria. Thus, the visibility and associated marketing value of various measures is a key factor to consider when assessing commercial viability in the retail trade sector. Furthermore, the marketing value of visible environmental techniques depends on public prioritisation of environmental issues, whilst basic payback calculations are dependent on resource availability and prices, all of which vary over time. Given that it can take some time to widely implement various measures, it may be commercially rational for retailers to implement measures based on future rather than current prices. In this way, techniques considered 'emerging' from a short-term business perspective may be regarded as best available techniques from a long-term business perspective. Much of the recent retailer focus on supply chain sustainability reflects concern over future resource scarcity.

Reference Literature

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3.1 Improvement of energy performance

Within each described technique of Section 2.1.6, an important number of techniques were given as best practices, available for the improvement of energy performance. In this section, emerging techniques with the same objective are described. These are still in their development phase or their economic results are still far from the scope of a best practice.

3.1.1 Building design, including HVAC: Trigeneration

Trigeneration is the combination of a cogeneration process with thermally-driven refrigeration system. So, the output of this process would be electrical power, heating and cooling. It consists of a combined heat and power (CHP) system, which is integrated with a thermally-driven refrigeration system (e.g. absortion technology) to provide cooling. A usual CHP burns fuel to produce heat coupled to a generator of electricity. When there are seasonal variations in heat demand, part of the heat can be used in a thermally-driven refrigeration process.

The overall efficiency of the trigeneration processes is more than 90 %. Nevertheless, there are several drawbacks for the use of this system.

- Effective utilisation of the CHP system requires maximum utilisation of electrical power and heat. Usually, a store demands more electricity than heat in a store, so the overall needs should be carefully assessed for the application of the system.
- The fluctuation of heating demand and climate conditions and the low COP of absortion refrigeration processes make this system to be complemented with an electrically-driven refrigeration process.

There is wide experience of trigeneration systems in the food processing industry, where there are important heat and refrigeration demands. The large refrigeration demand of food plants is usually met using an ammonia compression installation. Cogeneration processes generate a large amount of heat that can be recovered in auxiliary thermally-driven refrigeration plants (Bassols et al., 2002). For large plants, ammonia absorption technology produces great savings.

Applicability for stores is quite limited. Large plants, with refrigeration needs in the range of MW, can benefit from this technology. Small applications for supermarkets are still in a research and development phase (Tassou et al., 2010). IKEA has allowed a supplier to install trigeneration equipment at several sites in Italy and buys the electricity, heat and cooling generated by the equipment. There is an excess of power that has to be sold to other users. The fuel is bio-oil, from jatropha and other feed stocks.

Reference Literature

- Bassols, J. Kuckelkorn, B., Langreck, J., Schneider, R., Veelken, H., 'Trigeneration in the food industry'. *Applied Thermal Engineering*, 22, 2002, pp. 595-602
- Tassou, S.A., Lewis, J.S., Ge, Y.T., Hadawey, A., Chaer, I., 'A review of emerging technologies for food refrigeration applications', *Applied Thermal Engineering*, 30, 2010, pp. 263-276.

3.1.2 Refrigeration: beyond the vapour-compression cycle

The use of the vapour-compression cycle for the refrigeration process consumes a huge amount of energy and the GWP of some refrigerants makes the carbon footprint of refrigeration processes to be really high and relevant to a store operation. To avoid this, new developments with secondary refrigerant loops and natural refrigerants are proposed in Section 2.1.6.6. These technologies are really available in the market and all of them are based on the vapour-compression cycle.

Innovative solutions, based on other physical phenomena rather than the vapour-compression cycle, are currently being developed. Tassou et al. (2010) reviewed technologies going beyond of the vapour-compression cycle. A summary of their findings and potential technologies for supermarkets are shown in Table 3.1. More information can be found in Tassou et al. (2010).

Table 3.1: Emerging techniques for refrigeration

Technique	Concept	Environmental and technical benefits	Barriers for implementation	Application examples
Absorption/adsorption technology	Absorption-adsorption process at constant pressure produces phase changes in the sorption/desorption process	No compressor needed for the operation; Use of waste heat to produce cooling	Complex heat transfer loops; Regeneration of sorbents; Coefficient of performance (COP) 0.7 lower than conventional refrigeration; Temperature above 0 °C	Silica-gel/water adsorption devices for air-conditioning. Application in a UK retailer with cogeneration system for subcooling of the refrigerant and for air conditioning
Air compression cycle	Air compression (several stages), cooling, expansion, heat exchange and then compression again. Similar to the vapor compression cycle, but without phase change.	Use of open cycle, direct contact of refrigerant (air) with food (better heat exchange); Independence of climate conditions	Higher energy consumption than conventional refrigeration; COP less than 0.7; No small applications available	Large cooling capacities; Icing plants; Large refrigerated storage cabinets; Fast heating/cooling
Thermoelectric systems	Peltier effect: when a direct electric current passes through the junction of two different conducting materials, they warm up or cool down depending on the current direction	Lower cost of technology	Low efficiency; Lower COP	Small applications (e.g. hotels minibar) at lower costs
Thermoacoustic systems	Sound waves produce cooling in an inert gas confined in a resonator. Gas oscillation creates temperature differences	Constant pressure; Wide scope: from normal refrigeration to cryogenics	Lower efficiency	Ben and Jerry prototype for freezing cabinet

Reference Literature

- Tassou, S.A., Lewis, J.S., Ge, Y.T., Hadawey, A., Chaer, I. 'A review of emerging technologies for food refrigeration applications', *Applied Thermal Engineering*, 30, 2010, pp. 263-276.

4 APPLICATION OF THIS DOCUMENT TO MICRO, SMALL AND MEDIUM ENTERPRISES

The purpose of this chapter is to ease the use of this document for SMEs of the Retail Trade sector and other stakeholders, dealing with SMEs.

About 50% of sales is performed by large retailers, but more than 99% of retailers are SMEs. As a general rule, it is found that larger companies have better environmental performance. Around 60% of the sector environmental impact is caused by SMEs, so their improvement potential is huge. The variability of SME size is high: from corner shops, with only one employee, to small supermarket or store chains, with a certain degree of corporate social responsibility integrated in the business structure.

In Chapter 2, this document provides technical and useful information to reduce the environmental impact of any company, regardless of its size and its implemented environmental management system (EMAS, ISO 14000 or other individual management systems). So, the conclusions on indicators and benchmarks (see Chapter 1) are applicable to SMEs. To be an SME may not be an excuse to reduce the responsibility for the produced environmental impact. With this thought, section 4.1 describes which practices are suitable to SMEs reflecting three areas: costs, applicability and achieved environmental benefit.

Section 4.2 of this chapter provides background information on the relative environmental performance of SMEs and Section 4.3 gives some guidance for stakeholders dealing with SMEs on mechanisms for the integration of sustainability issues in the business management of these enterprises.

4.1 Implementation of Best Environmental Management Practices

SMEs wishing to improve their environmental performance may consider the different options mentioned in Table 4.1 to Table 4.8. A user-friendly analysis of costs, applicability and environmental benefit, is performed below with three colour symbols representing the level of each aspect. For more detailed information, the sections concerned in Chapter 2 are indicated.

Usually, the investment capacity of small companies on environmental solutions for direct or indirect aspects is quite limited and the management capabilities are usually more limited than for bigger companies. Especially, micro, small and medium enterprises are, in some cases, less able to manage indirect aspects, although several practices can produce costs savings for them. For example, removal of plastic bags, as it is affecting an indirect aspect ('consumer behavior'), would avoid the purchasing of plastic bags, and the implementation cost would be really low. For other indirect aspects, as the supply chain management, limitations are more evident, although there are good opportunities for them (e.g. sourcing locally and environmental labelled products). It should be reminded that, to have an overall picture of each possibility, the full description of techniques should be consulted in Chapter 2.

Table 4.1: Color code for the assessment of best environmental management practices for SMEs

Symbol	(orange circle)	(yellow circle)	(green circle)
Cost (initial investment)	High	Medium	Low
Applicability to SME	Not applicable	Applicable with restrictions	Fully applicable
Environmental Benefit	Low	Significant	High

Table 4.2: Best Environmental Management Practices for SMEs: energy performance– including refrigerants consumption

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Energy performance – including refrigerants consumption	Improvement of Building Envelope	2.1.6.1.				Usually, SMEs do not own the building or the building unit where they operate. Nevertheless, they have direct control of glazing, shading, entrances, space heating and cooling (in some cases not), management and control of air flow and general maintenance of building-related aspect. Costs to retrofit existing systems are high, although some measures have very low payback times.
	Optimized design of HVAC systems	2.1.6.2.				
	Integrative concepts for buildings	2.1.6.3.				
	Heat recovery from refrigeration	2.1.6.4.				Only suitable for central refrigeration systems. The engineering of the system can be contracted to third parties.
	Monitoring	2.1.6.5.				Metering system needed for each process. The environmental benefit depends on the implementation of corrective measures.
	Efficient refrigeration: single measures	2.1.6.6.				Cost-efficient solutions through good management and operation are feasible. Other measures, as glass lids on cabinets, are less accessible to SMEs.
	Efficient refrigeration: shift to natural refrigerants	2.1.6.6.				For small stores with plug-in devices, it would be only possible for new equipment.
	Efficient lighting	2.1.6.7.				Use of smart lighting systems and efficient devices is feasible for SMEs
	Secondary measures	2.1.6.8.				Efficient appliances, staff training and communication are feasible measures
	Alternative Energy sources	2.1.6.9.				Green purchasing can be a good solution for micro enterprises. For SMEs, the use of renewable energy or other alternative sources can be achievable, although the payback times are usually high.

Table 4.3: Best Environmental Management Practices for SMEs: supply chain

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Supply chain	Integrate supply chain sustainability into business strategy and operations	2.2.6.1				The managing director of an SME may decide to stock and sell products certified to environmental standards, based on identification of priority product groups and a plan of action.
	Assess core product supply chains to identify priority products, suppliers and improvement options	2.2.6.2				For SMEs, this involves identification of priority products to which third party environmental certification should be applied, based on sales volume and environmental impact intensity (identified through reference to scientific literature).
	Identify effective product supply chain improvement mechanisms	2.2.6.3.				For SMEs, this involves identification of appropriate third party environmental standards for either universal application (for use in green procurement) or to identify front-runner products (to encourage sustainable consumption).
	Choice editing and green procurement of priority product groups based on third party certification	2.2.6.4.				Certified products may be more expensive, thought this is highly dependent on the specific standard and product. By marketing the value-added of certified products, retailers can charge consumers a small price premium.
	Enforce environmental requirements for suppliers of priority product groups	2.2.6.5.				This BEMP is applicable only to private label products, and may involve significant costs. It is not applicable to SMEs.
	Drive supplier performance improvement through benchmarking and best practice dissemination	2.2.6.6.				This BEMP is applicable only to private label products, and may involve significant costs. It is not applicable to SMEs.
	Collaborative research and development to drive widespread supply chain improvement and innovation	2.2.6.7.				This BEMP is applicable only to private label products, and therefore not to SMEs.
	Promote front-runner ecological products	2.2.6.8.				Front-runner environmental products are usually associated with a significant price premium which consumers must be convinced to pay through effective marketing.

Table 4.4: Best Environmental Management Practices for SMEs: transport and logistics

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Transport and Logistics	Green procurement and environmental requirements for transport providers	2.3.4.1				Applicable to all retailers, and the main improvement option for SMEs who rely on third party providers for most of their transport requirements.
	Efficiency monitoring and reporting for all transport and logistic operations	2.3.4.2				Applicable to all retailers. For small retailers, BEMP requires collation of basic information on the transport mode and distance.
	Integrate transport efficiency into sourcing decisions and packaging design	2.3.4.3				Only applicable to large retailers with private label products. Not applicable to SMEs.
	Shift towards more efficient transport modes	2.3.4.4				Primarily applicable to retailers with extensive in-house transport and logistic operations. Not applicable to SMEs, except where available procurement choices enable selection of more efficient transport modes for particular products.
	Optimise the distribution network	2.3.4.5				Only applicable to retailers with extensive in-house transport and logistic operations. Consolidated platforms may be implemented with little investment, but development of strategic central hubs is expensive. Not applicable to SMEs.
	Otimised route planning, use of telematics and driver training	2.3.4.6				Applicable to SMEs if they have their own transport vehicles (e.g. delivery vans).
	Minimise the environmental impact of road vehicles through purchasing decisions and retrofit modifications	2.2.3.7				Applicable to SMEs if they have their own transport vehicles (e.g. delivery vans). There is a wide variation in investment costs for different procurement options and vehicle modifications.

Table 4.5: Best Environmental Management Practices for SMEs: Materials consumption – excluding refrigerants consumption

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Materials consumption	Reduce consumption and use of more environmentally friendly paper for commercial publications	2.5	🟡	🟢	🟡	This technique can be applied to any company generating commercial publications.

Table 4.6: Best Environmental Management Practices for SMEs: Waste Management

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Waste management	Food waste prevention and minimization	2.4.6.1	🟢	🟢	🟢	Any SMEs can apply preventing measures to avoid food waste generation. Management costs would be compensated by cost savings derived from less product losses and less generated waste
	Integration of waste management activities	2.4.6.2	🟡	🟢	🟢	SMEs producing a huge amount of wastes should allocate resources and train staff for waste management.
	Return systems for PET and PE bottles and for used products	2.4.6.3	🟠	🟡	🟢	These systems are increasing reuse and recycling rates in the countries where it is mandatory. Extra resources would be needed for management of the return system.
	Fermentation of food waste	2.4.6.4	🟡	🟡	🟢	Applicable to food retailers with direct control on the treatment of their wastes.

