ECOFYS

sustainable energy for everyone

Background document III: Assessing Requirements for Non-energy Related Products and Means of Transportation

Evaluation of the Energy Labelling Directive

and specific aspects of the Ecodesign Directive

ENER/C3/2012-523

Background document III: Assessing Requirements for Non-energy Related Products and Means of Transportation

Evaluation of the Energy Labelling Directive

and specific aspects of the