Table 4.7: Best Environmental Management Practices for SMEs: Water Management

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Water management	Rainwater collection and reuse to the ground at retail supermarket from roofs and parking areas	2.6				Applicable for large surfaces, in case of new stores.

Table 4.8: Best Environmental Management Practices for SMEs: Consumer Behaviour

Aspect	Best Environmental Management Practice	Section	Cost	App. To SME	Env. Benefit	Comments
Consumer behaviour	Influencing the consumer behaviour: the example of plastic bags	2.7.2				Small and medium enterprises can be benefitted from the removal of free disposable plastic bags, as they can save a significant amount of money by avoiding its purchase and/or adding a fee to each disposable bag

4.2 The performance of SMEs in the Retail Trade Sector

According to the formal definition, retail trade sector is composed by 93 % of micro enterprises, 7 % of small and medium enterprises and 0.1 % of large enterprises. Figure 4.1 shows how the sector is divided according to the number of companies, number of employees and the annual turnover.

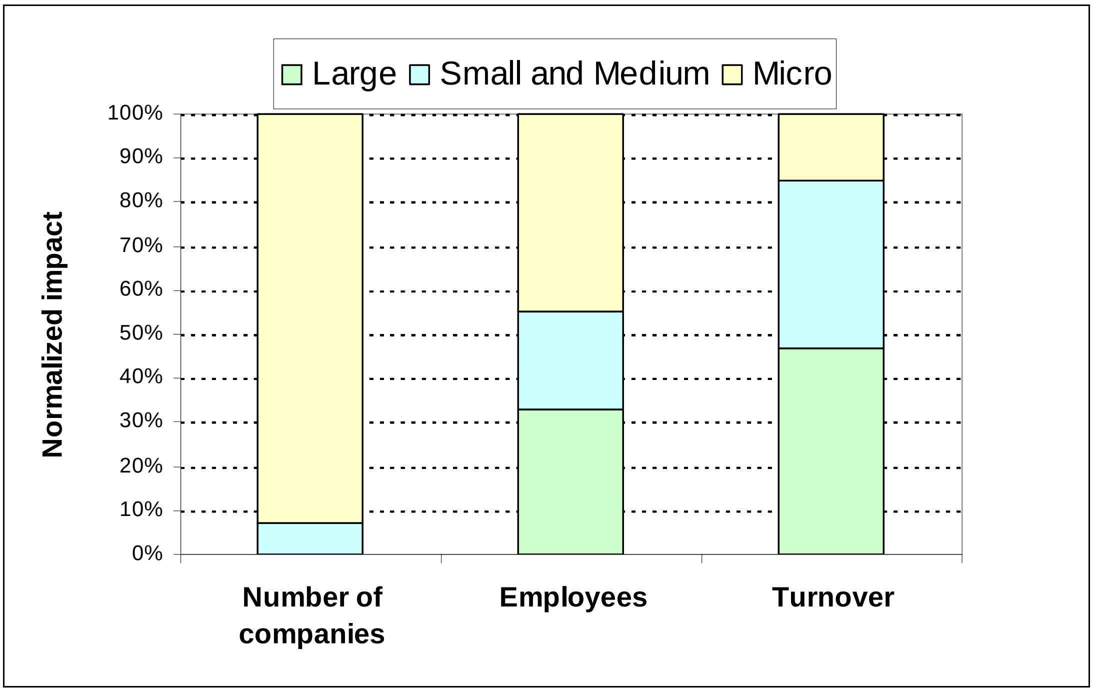

Figure 4.1: Distribution of numer, employees and turnover per size in the Retail Trade sector

Around 85 % of the turnover of the sector is produced by small, medium and large companies. Small companies, from 10 to 50 employees, correspond to individual supermarkets, specialized stores and others working independently or within a larger retailer but with the legal status of SMEs. Medium and large companies usually correspond to companies managing more than one store and are usually independent from other companies in their management. The independency of the company seems to be an important factor regarding to the nature of the investment to be performed in order to improve the environmental performance. The overall impact of the sector is distributed, for several impact categories, as shown in Figure 4.2.

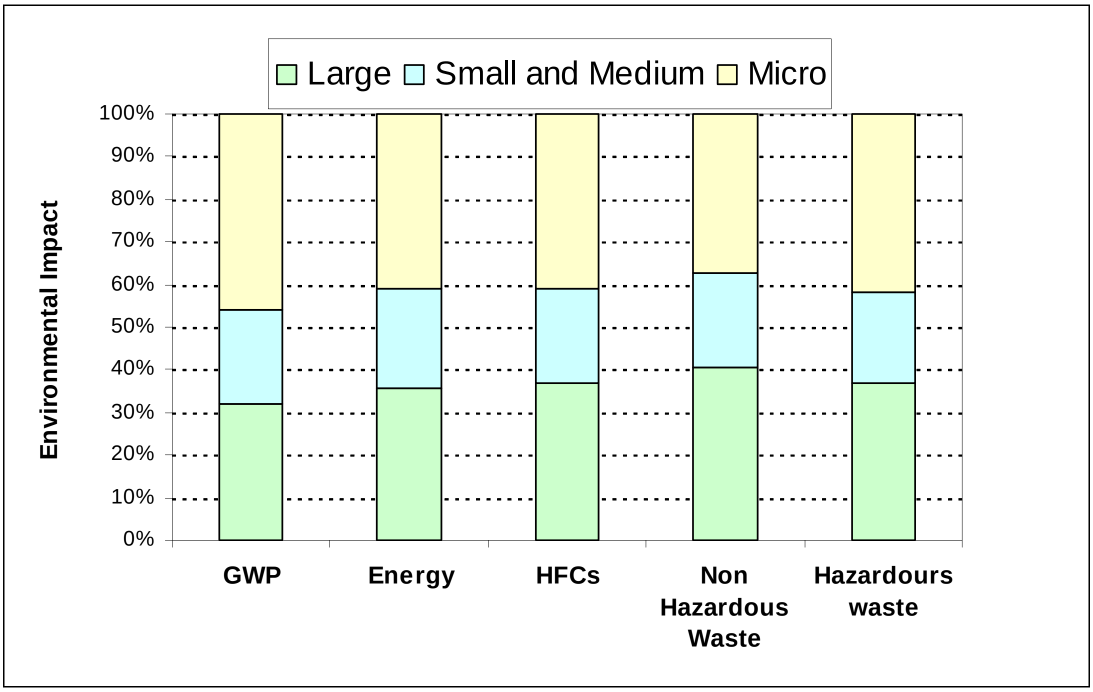

Figure 4.2: **Environmental Impact per category and per size of companies in the Retail Trade sector**

The impact of large companies is 30-40 % of the total. Small and medium companies account for 20 % of the impact and the impact of micro enterprises is about 35-45 % of the total. The environmental impact per 1000 employees of the retail trade sector enterprises seems to be independent form the amount of employees, as shown in Figure 4.3.

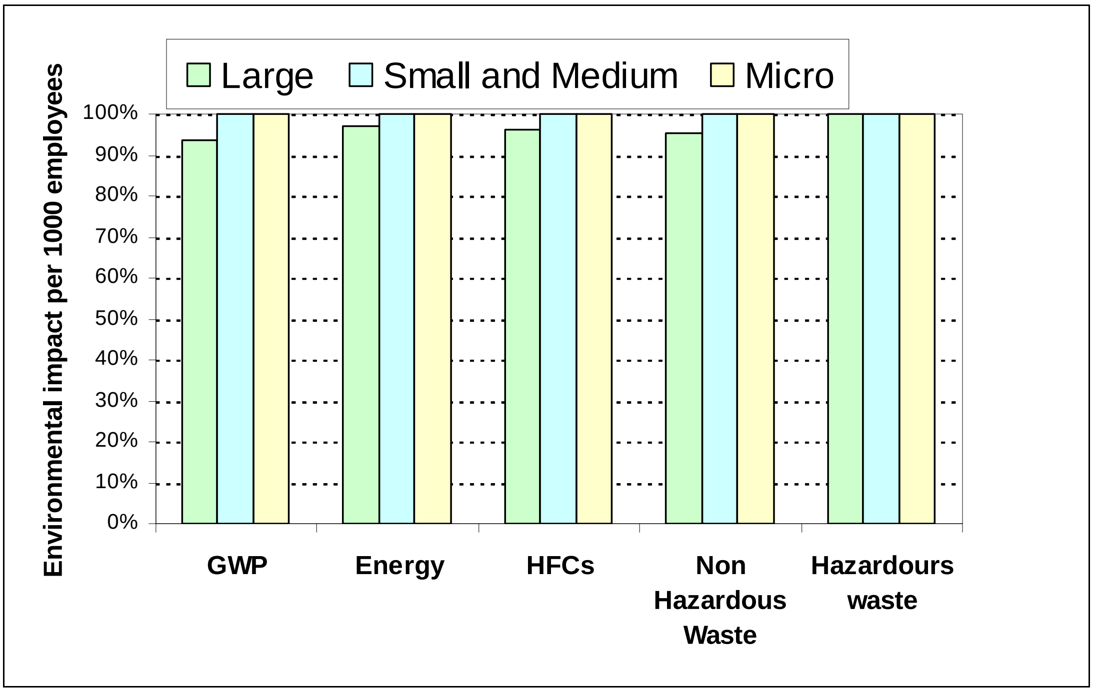

Figure 4.3: **Environmental impact per 1000 employees and per size of companies in the Retail Trade sector**

Nevertheless, the environmental impact per EUR million of turnover is much smaller for bigger companies (Figure 4.4).

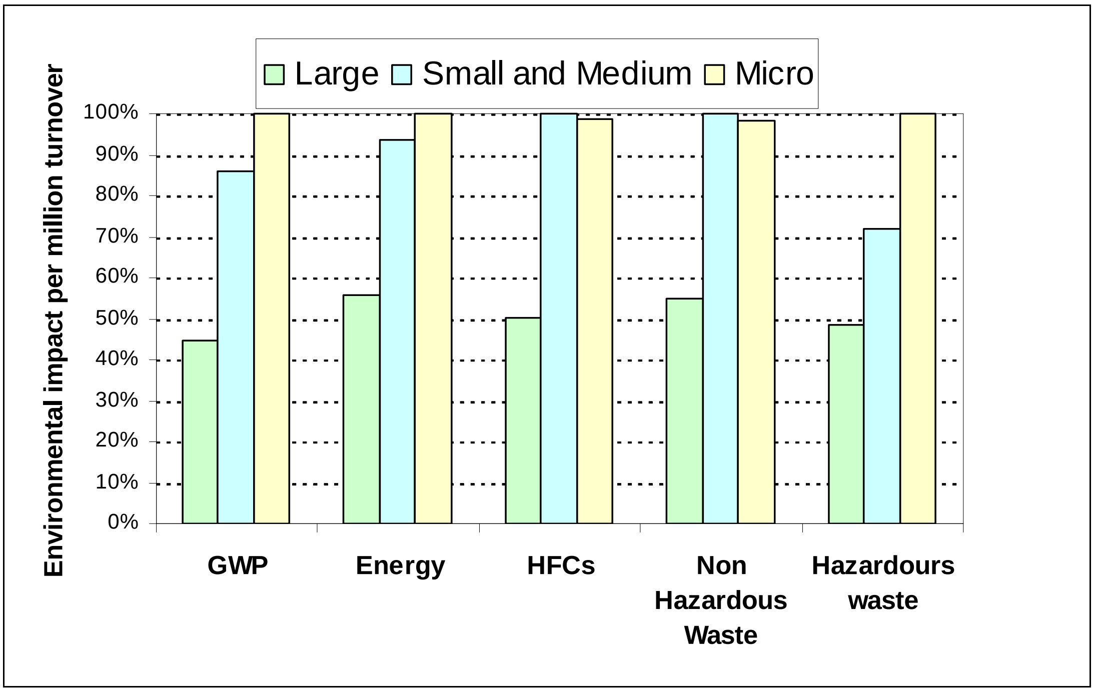

Figure 4.4: Environmental impact per EUR mill turnover and per size of companies in the Retail Trade sector

So the efficiency of their environmental performance is higher than smaller companies. If micro, small and medium enterprises achieve efficiency levels similar to large companies, the overall impact of the sector would be reduced by 27 % in average for the five categories shown in Figure 4.4. The case of energy use is really illustrative: micro, small and medium enterprises need almost double energy to produce EUR 1 million turnover. So, the improvement potential is mainly located on the high inefficiency of the environmental performance of SMEs in the sector.

4.3 SMEs and sustainability

The European Commission published, in 2010, the report 'Opportunity and Responsibility: how to help more small businesses to integrate social and environmental issues on what they do'. This report encourages to uptake the concept of Corporate Social Responsibility (also called responsible entrepreneurship in this context) by SMEs. This report is complemented by other report, from 2004, called 'Fostering CSR among SMEs'([24]). The views of these two reports about the integration of environmental aspects in SMEs management are gathered in the following text.

Drivers:

- management of internal aspects
- some environmental measures pay off in the medium/longer term
- environment, health and cost-efficiency can be improved
- branding: SMEs identified as good or best performer at local level
- external aspects: as better response to existing or new legislation.

Barriers:

- generalization about SMEs can not be done and most solutions should be tailor-made;
- SMEs are a hard to reach group in terms of dissemination;
- usually, manages have limited capacity;
- perceived costs are high;
- actual costs are also high and, usually lower than perceived costs;
- generally, there is lack of awareness, motivation, know-how and know-who and
- there is reluctance to external help.

Mechanisms to address environmental performance improvement:

- solutions for SMEs should be practical and result oriented;
- education of staff and managers is essential;
- building SMEs clusters to address common problems would reduce costs
- intermediary organizations with a high level of awareness can be helpful (trade unions, consultants, commerce chambers, etc.)
- for SMEs, it is really important to receive advice and financial support at national, regional and local level
- in the retail trade sector, the environmental performance of intermediaries SMEs in supply chain is really important and retailers have an important influence of them

The study 'SMEs and the environment in the European Union'([25]), 2010, revealed, among other important issues, that only 24 % of SMEs are engaging actions to reduce their environmental impact and only 0.4 % have an environmental management system. As well, the impact of new environmental legislation is high on the performance of SMEs, as their available resources to comply with new legislations are lower than those of large companies, so financial support can alleviate the costs of complying with environmental legislation. In the application of new environmental solutions, the simplicity, cost and the training needed of the measure are important factors for a SME deciding whether to apply it.

([24]) Chapter based upon the report of the European Commission on 'Opportunity and Responsibility: how to help more small businesses to integrate social and environmental issues on what they do' (2010), http://ec.europa.eu/enterprise/policies/sustainable-business/files/csr/documents/eg_report_and_key_messages/key_messages_en.pdf and 'Fostering CSR among SMEs' (2004) http://ec.europa.eu/enterprise/policies/sustainable-business/files/csr/documents/mainstreaming/ms_sme_roundtable_en.pdf

([25]) SMEs and the environment in the European Union", 2010 http://ec.europa.eu/enterprise/newsroom/cf/itemlongdetail.cfm?displayType=library&tpa_id=0&item_id=4711

5 CONCLUSIONS

5.1 General aspects

Validation process and timing

A Technical Working Group (TWG) was set up to get a broader access to the sector, to obtain more qualified information and to validate the proposed best environmental management practices as well as to draw conclusions with respect to appropriate environmental performance indicators and benchmark of excellence.

Two meetings of the TWG were held. A kick-off meeting took place in June 2009, where the overall structure of the document and the structure for presenting the techniques were agreed. After the period for collecting information and data, carrying out important site visits and developing the draft document, a second TWG meeting was held in November 2010 in order to validate and to agree on information and data to be used for the document. The working group concluded by expert judgment on the most appropriate environmental performance indicators and benchmarks of excellence.

Sources of information, development of the document

The whole document was developed from scratch. Although extensive information, including a number of comprehensive reports, were publicly available and were used as a basis, most of the information needed was obtained from retailers. There were significant differences in the information provided by the various retailers. Some retailers provided all requested information and data in sufficient detail, including even the most recent equipment designs, whilst some were co-operative but provided limited information at a more general level, and others did not provide information beyond the level of press releases.

Level of consensus

The conclusions on the environmental performance indicators and benchmarks of excellence were drawn at the second meeting of the working group in November 2010. There was consensus and no split views were recorded.

5.2 Specific conclusions

This document identifies the most important environmental aspects, direct or indirect, relevant to the organisations or companies belonging to the Retail Trade sector (retailers). It summarises the best environmental management practices dealing with these identified aspects, including sector specific environmental indicators and derived benchmarks of excellence for the environmental performance of organisations and processes/techniques carried out by these organisations.

The conclusions, gathered on this chapter, have been derived by expert judgement, performed by the European Commission through the JRC-IPTS, and by the Technical Working Group (TWG). This group was composed of companies' representatives, umbrella associations, verification bodies, accreditation bodies and the European Commission, who organised and chaired the meetings of the TWG.

This document was developed based on information exchange with retailers, consultation with experts, literature review and site visits. Some of the retailers providing information were big players within the retail market, at European or even global level. This document should be regarded as a support for the efforts of all the actors in the retail trade sector who intend to improve their environmental performance.

Best practice techniques and benchmarks of excellence provide reference points against which an organisation can compare its environmental performance in order to identify improvement potentials.

In this conclusion chapter, first, the identified best environmental management practices (BEMP) are listed (chapter 5.3). Then, the common specific indicators of the retail trade sector are described (chapter 5.4) and derived benchmarks of excellence for each aspect, where appropriate, are shown, with the links to indicators and best practices (chapter 5.5). A final table (chapter 5.6) presents a set of recommended sector-specific key environmental performance indicators. These are a subset of all the indicators listed in the document and in the previous section of the conclusions and are those indicators whose use is recommended for the organisations within the sector.

5.3 Best environmental management practices

Best environmental management practices (BEMPs) are those techniques, measures or actions that allow organisations of the sector to minimise their impact on the environment in all the aspects under their direct control (direct environmental aspects) or on which they have a considerable influence (indirect environmental aspects), resulting in best environmental performance under given economic and technical conditions.
In this document, the identified best practices in the retail trade sector are described in Chapter 2. Their environmental performance has been evaluated in technical detail along with economic considerations. The described practices address the most important environmental aspects of the retail trade sector, both direct and indirect.
The aim of this document is to help organisations to better focus on the most important environmental aspects of the sector. For this purpose, detailed technical information and data were collected and collated, based in many situations on case studies.
The structure of the technical descriptions of the different practices is similar to the Best Available Techniques Reference Documents (BREFs) according to Article 13 of the Industrial Emissions Directive (formerly the IPPC Directive): description, achieved environmental benefits, appropriate environmental indicator, cross-media effects, operational data, applicability, economics, driving force for implementation, reference retailers and reference literature.

In the following sections, best practices for the different environmental aspects are submitted. The most important environmental aspects identified for the Retail Trade sector were:

- energy Performance – including refrigerants consumption (direct)
- supply chain (indirect)
- transport and logistics (direct/indirect)
- waste management (direct)
- materials consumption – excluding refrigerants consumption (direct)
- water management (direct)
- consumer behaviour (indirect).

5.3.1 Energy performance – including refrigerants consumption

1. BEMP is to improve the envelope of existing retailers' buildings to minimise energy losses to an acceptable and feasible level. **BEMP is to optimise the building envelope design** in order to fulfil demanding standards going beyond existing regulations. **See Section 2.1.6.1.**

2. BEMP is to retrofit existing HVAC (Heating, Ventilation and Air Conditioning) systems in order to reduce the energy consumption and improve indoor air quality**. BEMP is to optimise the design of HVAC systems in new buildings,** using innovative systems to reduce the primary energy demand and to increase efficiency**. See Sections 2.1.6.2 and 2.1.6.4**.
3. BEMP is to use integrative concepts for the whole building or for parts of it to reduce the energy demand of the store**. See Section 2.1.6.3**.

4. BEMP is to recover the waste heat from the refrigeration cycle and to maximise its use. See Sections 2.1.6.4 and 2.1.6.2.

5. BEMP is to monitor the energy use of the processes inside a store (heating, refrigeration, lighting, etc.), also at the store and organisation levels. **BEMP is to benchmark the energy consumption** (per process) and **to implement preventive and corrective measures. See Section 2.1.6.5**.

6. BEMP is to implement energy saving measures in the refrigeration system of a food store, especially the covering of refrigeration display cases with glass lids, when the energy saving potential produces relevant environmental benefits. **See Section 2.1.6.6**.

7. BEMP is to use natural refrigerants in food stores, as the environmental impact would be reduced substantially and **to avoid leakages** by ensuring that installations are tightly-sealed. **See Section 2.1.6.6**.

8. BEMP is to design smart lighting strategies with enhanced efficiency and reduced consumption**, to use daylight** without affecting the sales concept and **to use the most efficient lighting devices. See Section 2.1.6.7**.

9. BEMP is to implement energy saving measures in distribution centres, **to audit** periodically energy use within the environmental management system, **to train staff** regarding energy savings and **to communicate** the energy saving efforts of the organisation internally and externally. See **Section 2.1.6.8**.

10. BEMP is to integrate renewable energy sources in stores where, previously, measures to reduce the energy demand and increase the efficiency have been applied. **See Section 2.1.6.9.**

5.3.2 Product supply chain

1. BEMP is for top-level management to integrate supply chain sustainability into **business strategy**, and for dedicated management personnel or units to **coordinate implementation** of necessary actions across retail operations. **See Section 2.2.6.1.**

2. BEMP is to identify priority products, processes and suppliers for improvement through environmental assessment of product supply chains, using **existing scientific information**, **consultation with experts** (e.g. NGOs), and **lifecycle assessment tools**. **See Section 2.2.6.2.**

3. BEMP is to identify effective supply chain improvement mechanisms for **priority products,** specifically **chains of custody** and **control points** that could be used to effectively influence environmental performance. **See Section 2.2.6.3.**

4. BEMP is to exclude worst performing products, and **require widespread** certification according to third party environmental standards for **priority products. See Section 2.2.6.4.**

5. BEMP is to establish environmental criteria for priority products and their suppliers, targeting identified **environmental hotspots,** and to **enforce** compliance these criteria through product and supplier **auditing**. **See Section 2.2.6.5.**

6. BEMP is to drive supplier improvement by establishing **information exchange systems** that can be used to **benchmark suppliers**, and by **disseminating better management practices**. The latter aspect may assist supplier compliance with third party standards and retailer-defined criteria. **See Section 2.2.6.6.**

7. BEMP is to strategically collaborate with other stakeholders to identify and develop **innovative supply chain improvement** options, and to develop **widely accepted environmental standards. See Section 2.2.6.7.**

8. BEMP is to promote front-runner certified ecological products. Awareness campaigns, sourcing, pricing, in-store positioning and advertising are important components of this technique, which can be effectively implemented through development of **own-brand ecological ranges. See Section 2.2.6.7.**

5.3.3 Transport and logistics

1. BEMP is for retailers to integrate environmental performance and reporting criteria into procurement of transport and logistic services provided by third parties, including requirements for implementation of BEMPs described in this document. **See Section 2.3.4.1.**

2. BEMP is to report on the efficiency and environmental performance of all transport and logistic operations between first-tier suppliers, distribution centres, retailers and waste management facilities, based on monitoring of in-house operations and data provided by third party operations. **See Section 2.3.4.2.**

3. BEMP is to integrate transport efficiency into sourcing decisions and packaging design, based on **lifecycle assessment of products** sourced from different regions, and through **designing product packaging to maximise the density of transport units. See Section 2.3.4.3.**

4. BEMP is to shift towards more efficient transport modes, especially rail, water-based transport and larger trucks, and to minimise air-freight. This overlaps with planning of product sourcing and distribution networks. **See Section 2.3.4.4.**

5. **BEMP is to optimise the distribution network** through systematic implementation of the most efficient of the following options: (i) **strategic centralised hubs** to accommodate rail and water-based transport, (ii) **consolidated platforms, (iii)** and **direct routing. See Section 2.3.4.5.**

6. BEMP is to optimise operational efficiency through efficient route planning, use of telematics, and driver training. Efficient route planning includes **back-loading** store delivery vehicles with waste and with supplier deliveries to distribution centres, and making **night-time deliveries** to avoid traffic congestion. **See Section 2.3.4.6.**

7. BEMP is to minimise the environmental impact of road vehicles through purchasing choices and retrofit modifications. This includes purchase of **alternatively powered vehicles, efficient vehicles** and **low-noise** vehicles, **aerodynamic modifications**, and application of **low rolling resistance tyres. See Section 2.3.4.7.**

5.3.4 Waste Management

1. BEMP is to integrate environmental practices to avoid food waste generation, as monitoring, auditing, prioritising, logistic issues, better preservation mechanisms, temperature and humidity control at store, distribution centres and delivery trucks, training staff, donation, etc. **See Section 2.4.6.1.**

2. BEMP is to integrate efficient measures to improve waste management, as waste prevention, collection, segregation, to implement facilities, to use reverse logistics, to monitor waste generation at store and at distribution centres, to re-use packaging materials, to establish local and regional partnerships to improve recycling rate, to manage wastes in the most appropriate way, to train staff on waste management, etc. **See Section 2.4.6.2.**

3. BEMP is to implement take-back systems and to integrate them in the company logistics, as, for example, for PET or PE bottles**. See Section 2.4.6.3.**

4. BEMP is to avoid landfilling or incineration of food waste through fermentation processes. **See Section 2.4.6.4.**

5.3.5 Materials consumption – excluding refrigerants consumption

1. BEMP is to reduce the impact through less consumption of materials, as paper optimization for commercial publications. **See Section 2.5.**

5.3.6 Water management

1. BEMP is to collect rainwater, use it if appropriate and to recirculate it to the natural water cycle (as groundwater recharge). **See Section 2.6.**

5.3.7 Consumer behaviour

1. BEMP is to influence consumers to reduce their environmental impact, through campaigns, as, for example, the removal of plastic bags, responsible advertising and providing best guidance information to consumers**. See Section 2.7.**

5.4 Common specific key performance indicators of the retail trade sector

Indicator	Common Units	Short description	Recommended minimum level of monitoring	Key environmental area [26]	Alternative indicators
ENERGY PERFORMANCE					
Specific energy consumption	kWh/m^2 yr	Energy consumption (electricity, heat from gas or others) per unit of sales area and year. Indications: - Renewable energy consumption should not be subtracted. - Correction factors can be used to determine sales area (in function of height and other technical parameters). 'Sales area' should be defined by retailer. - No correction on opening hours is recommended. Annual consumption figures should be reported.	Per store (site), distribution centre or other and at the organisational level (aggregated value) Per main energy-consuming processes: heat, electricity for refrigeration (where applicable) and electricity for all other uses	Energy efficiency	Specific primary energy consumption Specific (linear) consumption for refrigeration cabinets
Percentage of refrigerant leakages	%	Loss of refrigerants in relation to total refrigerant load of the installation. Indications: - Appropriate for food refrigeration at large installations (centralised systems) - It is recommended to calculate it from annual refrigerant purchases. - It is not environmentally relevant for installations using natural refrigerants.	Per store (site), distribution centre or other and at the organizational level (aggregated value) Per type of refrigerant	Emissions	Direct GHG emissions Use of natural refrigerants (y/n) or % of stores with natural refrigerants

([26]) As defined for core environmental performance indicators in Annex IV of the 1221/2009 EMAS regulation (Section C.2.)

Indicator	Common Units	Short description	Recommended minimum level of monitoring	Key environmental area (26)	Alternative indicators
Lighting Power Density	W/m^2	Lighting power installed to meet illumination needs (basic and for product presentation purposes) per unit of sales Indications: - It is an indicator related to the design and sales concept, applicable to all sizes and types of retailers. - Correction factors can be used to determine sales area (in function of height and other technical parameters). 'Sales area' should be defined by retailer. - Lumens per m2 is a good technical indicator, but the environmental performance should be measured in terms of W/m2. - It can vary within the store (per zone) and during the day (per period).	Per store (site), distribution centre or other Per store zone and per day period, where appropriate	Energy efficiency	Specific energy consumption for lighting
Specific energy generation	kWh/m^2yr	Own-generated energy per square metre of sales area (at stores) or per building floor area (e.g. at distribution centres). Indications: - Green-electricity purchased should not be included. - Correction factors can be used to determine the area (in function of height and other technical parameters).	Per store (site), distribution centre or others and at organizational level (aggregated value) Per source (renewable, from CHP, etc.)	Energy efficiency	Percentage of energy from alternative generation Percentage of alternative energy generation in excess to consumption Greenhouse gases emissions avoidance

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area [26]	Alternative indicators
SUPPLY CHAIN PERFORMANCE					
Assessment of supply chain environmental impacts	Lifecycle impact loading (kg) per product kg or functional unit Environmental hotspots	Lifecycle environmental loadings (CO_2 eq., kg SO_x eq., kg VOC eq., kg 1,4-DCB eq., kg Sb eq., m^3 water, kg PO_4 eq.), biodiversity pressures, location-specific water pressures, expressed per product mass or, where more accurate, per functional unit Identified environmental hotspots for particular supply chains Indications: - Products may be aggregated into groups with similar supply chains (e.g. wild-catch fish, dairy products, wood and paper) - Data may be obtained from scientific literature and expert consultation - Full lifecycle assessments should be performed only to fill critical knowledge gaps - Supplier performance data may be required for some supply chains.	Organisation level, per product supply chain At supplier level where necessary to drive improvement (e.g. through dissemination of better management practices)	Supply chain environmental performance assessment covers: Energy efficiency Material efficiency Water Waste Biodiversity Emissions	Implementation of systematic assessment (independently or through consortia) of core product supply chains (y/n) Number of priority product supply chains that are environmentally improved through application of best practice techniques
Basic product environmental standards	Global Good Agricultural Practice Greenpeace red-list fish Oeko-Tex 1000 National/regional Production Certification Equivalent standards	Basic standards require avoidance of the most environmentally-damaging practices, and approximate to minimum legal environmental requirements in Europe. The main requirements of basic standards are: - compliance with local regulations - record keeping for important environmental aspects (especially land use, chemical use, water management - implementation of a general management plan - in some cases, exclusion of the most damaging practices or products - in some cases, specific benchmarks for a minority of important environmental aspects.	Organisation level, per product group	Environmental standards address: Energy efficiency Material efficiency Water Waste Biodiversity Emissions	Retailer-defined environmental requirements (e.g. H&M Code of Conduct)

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area [26]	Alternative indicators
Improved environmental standards	Better Cotton Initiative Better Sugarcane Initiative Fair Trade Rainforest Alliance Round Table on Sustainable Palm Oil Programme for the Endorsement of Forestry Certification RTRS: Round Table on Responsible Soy UTZ Equivalent standards	Improved standards require important environmental aspects to be addressed more rigorously and more completely than basic standards. In addition to requirements contained in basic standards, improved standards include the following requirements in relation to important environmental aspects: - specific management practices associated with significant environmental improvement - compliance with quantitative environmental performance benchmarks - demonstrated continuous improvement within a specified framework.	Organisation level, per product group	Environmental standards address: Energy efficiency Material efficiency Water Waste Biodiversity Emissions	Retailer environmental performance improvement programmes for suppliers (e.g. Sainsbury's Dairy Development Group)

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area (26)	Alternative indicators
Exemplary environmental standards	Blue Angel EU Ecolabel Forest Stewardship Council Marine Stewardship Council Nordic Swan Organic Equivalent standards	Exemplary standards require important environmental aspects to be addressed sufficiently robustly and completely that certified products may be defined as either: - environmentally sustainable - clear front-runner ecological products - within top 20 % of products rated according to overall environmental performance.	Organisation level, per product group	Environmental standards address: Energy efficiency Material efficiency Water Waste Biodiversity Emissions	Retailer-defined environmental requirements (e.g. Migros Terra Suisse)
Product improvement rate	Percentage products certified to specified environmental performance level	- Percentage product sales within a product group certified according to specified third party environmental standard - Environmental performance level of that standard - May be expressed for private label or total sales (specified) - Include any portion of sales within a product group that is certified to a higher standard than that being reported - Number or percentage of product groups with extensive certification (more than 50 %) at organisation level - Where a programme for widespread certification is being implemented, it is appropriate to express certification targets for product groups	Organisation level, per product group	Environmental standards address: Energy efficiency Material efficiency Water Waste Biodiversity Emissions	Percentage product sales within a product group compliant with specified environmental requirements Percentage product sales within a product group sourced from suppliers participating in specified environmental improvement programmes

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area [26]	Alternative indicators
TRANSPORT AND LOGISTICS PERFORMANCE					
Specific transport energy consumption	MJ/tkm	Direct fuel energy consumption per tonne km transported to compare modal options. Indications: - Based on fuel energy contents - For electric power, based on primary energy for electricity generation (e.g. multiply by 2.7)	Per transport mode and major route	Energy efficiency Material efficiency	Lifecycle primary energy consumption per tkm Diesel consumption l / tkm Diesel consumption of HGVs: l / 100 km Transport mode
Specific transport GHG emissions	kg CO_2 eq./tkm	Provides an indication of the environmental efficiency of transport operations. Indications: - For fossil fuels, based on direct combustion plus indirect extraction and processing emissions - For electricity, based on national average specific GHG emissions of electricity generation and distribution - For biofuels, based on lifecycle assessment of GHG emissions for relevant fuel source	Per transport mode and major route Per fuel type	Material efficiency Emissions	Lifecycle environmental loadings per tkm kg CO_2 eq. / m^3.km or per pallet.km Transport mode

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area (26)	Alternative indicators
Transport GHG emissions	kg CO_2 eq. / m^3 (or pallet) delivered kg CO_2 eq. / per tonne product delivered	Provides an indication of the final environmental impact of transport operations. Indications: - For fossil fuels, based on direct combustion plus indirect extraction and processing emissions - For electricity, based on national average specific GHG emissions of electricity generation and distribution - For biofuels, based on lifecycle assessment of GHG emissions for relevant fuel source.	Per transport mode and major route Per product group	Material efficiency Emissions	Sourcing distance Transport mode

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area (26)	Alternative indicators
WASTE MANAGEMENT					
Generation of wastes	kg, tonnes kg/m^2	Weight of produced waste. Indications: - It can be expressed per unit of sales area.	Per type of waste: e.g. food waste, plastic, paper and cardboard, wood, metal, hazardous materials, etc. Per destination: reuse, external recycling, fermentation, donation, etc.	Waste	Life cycle impact of wastes, for example kg CO_2, MJ, distance etc. Weight per turnover unit, e.g. kg / EUR mill

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area (26)	Alternative indicators
Recycling rate	%	Weight of recycled materials divided by total amount of wastes Indications: - Some retailers include the amount of reused materials. A clear indication on that should be provided when reporting this indicator - For return systems, the rate of take-back should measured per bottles sold	Per type of waste: e.g. food waste, plastic, paper and cardboard, wood, metal, hazardous materials, etc.	Material efficiency Waste	Recovery rate, %, would account for the reuse rate, recycling rate and fermented food waste rate

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area (26)	Alternative indicators
MATERIALS CONSUMPTION EXCLUDING REFRIGERANTS					
Certified paper for commercial consumption	%	Percentage of certified paper (e.g. FSC) used for commercial publications	-	Material Efficiency Waste	Grammage of used paper Number of certified suppliers
WATER MANAGEMENT					
Stores with rainwater collection	%	Percentage of stores with a system of rainwater collection and/or rainwater infiltration systems	-	Water	-
CONSUMER BEHAVIOUR					
Number of bags	#	Number of plastic bags given or sold at check outs. Indications: - The number of free one-use plastic bags should be controlled but, as well, sold or given with promotional purposes or the number of reusable plastic bags sold - It can be reported per customer or per 1000 customers or per turnover unit.	Free one-use plastic bags, free one-use biodegradable plastic bags, sold one-use plastic bags, sold re-usable bags	Material Efficiency Wastes	Other indicators on consumer behaviour can be reported: number of consumer claims regarding environmental information, number of public campaign addressing environmental aspects, etc.

5.5 Benchmarks of excellence and links to BEMP and related specific indicators

Benchmarks of excellence	Link to BEMP	Recommended indicators	Remarks
ENERGY PERFORMANCE			
Specific energy consumption for heating, cooling and air conditioning **less or equal to 0 kWh/m²yr if waste heat from refrigeration can be integrated (see Section 2.1.6.4)**. Otherwise, less or equal to **40 kWh/m²yr for new buildings and 55 kWh/m²yr for existing buildings**	Retrofitting the building envelope for optimal energy performance (see Section 2.1.6.1) Optimised design premises for new and existing Heating, Ventilation and Air Conditioning systems (see Sections 2.1.6.2 and 2.1.6.3) Use of integrative concepts (see Section 2.1.6.3)	**Store specific energy consumption** per m²(sales area) and year **Store primary energy consumption** per m² (sales area) and year	**Applicability:** these practices are applicable to new and existing stores and to all sales concepts. Climatic dependence factors can be applied to the benchmark if backed up by a sound scientific justification. **Economics**: long payback times for envelope retrofitting are foreseen (see Table 2.7). A new optimised building should not cost more than 10 % of a similar building without improvement measures.
Heat consumption of **0 kWh/m²yr** (absence of heating system)	Integration of refrigeration and HVAC (Sections 2.1.6.4 and 2.1.6.2)	**Store energy consumption** per m²(sales area) and year **Energy savings** per m² sales area and year **Produced or recovered heat** per m² sales area and year	**Applicability:** described practice can be applied to any food retailer. Benchmark of excellence derived for a load of refrigeration (low and medium temperature) higher than 40 m of refrigeration cabinets per 1000 m² sales area. Climatic dependence factors can be applied to the benchmark if backed up with a sound scientific justification. **Economics**: Integration with building envelope and HVAC retrofitting have long payback periods (>3 years).
100 % of stores and processes monitored Implemented **benchmarking** mechanisms (y/n)	Monitoring of stores in the energy management system (see Section 2.1.6.5)	**Implementation** of a monitoring system **(y/n)** Percentage of **stores controlled** Number of controlled **processes**	**Applicability:** described practice can be applied to any sales concept. This practice is very relevant for retailers managing a large number of stores. **Economics**: Low cost of implementation if it is integrated into business management structures for new stores. For existing stores, it can be complex but can result in higher savings due to the implementation of corrective measures.

Benchmarks of excellence	**Link to BEMP**	**Recommended indicators**	**Remarks**
100 % covered LT cabinets **100 % use of cooling zones** (e.g. in cash and carry) or **100 % covering of MT** refrigeration where this can lead to an **energy savings of more than 10 %** Specific (linear) consumption of refrigeration **3000 kWh/m yr**	Reduce energy consumption of refrigeration (see Section 2.1.6.6)	**Specific energy consumption** per m^2 sales area and year **Specific (linear) energy consumption per m** of display case and year **Percentage** of stores with **natural refrigerants**	**Applicability:** described practice is applicable to food retailers. Covering freezers and medium temperature cabinets have an impact in the HVAC system. **Economics:** Covering of cabinets can have short payback times (< 3 years) if the achieved savings are equal to or higher than 20 %.
General use of natural refrigerants (y/n)	Use of natural refrigerants (see Section 2.1.6.6)	**Leakage control** (% of refrigerant) **Percentage** of stores with **natural refrigerants**	**Applicability:** described practice is applicable to food retailers. The application of CO_2 for medium temperature cycles depends on ambient temperature. **Economics:** Shifting to natural refrigerants, such as CO_2, has the lowest emissions abatement cost.
Power consumption less than **12 W/m²** for supermarkets and **30** W/m² for specialist stores	Efficient lighting (see Section 2.1.6.7)	**Specific energy consumption** per m^2 sales area and year Installed **lighting power per m²**	**Applicability:** described practice is applicable to any sales concept. An important influence on marketing aspects is observed for lighting. **Economics:** The definition of an optimal lighting strategy and using the most efficient devices can lead to savings higher than 50 %.
100 % of **distribution centres exclusively** in service to the retailer are **monitored**	Secondary measures for reducing energy consumption (see Section 2.1.6.8)	**Specific energy consumption** per m^2 sales area and year Installed **lighting and/or appliances power per m²** **Energy management system in place to drive continuous improvement (y/n)**	**Applicability:** There is no limitation on the size, type or geographical location of the retailer to perform a comprehensive management system, taking into account appliances, distribution centres, specific energy uses or communication and training.
To have **net zero energy buildings** (store or distribution centre) where local conditions allow the production of renewable energy on site, or investment in equivalent renewable energy generation at other locations (y/n)	Use of alternative energy sources (see Section 2.1.6.9)	**Specific energy generation** per m^2 of sales area **Percentage** of energy from **alternative generation** **Percentage** of alternative energy generation in excess of consumption	**Applicability:** described practice is applicable to any sales concept. Important limitations are the availability of renewable sources, accessibility of land or roof installations and demand fixing for combined heat and power systems. **Economics:** Implemented technologies will produce benefits in the long term.

Benchmarks of excellence	Link to BEMP	Recommended indicators	Remarks
SUPPLY CHAIN IMPROVEMENT			
Systematic implementation of supply chain improvement programmes across priority product groups	Integrate supply chain sustainability into business strategy and operations (see Section 2.2.6.1)	**Public reporting** of quantitative corporate targets specifically related to improving the sustainability of priority product supply chains (y/n) Presence of a **high-level business unit** with responsibility for **driving and coordinating** supply chain sustainability actions (y/n) **Systematic implementation of supply chain improvement** programmes across priority product groups (y/n)	**Applicability:** all retailers can integrate supply chain sustainability into business strategy. For small retailers, this is limited to green procurement and encouraging ecological consumption. For larger retailers that sell private label products, a higher level of integration is possible. **Economics**: costs associated with systematic improvement of supply chains should be balanced against: (i) mitigation against supply chain cost volatility arising from anticipated resource supply constraints; (ii) higher profit margins associated with value-added product ranges; (iii) long-term economic advantage associated with reputational and marketing advantages.
Implementation of systematic assessment (independently or through consortia) of core product supply chains	Assess core product supply chains to identify priority products, suppliers and improvement options (see Section 2.2.6.2) Identify effective product supply chain improvement mechanisms (see Section 2.2.6.3)	Lifecycle environmental loadings (CO_2 eq., kg SO_x eq., kg VOC eq., kg 1,4-DCB eq., kg Sb eq., m^3 water, kg PO_4 eq.), biodiversity pressures, location-specific water pressures, expressed per product mass or, where more accurate, per functional unit **Number** of core product supply chains assessed **Number o**f priority product supply chains that are environmentally improved through application of best practice techniques Implementation of **systematic assessment** (independently or through consortia) of core product supply chains (y/n)	**Applicability:** basic environmental assessment methods are relevant to all retailers and all products, to select the most appropriate product groups for choice editing and green procurement and for promotion of front-runners. More data intensive assessment methods are applicable to private label products sold by larger retailers, to inform implementation of supply chain improvement through environmental requirements and supplier environmental performance benchmarking. Core (high sales volume) products should be prioritised for assessment. **Economics:** basic assessment of hotspots based on existing literature is inexpensive, but full supplier-specific assessment is expensive. Costs may be compensated by the identification of new process efficiencies, and by revenue increases associated with value-added products, marketing and reputational benefits.

Benchmarks of excellence	**Link to BEMP**	**Recommended indicators**	**Remarks**
100 % certification according to third party environmental standards	Choice editing and green procurement of priority product groups based on third party certification (see Section 2.2.6.4)	**Percentage of sales** within a product group certified to a specified third party environmental standard The **environmental performance** represented by that standard **Percentage certification targets**, for product groups where a programme for widespread certification is being implemented **Number of product groups** where more than half of sales are certified	**Applicability:** choice editing and green procurement may be implemented by any retailer, to branded and private label products. This technique should be applied to priority product groups identified during supply chain assessment. **Economics:** Achieving widespread certification incurs significant supplier costs usually passed on to the retailer. These costs may be offset by small price premiums that can be asked for certified products. Certification may also increase retailer's overall private label sales through a positive 'halo effect' (improved customer perception).
100 % private label sales within a product group comply with particular retailer-defined environmental requirements	Enforce environmental requirements for suppliers of priority product groups (see Section 2.2.6.5)	**Percentage of private label sales** within a product group compliant with specified environmental requirements The **environmental performance** represented by those requirements **Percentage compliance targets**, for product groups where a programme for widespread compliance is being implemented **Number of product groups** where more than half of sales are compliant with specific environmental requirements	**Applicability:** large retailers, private label priority products. **Economics:** Auditing of supplier environmental performance can be integrated with social auditing and product quality control systems to minimise additional costs. For suppliers, compliance costs should be balanced against improved security of demand and enhanced marketability for their products, and any price premiums they may consequently realise. For retailers, costs should be balanced against reduced reputational and medium-term business supply chain risks associated with unsustainable practices, and against price and marketing premiums they may consequently realize.
100 % private label sales within a product group are sourced from suppliers participating in a retail programmes to improve environmental performance	Drive supplier performance improvement through benchmarking and best practice dissemination (see Section 2.2.6.6)	**Percentage of private label sales** that originate from suppliers participating in retail programmes to improve environmental performance The level of **environmental performance** represented by those programmes **Percentage participating suppliers targets**, for product groups where a supplier improvement programme is being implemented **Number of product groups** where more than half of sales originate from suppliers participating in retail programmes to improve environmental performance.	**Applicability:** large retailers, private label priority products. **Economics:** Retailers may offer suppliers a small price premium to encourage participation in improvement schemes, and pay for data collation and dissemination of better management practice techniques. These costs should be balanced against reduced reputational and medium-term business supply chain risks associated with unsustainable practices, and against price premiums that retailers may consequently realise. The dividends of any identified efficiency improvements may be shared with retailers through contractual agreement.

Benchmarks of excellence	**Link to BEMP**	**Recommended indicators**	**Remarks**
10 % sales within food product groups certified as organic 50 % cotton sales certified as organic 10 % sales within non-food product groups certified according to official (ISO Type-I) environmental labels	Promote front-runner ecological products (see Section 2.2.6.8)	**Percentage sales** within a product group certified according to front-runner exemplary standards **Number of product groups** for which front-runner ecological products are offered Existence of an extensive **own-brand ecological product range** (y/n)	**Applicability:** all retailers can stock and encourage consumption of front-runner ecological products. Large retailers can implement this technique more extensively, through development of own-brand ecological ranges. **Economics:** Supplier costs associated with front-runner certification are passed on to retailers. Certified front-runner ecological products are associated with significant price premiums and higher profit margins. Own-brand ecological ranges are also likely to increase retailer's overall private label sales through a positive 'halo effect'.

Benchmarks of excellence	Link to BEMP	Recommended indicators	Remarks
TRANSPORT AND LOGISTICS PERFORMANCE			
100 % of transport and logistics (T&L) providers comply with either: (i) third-party-verified environment-related standards; (ii) specific environmental requirements; (iii) best environmental management techniques contained in this document	Green procurement and environmental requirements for transport providers (see Section 2.3.4.1)	**Percentage transport providers certified** to environment-related standards (includes registration to reporting programmes), such as: Clean Shipping Project, ERRT Way Ahead Programme, US Smartway Programme **Percentage transport providers complying** with specific **environmental requirements** or BEMPs described in this document	**Applicability:** all retailers purchase at least part of their transport and logistic operations from third party providers, and can make purchasing decisions according to efficiency or environmental criteria. Small retailers are completely dependent on third party providers. **Economics:** improving the efficiency of transport and logistic operations reduces operating costs, and requires effective monitoring and reporting. Efficient third party transport providers may be able to offer lower cost services to retailers.
For 100 % T&L operations between first-tier suppliers, retail stores and waste management facilities, including those performed by third party transport providers, the following indicators are reported: (i) percentage transport by different modes (ii) kg CO_2 eq. per m^3 or per pallet delivered For all in-house T&L operations between first-tier suppliers, retail stores and waste management facilities following indicators are reported: (i) truck load factor (% weight or volume capacity) (ii) kg CO_2 eq. per tkm	Efficiency monitoring and reporting for all transport and logistic operations (see Section 2.3.4.2)	**Tonnes CO_2 eq. per year** emitted by transport and logistic operations **kg CO_2 eq. per m^3**, or pallet delivered Are the following parameters reported for **all** relevant transport and logistic operations: (i) percentage transport by **different modes** (ii) **kg CO_2 eq. per tonne, per m^3 or per pallet delivered (y/n)** Are the following indicators reported for **all in-house** transport and logistics operations: (i) **truck load factor** (% weight or volume capacity) (ii) **kg CO_2 eq. per tkm**	**Applicability:** all retailers. Reporting on in-house transport and logistic operations will only apply to larger retailers. Small retailers can use basic data on average emission factors for different modes of transport to estimate emissions. **Economics:** effective monitoring and reporting requires small investment in necessary information technology systems and management but can identify options to improve the efficiency of transport and logistic operations, and therefore reduce costs.
Systematic implementation of packaging improvements to maximise density and improve T&L efficiency	Integrate transport efficiency into sourcing decisions and packaging design (see Section 2.3.4.3)	**kg CO_2 eq. / m^3** (or pallet) delivered **Modal split** of transport **Number of product groups** where sourcing or packaging has been modified specifically to	**Applicability:** large retailers with private label ranges. **Economics:** for sourcing, highly dependent on product and source location, related to a multitude of sourcing factors. For packaging, increasing the density of packaged goods can considerably improve transport efficiency (by

Benchmarks of excellence	Link to BEMP	Recommended indicators	Remarks
	Assess core product supply chains to identify priority products, suppliers and improvement options (supply chain improvement)	**reduce T&L and lifecycle environmental impact** **Systematic implementation of packaging improvements** to maximise density and improve T&L efficiency (y/n)	up to 30 % for the example of IKEA tea-light candles), and therefore reduce transport costs.
Over 50 % of overland transport between first-tier suppliers and retail distribution centres (tkm or sales value) is by water/rail (where infrastructure allows) Over 99 % of overseas transport, according to sales value, is by ship	Shift towards more efficient transport modes (see Section 2.3.4.4)	**Percentage of total product transport** (tkm or sales value), from first-tier suppliers to stores, accounted for by **specified more-efficient modes**	**Applicability:** large retailers with in-house transport and logistic services, small retailers where they can select transport providers based on different modes, third party transport providers. Products sourced over longer distances. **Economics:** loading and unloading costs for efficient modes (train and ship) are more than compensated for by lower specific transport costs over longer distances.
Systematic optimisation of distribution networks through implementation of strategic hub locations, consolidated platforms, and direct routing	Optimise the distribution network (see Section 2.3.4.5)	**kg CO_2 eq. per m^3 (**or pallet) delivered Number of **consolidation platforms** in use Number of **strategic central hubs** in use Number of **direct transport routes** in use **Percentage reduction in T&L GHG emissions** through implementation of specified distribution network improvement options Outsourcing of T&L operations to a **third party provider with an optimised distribution network** **systematic optimisation of distribution networks** through implementation of strategic hub locations, consolidated platforms, and direct routing (y/n)	**Applicability:** large retailers with in-house transport and logistic services, third party transport providers. Products sourced over longer distances. **Economics:** distribution network optimisation to coordinate transport from multiple suppliers does not require significant investment. Building new central hubs integrated with rail and water-based transport networks does require significant investment. In both cases, increased loading efficiency and the use of more efficient modes for longer distance routes can significantly reduce operating costs. Payback periods vary from months to years. Efficiency dividends may be shared between cooperating parties.

Benchmarks of excellence	Link to BEMP	Recommended indicators	Remarks
100 % of drivers continuously trained in efficient driving, or implementation of an efficient driving incentive scheme for drivers systematic optimisation of routing through back-hauling waste and supplier deliveries on store-delivery return journeys, use of telematics, and extended delivery windows	Optimised route planning, use of telematics and driver training (see Section 2.3.4.6)	**kg CO_2 eq. per m^3** (or pallet) delivered Fleet average **percentage load efficiency** (volume or mass capacity) Fleet average percentage **empty running** (truck km) **Fleet average g CO_2 eq. / tkm** **Percentage of drivers** continuously trained in efficient driving Implementation of an **efficient driving incentive scheme** for drivers (y/n) **Percentage reduction in T&L GHG emissions** through implementation of specified options (i.e. back-hauling waste or supplier deliveries, telematics, driver training and incentive schemes, out-of-hour deliveries) **Systematic optimisation of routing** through back-hauling waste and supplier deliveries on store-delivery return journeys, use of telematics, and extended delivery windows (y/n)	**Applicability:** large retailers with in-house transport and logistic services, third party transport providers. All products. **Economics:** driver training costs are low, and offer payback periods of weeks to months assuming a 5 % fuel saving. Route optimisation may require significant investment in information technology, but can reduce capital investment costs (fewer trucks required) and significantly reduce operating (fuel) costs. Payback periods are short. Efficiency dividends may be shared between cooperating parties.

Benchmarks of excellence	**Link to BEMP**	**Recommended indicators**	**Remarks**
100 % trucks EURO 5 compliant HGV fuel consumption less than 30 l/100 km 100 % trucks, trailers and loading equipment compliant with PIEK noise standards, or equivalent standards that enable night-time deliveries Operation of alternatively fuelled vehicles (natural gas, biogas, electric) 100 % vehicles fitted with low rolling resistant tyres 100 % vehicles and trailers designed or modified to improve aerodynamic performance	Minimise the environmental impact of road vehicles through purchasing decisions and retrofit modifications (see Section 2.3.4.7)	**l/100 km** (vehicle fuel consumption) **kg CO_2 eq. per tkm** **Percentage vehicles** within transport fleet compliant with different **EURO classes** **Percentage of vehicles**, trailers and loading equipment compliant with PIEK **noise standards**, or equivalent standards that enable night-time deliveries with **Percentage of vehicles** in transport fleet powered by **alternative fuel sources**, including natural gas, biogas, or electricity **Percentage of vehicles** within transport fleet fitted with **low rolling resistance tyres** **Percentage of vehicles** and trailers within transport fleet designed or modified to improve **aerodynamic performance**	**Applicability:** large retailers with in-house transport and logistic services, third party transport providers. **Economics:** for vehicles driven long distances at higher speeds (> 80 km/h) small investments in aerodynamic modifications and larger investments to upgrade to aerodynamic tractor and trailer units offer payback periods of months to years. Low rolling resistance tyres payback over months to years. Alternatively powered vehicles require considerably higher investment costs that may not be paid back, but this depends on national fuel and road taxation policies. For the example of Albert Heijn, investment in low-noise transport and loading equipment increased capital costs by 15 %, but reduced overall transport and logistic costs by more than 20 %.

Benchmarks of excellence	Link to BEMP	Recommended indicators	Remarks
WASTE MANAGEMENT			
Zero food waste sent to landfills or incineration plants	Food waste minimization (see Section 2.4.6.1) Integration of waste management in retailers activities (see Section 2.4.6.2) Anaerobic fermentation of food waste (see Section 2.4.6.4)	kg or tonne of food waste, absolute value, per m^2 or per EUR mill. of turnover **Percentage of food waste generation** referred to total food purchases **kg or tonne of food exceeding the sell-by date** but not the use-by date, **donated to charitable institutions** **kg of food waste** sent to **recovery operations**, such as fermentation **kg of food waste** sent to **landfill or incineration** plans	**Applicability:** food retailers of any size and in any European country **Economics:** treatment costs less than EUR 100 per tonne. Achieved savings are higher if prevention measures are implemented or food exceeding sell-by date is donated.
A waste management system is integrated in the store and its objective is to recycle or reuse 100% of secondary packaging materials	Integration of waste management in retailers activities (see Section 2.4.6.2)	**Percentage of recycling and reuse rates**	**Applicability:** any food retailer could implement this practice **Economics:** prevention measures and joint initiatives among stores can produce costs savings
Consumer return of 80% without deposit Consumer return of 95% with deposit	Return systems for PET and PE bottles and for used products (see Section 2.4.6.3)	**Percentage recycling rate** defined per sales of returnable bottle	**Applicability:** any food retailer could implement this practice **Economics:** expensive equipment and maintenance and staff resources needed. In some countries it is mandatory, as Germany. For example, Switzerland is implementing EUR 0.013 fee per bottle to incentive the system.
MATERIALS CONSUMPTION			
100 % certified/recycled paper Grammage less than 49 gr/m^2 Less than 10 % coated paper 100 % print shops EMAS/ISO 14001 certified	Reduced consumption and use of more environmentally- friendly paper for commercial publications (see Section 2.5)	**Percentage of paper** used that is **certified** **Grammage** of paper used **Percentage** of **coated paper** **Percentage of printing shops** certified **EMAS** or **ISO 14001**	**Applicability:** any food retailer could implement this practice **Economics:** expected costs reduction, if compared to normal practices.
WATER MANAGEMENT			

Benchmarks of excellence	Link to BEMP	Recommended indicators	Remarks
WASTE MANAGEMENT			
Rainwater collection and/or infiltration on site is integrated in the water management system	Rainwater from roofs and parking areas: collection and reuse and/or infiltration on site (see Section: 2.6)	**Y/N**	**Applicability:** any retailer could implement this practice, although climate can be an important factor when implementing this measure **Economics:** cost intensive measure
CONSUMER BEHAVIOR			
Zero one-use bag available at checkouts	Influencing consumer environmental behaviour (see Section 2.7)	**Number** of available on-use bags at check outs	**Applicability:** any food retailer could implement this practice **Economics:** expected costs reduction, if compared to normal practices.

5.6 Recommended sector specific key environmental indicators

Indicator	Common Units	Short description	Recommended minimum level of monitoring	Key environmental area (26)	Benchmark of excellence and related best environmental management practice
ENERGY PERFORMANCE					
1. Specific energy consumption	kWh/m^2 yr	Energy consumption (electricity, heat, other fuels) per unit of sales area and year. Indications: - Renewable energy consumption should not be subtracted. - Correction factors can be used to determine sales area (in function of height and other technical parameters). 'Sales area' should be defined by the retailer. - No correction on opening hours is recommended. Annual consumption figures should be reported.	Per store (site), distribution centre or other and at the organisational level (aggregated value) Per main energy-consuming processes: heat, electricity for refrigeration (where applicable) and electricity for all other uses	Energy efficiency	Specific energy consumption for heating, cooling and air conditioning less or equal **to 0 kWh/m^2yr** if waste heat from refrigeration can be integrated. Otherwise, less or equal to **40 kWh/m^2yr** for new buildings and **55 kWh/m^2yr** for existing buildings. (see BEMPs: 2.1.6.1, 2.1.6.2, 2.1.6.3, 2.1.6.4)
2. Specific (linear) consumption for refrigeration	kWh/m yr	Energy consumption of the refrigeration system per linear metre of display case and year. Indications: - Not applicable to stores without refrigeration cabinets, such as non-food retailers.	Per store (site)	Energy efficiency	Specific (linear) consumption of centralised refrigeration of **3000 kWh/m yr**. (see BEMP: 2.1.6.6)

Indicator	Common Units	Short description	Recommended minimum level of monitoring	Key environmental area [26]	**Benchmark of excellence** and related best environmental management practice
3. Lighting Power Density	W/m^2	Lighting power installed to meet illumination needs (basic and for product presentation purposes) per unit of sales area and year. Indications: - It is an indicator related to the design and sales concept, applicable to all sizes and types of retailers. - Correction factors can be used to determine sales area (in function of height and other technical parameters). 'Sales area' should be defined by the retailer. - Lumens per m^2 is a good technical indicator, but the environmental performance should be measured in terms of W/m2. - It can vary within the store (per zone) and during the day (per period).	Per store (site), distribution centre or other Per store zone and per day period, where appropriate	Energy efficiency	Power consumption less than **12 W/m^2** for supermarkets and less than **30 W/m^2** for specialist stores. (see BEMP: 2.1.6.7)
4. Energy monitoring	%	Percentage of stores monitored in the energy management system. Indications: - The monitoring should include all stores and the most relevant processes. - Information should be provided about eventual benchmarking mechanisms implemented	Per store (site) Per process	Energy efficiency	**100%** of stores and processes monitored. Benchmarking mechanisms implemented. (see BEMPs: 2.1.6.5, 2.1.6.8)
5. Percentage of refrigerant leakages	%	Loss of refrigerants in relation to total refrigerant load of the installation. Indications: - Appropriate for food refrigeration at large installations (centralised systems) - It is recommended to calculate it from annual refrigerant purchases. - It is not environmentally relevant for installations using natural refrigerants.	Per store (site), distribution centre or other and at the organisational level (aggregated value) Per type of refrigerant	Emissions	- (see BEMP: 2.1.6.6)

Indicator	Common Units	Short description	Recommended minimum level of monitoring	Key environmental area [26]	Benchmark of excellence and related best environmental management practice
6. Percentage of stores using natural refrigerants	%	Percentage of stores using natural refrigerants out of the total number of stores with refrigeration cabinets. Indications: - Appropriate for food retailers with refrigeration cabinets.	Organisation level	Emissions	General use of natural refrigerants. (see BEMP: 2.1.6.6)

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area [26]	**Benchmark of excellence** and related best environmental management practice
SUPPLY CHAIN PERFORMANCE					
7. Systematic implementation of supply chain improvement programmes across priority product groups	(y/n)	This indicator states whether supply chain improvement programmes are implemented systematically for priority product groups. Indications: - Applicable for retailers of all sizes. - For small retailers, this refers to the application of green procurement and to encouraging environmentally friendly consumption. - For large retailers selling private label products, a higher level of integration of supply chain sustainability into the business strategy is possible.	Organisation level, per product supply chain	Supply chain environmental performance improvements cover: Energy efficiency Material efficiency Water Waste Biodiversity Emissions	Systematic implementation of supply chain improvement programmes across priority product groups. (see BEMP: 2.2.6.1)
8. Implementation of systematic assessment (independently or through consortia) of core product supply chains	(y/n)	This indicator refers to the assessment of supply chain environmental impacts and to the identification of effective product supply chain improvement mechanisms. Indications: - If available, data on the lifecycle environmental loadings (CO_2 eq., kg SO_x eq., kg VOC eq., kg 1,4-DCB eq., kg Sb eq., m^3 water, kg PO_4 eq.), biodiversity pressures, location-specific water pressures, expressed per product mass or, where more accurate, per functional unit, for the assessed products could be reported. - High sales products should be considered core products and be prioritised for the assessment.	Organisation level, per product supply chain	Supply chain environmental performance improvements cover: Energy efficiency Material efficiency Water Waste Biodiversity Emissions	Implementation of systematic assessment (independently or through consortia) of core product supply chains. (see BEMP: 2.2.6.2)

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area (26)	**Benchmark of excellence** and related best environmental management practice
9. Product improvement rate	Percentage sales of products certified to specified environmental performance level	The following rates should be considered. Percentage sales of: - products with third party environmental certification; - private labels products complying with retailer-defined environmental requirements; - food products certified as organic; - cotton certified as organic; - non-food products with eco-labels.	Organisation level, per product group	The environmental standards address: Energy efficiency Material efficiency Water Waste Biodiversity Emissions	**100%** certification, within a product group, according to third party environmental standards. **100%** private label sales, within a product group, complying with retailer-defined environmental standards. **10%** sales within food product groups certified as organic. **50%** cotton sales certified as organic. **10%** sales within non-food product groups certified according to official (ISO Type-I) environmental labels. (see BEMPs: 2.2.6.2, 2.2.6.3, 2.2.6.4, 2.2.6.5, 2.2.6.6, 2.2.6.7, 2.2.6.8)

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area [26]	**Benchmark of excellence** and related best environmental management practice
TRANSPORT AND LOGISTICS PERFORMANCE					
10. Specific transport energy consumption	MJ/tkm	Direct fuel energy consumption per tonne kilometre transported, for total transport and by mode to compare modal options. Indications: - Based on fuel energy contents. - For electric power, based on primary energy for electricity generation (e.g. multiply by 2.7).	Organisation level Per transport mode and major route	Energy efficiency Material efficiency	- (see BEMPs: 2.3.4.1, 2.3.4.2, 2.3.4.3, 2.3.4.4, 2.3.4.5, 2.3.4.6, 2.3.4.7)
11. Specific transport GHG emissions (per product quantity and distance)	kg CO_2 eq./tkm	Provides an indication of the environmental efficiency of transport operations. Indications: - For fossil fuels, based on direct combustion plus indirect extraction and processing emissions. - For electricity, based on national average specific GHG emissions of electricity generation. - For biofuels, based on lifecycle assessment of GHG emissions for relevant fuel source.	Organisation level Per transport mode and major route Per fuel type	Material efficiency Emissions	- (see BEMPs: 2.3.4.1, 2.3.4.2, 2.3.4.3, 2.3.4.4, 2.3.4.5, 2.3.4.6, 2.3.4.7)
12. Specific transport GHG emissions (per product quantity)	kg CO_2 eq. / m^3 (or pallet) delivered kg CO_2 eq. / per tonne product delivered	Provides an indication of the final environmental impact of transport operations. This indicator reflects the distance the products are transported. It is lower if the products are sourced locally/regionally. Indications: - For fossil fuels, based on direct combustion plus indirect extraction and processing emissions. - For electricity, based on national average specific GHG emissions of electricity generation. - For biofuels, based on lifecycle assessment of GHG emissions for relevant fuel source.	Organisation level Per transport mode and major route Per product group	Material efficiency Emissions	- (see BEMPs: 2.3.4.1, 2.3.4.2, 2.3.4.3, 2.3.4.4, 2.3.4.5, 2.3.4.6, 2.3.4.7)

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area [26]	**Benchmark of excellence** and related best environmental management practice
13. Percentage of water/rail transport between first-tier suppliers and retailer distribution centres	%	This indicator shows the share of more efficient transport modes out of the total transport activities of the retailer. Indications: - The percentage of transport by mode can be calculated based on tkm or sales value. - Retailers should distinguish between inland transport and overseas transport. - This indicators is applicable to products sourced over longer distances.	Organisation level Per major route or at least distinguishing between inland and overseas transport	Energy efficiency Material efficiency	Over **50%** of inland transport between first-tier suppliers and retail distribution centres (tkm or sales value) is by water/rail (where infrastructure allows). Over **99%** of overseas transport, according to sales value, is by ship. (see BEMP: 2.3.4.4)
14. Systematic optimisation of route planning	(y/n)	This indicator reflects whether the retailer has implemented a systematic optimisation of its distribution networks through the implementation of strategic hub locations, consolidated platforms, and direct routing. This includes back-hauling waste and supplier deliveries on store deliveries return journeys, use of telematics, and extended delivery windows.	Organisation level	Energy efficiency Material efficiency	Systematic optimisation of route planning. (see BEMP: 2.3.4.5, 2.3.4.6)
15. Percentage of vehicles meeting EURO 5 standards	%	Indications: - Applicable to large retailers with in-house transport and logistics services, third party transport providers. - If possible, also vehicle fuel economy (l/100 km) should be monitored.	Organisation level	Emissions	**100%** trucks comply with the EURO 5 standards. (see BEMP: 2.3.4.7)

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area (26)	**Benchmark of excellence** and related best environmental management practice
WASTE MANAGEMENT					
16. Generation of waste	kg/yr tonnes/yr kg/m^2yr	Weight of produced waste per year. Indications: - It can be expressed per unit of sales area. - It should be monitored separately for different types of waste.	Organisation level Per type of waste: e.g. food waste, plastic, paper and cardboard, wood, metal, hazardous materials, etc. Per destination: reuse, external recycling, fermentation, donation, etc.	Waste	- (see BEMP: 2.4.6.1, 2.4.6.2)
17. Percentage of food waste sent to landfill or incineration	%	Percentage of food waste that is not sent to recovery operations, such as fermentation, out of the total food waste generated.	Organisation level	Waste	**0%** food waste sent to landfill or incineration. (see BEMP: 2.4.6.1)
18. Recycling rate of secondary packaging	%	Weight of recycled materials divided by total amount of waste. Indications: - Some retailers include the amount of reused materials. A clear indication on that should be provided when reporting this indicator.	Organisation level	Material efficiency Waste	A waste management system is integrated in the store and its objective is to recycle or reuse **100%** of secondary packaging materials. (see BEMP: 2.4.6.2)
19. Return rate of packaging and used products	%	Consumer return rate of product packaging, such as plastic bottles, and used products, such as batteries and electronic equipments, out of the total sales of such products. Indications: - For PE and PE bottles return systems, the rate of take-back should measured per returnable bottles sold.	Per type of returnable packaging/product	Material efficiency Waste	Consumer return of **80%** without deposit. Consumer return of **95%** with deposit. (see BEMP: 2.4.6.3)

Indicator	Common units	Short description	Recommended minimum level of monitoring	Key environmental area (26)	**Benchmark of excellence** and related best environmental management practice
MATERIALS CONSUMPTION EXCLUDING REFRIGERANTS					
20. Certified or recycled paper for commercial publications	%	Percentage of certified paper (e.g. FSC) or recycled paper used for commercial publications	-	Material Efficiency Waste	**100%** certified or recycled paper. (see BEMP: 2.5)
WATER MANAGEMENT					
21. Stores with rainwater collection	%	Percentage of stores with a system of rainwater collection and/or rainwater infiltration systems	-	Water	Rainwater collection and/or on-site infiltration is integrated in the water management system. (see BEMP: 2.6)
CONSUMER BEHAVIOUR					
22. Number of bags	#	Number of plastic bags given or sold at check outs. Indications: - The number of free one-use plastic bags should be controlled but, as well, sold or given with promotional purposes or the number of reusable plastic bags sold - It can be reported per customer or per 1000 customers or per turnover unit.	Free one-use plastic bags, free one-use biodegradable plastic bags, sold one-use plastic bags, sold re-usable bags	Material Efficiency Wastes	**Zero** one-use bags available at check-outs. (see BEMP: 2.7)

GLOSSARY OF TERMS AND ABBREVIATIONS

ENGLISH TERM	MEANING
4C	Common Code for the Coffee Community Association
Achieved environmental benefits	main environmental impact(s) to be addressed by the technique (process or abatement), including emission values achieved and efficiency performance. Environmental benefits of the technique in comparison with others
AD	Axfood
AD	Avoid Deforestation
ADEME	French Environment Agency
AFA	Air freight Avoidance
AH	Albert Heijn
Bar	bar (1.013 bar = 1 atm)
BCI	Better Cotton Initiative
BEMP	Best Environmental Management Practice
BMP	Better Management Practice (for agriculture, e.g. in BCI)
BOD	Biological Oxygen Demand (of emissions to water)
BSI	Better Sugarcane Initiative
BSR	Business for Social Responsibility
BSR WWQG	BSR Wastewater Quality Guidelines
C	Carbon
ºC	degree Celsius
CDD	Cooling Degree Days
CH_4	Methane
CHF	Swiss Franc
CFCs	chlorofluorocarbons
CML	Institute of Environmental Sciences (Leiden University)
CNG	Compressed Natural Gas
CO_2	Carbon Monoxide
CoC	Code of Conduct
COD	Chemical Oxygen Demand (of emissions to water)
COP	Coefficient of Performance
CPP	Cleaner Production Programme (H&M initiative for factory improvement)
CR	Chemical Restrictions
CRI	Colour Rendering Index
cross-media effects	the calculation of the environmental impacts of water/air/soil emissions, energy use, consumption of raw materials, noise and water extraction
CS	Coop Switzerland
CSR	Corporate Social Responsibility
dB (A)	Decibel sound
DC	Distribution Centre
1,4-DCB eq.	1,4-Dichlorobenzene equivalent (a reference for toxicity in LCA)
DEFRA	UK Department for Environment, Food and Rural Affairs
EC	European Commission
Eco Invent	LCA database
EIPRO	Environmental Impact of Products (2006 EC Study)
EL	Ecolabel
EMAS	the Community Eco-Management and Audit Scheme
EMS	Environmental Management System
EPBD	Energy Performance of Buildings Directive
EPI	Environmental Performance Indicator
ERRT	European Retail Round Table
ETH	Federal Institute of Technology Zurich
EU	European Union
EU-15	Member States of the European Union before 1 May 2004
EU-25	Member States of the European Union from 1 May 2004 until 31 December 2006
EU-27	Member States of the European Union from 1 January 2007
EUR	Euro – European currency

ENGLISH TERM	MEANING
FAO	Food and Agricultural Organisation (United Nations)
FCs	Fluorocarbons
FiBL	Swiss Research Institute for Organic Agriculture
FSC	Forest Stewardship Council
FT	Fair Trade
GBP	Great British Pound
GCD	Great Circle Distance
GEMIS	Global Emission Model of Integrated Systems (LCA tool)
GG	Global Good Agricultural Practice (also Global GAP) agricultural hygiene and environmental standard
GHG	Greenhouse Gases
GMO	Genetically Modified Organisms
GPS	Global Positioning System
GRI	Global Reporting Initiative (UN guidance for CSR reporting)
Gt	Giga (10^9) tonne
GWh	Gigawatt-hour (1 GWh = 3600 GJ)
GWP	Global Warming Potential (a measure of how a given mass of greenhouse gas contributes to global warming)
HCFCs	Hydrochlorofluorocarbons
HDD	Heating Degree Days
HFCs	Hydrofluorocarbons
HGV	Heavy Goods Vehicle
HVAC	heating, ventilation and air conditioning
IA	IKEA
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management (a BMP defined by the FAO))
IPPC	integrated Pollution Prevention and Control
kcal	kilocalorie (1 kcal = 4.19 kJ)
KF	Kingfisher
KF Sweden	Kooperativa Förbundet (Coop Sweden)
kg	kilogram (1 kg = 1000 g)
kJ	kilojoule (1 kJ = 0.24 kcal)
KRAV	Swedish organic certification organisation
kWh	kilowatt-hour (1 kWh = 3600 kJ = 3.6 MJ)
LCA	Lifecycle Assessment
LED	Light-Emitting Diode
LGV	Light Goods Vehicle
LHV	Longer Heavier Vehicle
lm	lumen
LT	Low Temperature (cooling), i.e. temperatures below 0ºC
m	metre
m/min	metre/minute
m^2	square metre
m^3	cubic metre
m^3/h	volume flow: if not otherwise mentioned in this document, the volume flows refer to 10 vol-% oxygen and standard state
MDO	Medium Density Oil
mg	milligram (1 mg = 10^{-3} gram)
mg/m^3	concentration: if not otherwise mentioned in this document, the concentrations of gaseous substances or mixtures of substances refer to dry flue-gas at 10 vol-% oxygen and standard state
MG	Migros
MGO	Medium Gas Oil (see also MDO)
µm	micrometre (1 µm = 10^{-6} m)
MJ	Mega Joule (1 MJ = 1000 kJ = 10^6 joule energy)
mm	millimetre (1 mm = 10-3 m)
MSC	Marine Stewardship Council
Mt	Megatonne (1 Mt = 10^6 tonne)

ENGLISH TERM	MEANING
MT	Medium Temperature (cooling), i.e. temperatures between 1ºC and 8 ºC
MW	Megawatt
MWh	Megawatt-hour (1 MWh = 3600 MJ = 3.6 GJ)
N	Nitrogen
N_2O	Nitrous Oxide (a GHG)
NACE code	French abbreviation for "Nomenclature generale des activites economiques"; it is the Classification of Economic Activities in the European Community
NGO	Non Governmental Organisation
ng	nanogram (1 ng = 10^{-9} gram)
NH_3	Ammonia
Nm^3	Normal cubic metre (101.3 kPa, 273 K)
NMVOC	Non-Methane Volatile Organic Compounds
NO_x	Nitrogen Oxides
NTM	Swedish Transport Association
OC	Organic
Q	total amount of energy transferred as heat
P	Phosphorus
PAH	Polycyclic Aromatic Hydrocarbons
PAS 2050	UK PCF standard
PCF	Product Carbon Footprint
PCR	Product Category Rule (for PCF calculation)
PDCA	Plan, Do, Check, Act (approach to energy/environmental management)
PE	polyethylene
PEB	Positive Energy Building
PEFC	Programme for the Endorsement of Forestry Certification schemes
PET	polyethylenterephthalate
PIEK	Dutch noise standard
PM	Particulate Matter (air emissions)
PO_4	Phosphate
ppm	parts per million
REAP	Retailers' Environmental Action Programme
RFA	Red-list Fish species Avoidance (based on Greenpeace red list)
RFI	Radiative Forcing Index (GWP index according to altitude or emissions)
RSPO	Roundtable on Sustainable Palm Oil
RTRS	Roundtable on Responsible Soy
RW	REWE
SAP	Sustainable Agricultural Production (M&S initiative)
SBB	Swiss rail company
SCSG	Sainsbury's Crop Sustainability Group
SDG	Sainsbury's Development Group (for non-dairy products)
SDDG	Sainsbury's Dairy Development Group
SimaPro	LCA tool
SME	small and medium enterprises
SO_x	Sulphur Oxides
SS	Sainsbury's
standard conditions for the cement and magnesium oxide industries	referring to a temperature of 273.15 K and a pressure of 1013 hPa and oxygen content of 10 %
standard conditions for the lime industry	referring to a temperature of 273.15 K and a pressure of 1013 hPa and oxygen content of 11 %
standard state	referring to a temperature of 273.15 K and a pressure of 1013 hPa
T	tonne (metric)
TEWI	Total Equivalent Warming Impact
TFEU	Twenty Foot Equivalent Unit
tkm	tonne-km (transport metric)
T&L	Transport and Logistics
TO	Tesco

ENGLISH TERM	MEANING
TOC	total organic carbon
UN	United Nations
UTZ	Certification organisation and label for cocoa, coffee, oils, tea
U-value	the overall heat transfer coefficient, describes how well a building element conducts heat. It measures the rate of heat transfer through a building element over a given area, under standardized conditions.
vkm	Vehicle kilometre
VOC	Volatile Organic Compounds (emissions to air)
WBCSD	World Business Council for Sustainable Development
WE	Waitrose
WRI	World Resources Institute
WWF	World Wildlife Fund
yr	year
ZEB	Zero Energy Building

APPENDICES

Appendix A1. Goals and targets listed in Coop Switzerland's 2010 Sustainability Report that reflect the integration of supply chain sustainability issues into this retailer's structure and operations

Goals 2008-2010	Measures taken 2009
Consolidate Coop's leadership in environmentally and socially responsible products in all retail formats	100 new products for Naturaplan range; CO_2 neutrality for Naturaline knitwear range; Relaunch and expansion of Oecoplan range; Range expansion and sales growth for Pro Montagna range
Expand the range of fish and shellfish from sustainable farming (organic) or from wild catch (MSC)	Increase share of certified sustainable fish to 33 % of fish sales; Delisting of additional six products (total 19) from endangered stocks and substitution with sustainable alternatives
Expand range of wood and paper products with the FSC label or made from recycled fibre	Prix Guarantee toilet paper entirely from recycled fibre; Increase in proportion products from FSC wood to 100 % wooden toys, 80 % of stationary and 70 % handicrafts range
Successfully market products that have been sustainably produced in Switzerland (pro Montagna, Slow Food, Bio Regio)	Range expansion and sales growth for Pro Montagna range
Introduce supplier management system that extends as far as their production facilities	New traceability and monitoring system for Naturaline and Naturafarm (low achievement); Examination of how supplier audit information can be integrated into SAP
Raise awareness, train and audit suppliers of fruit and vegetables in Spain, Morocco and Italy in quality, ecology and social standards	Organisation of stakeholder roundtable and support for two major employers (10 000 employees) to complete BSCI process Development of a training module and training of three vegetable suppliers (25 producers) in preparation for GRASP audit Auditing of ten suppliers of berries for compliance with Coop water management requirements
Increase the proportion of coffee, palm oil and soy from sustainable production	Rise in share of 4C coffee from 8 % to 20 % (2020 target 100 %); 80 % palm oil in own-brand products covered by sustainability certificates; Stipulation on sustainable soy included in Coop feed guideline for farmers
Define and exploit synergies with Eurogroup and Coopernic in relation to sustainable sourcing	Workshop on sustainability in fruit and vegetable sector; Drafting of commitments on fish, fruit and vegetables and products from risk countries within Coopernic
Make the best possible use of Coop Sustainability Fund	Promotion of research projects at interface of climate protection, securing food supplies and agriculture; Development of CO_2 neutral production of all Naturaline organic textiles and cotton wool products; Support for sustainable sourcing of cocoa in Honduras; Raising public awareness of sustainable consumption through exhibitions at innovative 'tropical houses'

Appendix A2. Some key commitments contained in M&S's 2009 Sustainability Report that demonstrate integration of supply chain environmental sustainability considerations into retailer structure and operations

Commitment	Aim	Progress
Buying guidelines	Training all relevant employees on responsible buying as part of their development by 2012.	Developed a responsible buying course with Traidcraft and Chartered Institute of Purchasing and Supply that is being integrated into a training programme.
Cotton	Produce 25 % of cotton from sustainable sources by 2015, and 50 % by 2020.	Cotton sustainability strategy promotes Fairtrade, organic, recycled and more sustainable cotton. Improving cotton production in India with WWF.
Food carbon footprint	Work with Carbon Trust to identify 'hotspots' and set targets to reduce GHG emissions by 2012.	Calculated carbon footprint of M&S food sales (3.3 Mt CO_2 eq./yr). Developing a CO_2 performance indicators and set of priority actions for dairy farmers.
Green factories	Support the development of "green" factories with suppliers.	Have supported the development of four general merchandise and one green food factory.
Pesticide network	Launch a Pesticide Residue Reduction Network with suppliers.	Trials underway to reduce pesticide use on strawberry production, and develop natural pesticide alternatives to control moth larvae in Indian rice production.
Product information	Improving traceability for principal raw materials used within General Merchandise supply chain by 2015.	Have developed an improved database using SAP software, operated with Supplier Ethical Data Exchange, to manage product information down to the factory level.
Supplier exchange	Launch a supplier exchange to drive best practices and stimulate innovation.	In 2009/10, used supplier exchange network to develop Food Supplier Environmental Sustainability Framework and Measurements.
Sustainable farming	Engage meat, dairy and flower farmers with M&S Sustainable Agriculture Programme by 2012, and other farmers by 2015.	In 2009/10 a set of environmental standards were trialled on selected dairy, lamb, chicken and produce farms.
Sustainable textiles	Reduce the environmental impact of textiles throughout the supply chain by 2012.	Contributed to UK DEFRA's Sustainable Clothing Action Plan and established new standards for clothing factories, dye houses and raw materials.
Water efficiency (suppliers)	Work with suppliers to improve water use efficiency during production.	Worked with WWF to establish water footprint for clothing and five food supply chains. Published Water Efficiency Guide for farmers and included water use in M&S farm standards.

Appendix A3. Business for Social Responsibility Waste Water Quality Guidelines

Table.5.1: Waste water quality guideline effluent concentration limit values

Parameter	value	Unit
Temperature	≤ 37	°C
pH	6.0 – 9.0	
Total Suspended Solids (TSS)	≤ 30	mg/l
Biochemical Oxygen Demand in 5 days (BOD_5)	≤ 30	mg/l
Chemical Oxygen Demand (COD)	≤ 200	mg/l
Antimony	≤ 0.01	mg/l
Arsenic	≤ 0.01	mg/l
Cadmium	≤ 0.01	mg/l
Chromium	≤ 0.01	mg/l
Cobalt	≤ 0.02	mg/l
Copper	≤ 0.25	mg/l
Cyanide	≤ 0.2	mg/l
Lead	≤ 0.1	mg/l
Mercury	≤ 0.01	mg/l
Nickel	≤ 0.2	mg/l
Zinc	≤ 1.0	mg/l
Colour	≤ 150	ADMI units or Co-Pt units
Foam	No visible discharge of floating solids or persistent foam	

Appendix A 4. H&M Chemical Restrictions List

Azo Dyes and Pigments: 4-aminodiphenyl, Benzidine, 4-Chloro-o-toluidine, 2-Naphthylamine, o-minoazotoluene, 2-Amino-4-nitrotoluene, 2,4-Diaminoanisole, 4,4'-Diaminodiphenylmethane, 3,3'-Dichlorobenzidine, 3,3'-Dimethoxybenzidine (o-Dianisidine), 3,3'-Dimethylbenzidine (o-Tolidine), 3,3'-Dimethyl-4,4'-diaminodiphenylmethane, p-Chloroaniline, p-Cresidine, 4,4'-Methylen-bis-(2-chloroaniline), 4,4'-Oxydianiline, 4,4'-Thiodianiline, 2,4-Toluenediamine, o-Toluidine, 2,4,5-Trimethylaniline, o-Anisidine, p-Aminoazobenzene, 2,4-Xylidines, 2,6-Xylidines, **Disperse Dyes:** Disperse Blue 1, Disperse Blue 3, Disperse Blue 7, Disperse Blue 26, Disperse Blue 35, Disperse Blue 102, Disperse Blue 106, Disperse Blue 124, Disperse Brown 1, Disperse Red 1, Disperse Red 11, Disperse Red 17, Disperse Orange 1, Disperse Orange 3, Disperse Orange 11, Disperse Orange 37, Disperse Orange 76, (previously designated Orange 37), Disperse Yellow 1, Disperse Yellow 3, Disperse Yellow 9, Disperse Yellow 23, Disperse Yellow 39, Disperse Yellow 49, **Other Dyes:** Acid Red 26, Basic Red 9, Basic Violet 14, Direct Black 38, Direct Blue 6, Direct Brown 95, Direct Red 28, Solvent Yellow 1, Solvent Yellow 2, Solvent Yellow 3, Para-phenylenediamine, **Flame Retardants:** Tris(2,3-dibromopropyl) phosphate (TRIS), Bis(2,3-dibromopropyl) phosphate, Tris-(aziridinyl)-phosphineoxide, (Tris(1-aziridinyl)phosphine oxide) or (TEPA), Polybromodiphenyl ethers (PBDE's), Tetrabromobisphenol A (TBBP A), Polybromobiphenyles (PBB's), Tri-o-cresyl phosphate, Tris(2-chloroethyl) phosphate (TCEP), Hexabromocyclododecane, 2,2-Bis(bromomethyl)-1,3-propanediol, Tris(1,3-dichloro-isopropyl) phosphate (TDCP), Triphenyl Phosphate (TPhP), **Chloroparaffines:** Short Chained (SCCP's), Medium Chained (MCCP's), **Formaldehyde, Polyvinylchloride (PVC), Phthalates:** Di-isononyl phthalate (DINP), Di(ethylhexyl) phthalate (DEHP), Di-n-octyl phthalate (DNOP), Di-iso-decyl phthalate (DIDP), Butyl benzyl phthalate (BBP), Dibutyl phthalate (DBP), All other phthalates (all other esters of o-phthalic acid), **Organotin Compounds:** Dibutyltin (DBT), Tributyltin (TBT), Tricyclohexyltin (TCyHT), Trioctyltin (TOT), Triphenyltin (TPhT), Tripropyltin (TPT), **Triclosan, Bisphenol-A (BPA), Antimony (Sb), Arsenic (As), Cadmium (Cd), Chromium (Cr), Chromium VI (Cr6+), Cobalt (Co), Lead (Pb), Mercury (Hg), Nickel (Ni), Phenols:** Pentachlorophenol (PCP) and its salts and esters, Tetrachlorophenol (TeCP) and its salts and esters, o-Phenylphenol (OPP), **Pesticides:** Aldrin, Captafol, Chlordane, Chlordecone (Kepone), Chlordimeform, Chlorobenzilate, DDD, DDE, DDT, Dibromochloroproprane (DBCP), Dieldrin, Dinoseb DTTB - (Timiperone), Endrin, Ethylene dibromide, Heptachlor, Heptachloroepoxide, Hexachlorobenzene, Hexachlorocyclohexane, ß-Hexachlorocyclohexane, δ-Hexachlorocyclohexane, Lindane (γ-Hexachlorocyclohexane), Isodrin, Kelevan, Metamidophos, Methoxychlor, Mirex, Monocrotophos, Monomethyldibromodiphenylmethane, Monomethyldichlorodiphenylmethane, Monomethyltetrachlorodiphenylmethane, Parathion, Parathion-methyl, Perthane (Ethylan), Phosphamidon, Quintozene, Strobane, Telodrin (Isobenzan), Toxaphene (Camphechlor), Halogenated biphenyls with the formula C12HnX10-n X=halogen, n=1,2,...9, Halogenated terphenyls with the formula C18HnX14-n X=halogen, n=1,2,...13, Halogenated naphthalenes with the formula C10HnX8-n X=halogen, n=1,2,...7, 2-(2,4,5-), Trichlorophenoxy, propionic acid and its salts and 2-(2,4,5-Trichlorophenoxy) propionyl compounds (2,4 – D), 2,4,5-Trichlorophenoxyacetic acid and its salts and 2,4,5-Trichlorophenoxyacetyl compounds (2,4,5 – T), **Alkylphenol Ethoxylates/Alkylphenols (APEO/AP):** Nonylphenol ethoxylates (NPEs), Octylphenol ethoxylates (OPEs), Nonylphenol (NP), Octylphenol (OP), **Cationic Surfactants:** Distearyldimethyl ammoniumchloride (DSDMAC), Ditallow dimethyl ammonium chloride (DTDMAC), Dihydrogenated Tallow, Dimethylammonium Chloride (DHTDMAC), **Octamethylcyclotetrasiloxane, Dimethylformamide (DMF), Isocyanates:** Hexamethylene diisocyanate (HDI), Isophorone diisocyanate (IPDI), 2,4-Toluene diisocyanate (TDI), Diphenylmethane diisocyanate (MDI), Tetramethylxylene diisocyanates (TMXD), **Perfluorinated Alkylated Substances (PFAS):** Perfluoro-octane sulphonate, (PFOS) and PFOS related substances, Perfluorooctanoic acid (PFOA), **Polychlorinated Biphenyls (PCBs), Polychlorinated Triphenyls (PCTs), Chlorinated Bleaching Agents, Chlorinated Aromatic Hydrocarbons:** Chlorobenzenes, Chloronaphthalenes, Chlorotoluenes, Chloroxylenes, **Polyaromatic Hydrocarbons (PAH):** Benzo(a)pyrene, Benzo(e)pyrene, Benzo(a)antracene, chrysene, Benzo(b)fluoranthene, Benzo(j)fluoranthene, Benzo(k)fluoranthene, Dibenzo(a,h)anthracene, **Mineral Oils, Organic Solvents:** Benzene (Benzol), Dimethylacetamide (DMAC), 1,4-Butanediol, Dimethylformamide (DMF), Ethylene glycol monoethyl ether, Methylene chloride, n-Hexane, 4,4'methylenebis(2-chloroaniline) (MBOCA), Phenol, Tetrachloroethylene (PERC), Tetrachloromethane, Trichloroethylene

Appendix A5. Promoting BMPs amongst farmers in India and Pakistan (WWF, June 2010)

Participatory Approaches for the implementation & dissemination of Better Management Practices in Pakistan

Training of facilitators, Farmer Field Schools (FFS) and Resource Centres (RC) have been demonstrated as an effective means for the dissemination of Better Management Practices (BMPs). The approaches are field-based and participatory where each setting has its own ground realities; problems and solutions; and farmers must be equipped to best address their problems. Under the ToF, 25–35 participants, mostly agricultural extension agents, representatives from the local NGOs, and research institutions are trained over a cropping season. The ToF course contents are developed on the basis of problems and issues identified by experts and farmers mutually, to address all aspects of farming including the socio-cultural aspects. Some non-formal group dynamic activities are also performed in which all ToF participants work in the field with the farmers. The ToF participants observe a selected field and perform Agro-Eco-System Analysis (AESA) and discuss the observations([27]) in the field, every 2nd and 3rd day of the week, throughout the crop season.

Followed by AESA, each group (comprised of five participants) of the ToF participants run 5–10 FFS (a total of 125–250 farmers). The AESA is again the basic activity of FFS([28]), where they collect the insects, disease specimens and weeds, etc., followed by drawing the figures and sharing results for further decision making. The farmers learn to organise themselves through this practice and enhance their decision-making capability for their crop with help and advice of the experts. This model aims to help farmers to discover and learn about field ecology and integrated crop management starting from land preparation to right seed selection, rational use of irrigation, fertilisers and pesticides, harvesting and marketing.

The establishment of RCs is another participatory approach to promote BMPs, where resource-poor farmers will be facilitated to receive the agricultural inputs on an actual basis and will be provided with the latest tools and equipment which otherwise are out of their reach. These centres will also be the focal point for farm advisory services and for the implementation of community development including agriculture, infrastructure, social and economic activities.

The key to the success of these participatory approaches is the empowerment of the farmers with an understanding of the agro-ecology of their own fields. Moreover, all these approaches address the skill development programme enhancing capacity of the farmers towards observation, analyses, interaction between different factors, developing and establishing simple experimentations based on their own hypotheses and making the right site-specific management decisions. In this way farmers become active learners and independent decision makers through a process of learning by doing; which has helped in increasing their income and improving their livelihood.

([27]) The observations including the soil, seed quality, biological pest controlling agents and crop variety, the crop health need for water, insect pests and their natural enemies etc

([28]) In a FFS (Farmer Field School) farmers are trained through Farmer Participatory Technology Development and Dissemination (FPTD&D), during which farmers learn how to make and record detailed observations, how to conduct simple experiments to solve complex issues and learn to analyse and interpret the results of the findings.

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Abstract

Retailers have a large potential to reduce their environmental impacts and many are already implementing effective actions. This document describes what are the best practices implemented by frontrunner retailers in all aspects under their direct control or on which they have a considerable influence. They cover the energy performance of retailers, the sustainability of retail supply chains, transport and logistics, waste and other areas including engaging with consumers.
The document also contains sector-specific environmental performance indicators and benchmarks of excellence. These can be used by retailers to monitor their environmental performance and to benchmark it against the performance of frontrunner retailers in each given specific area.
Overall, this document aims at supporting all actors in the retail trade sector who intend to improve their environmental performance and seek for reliable and proven information on how best to do it.

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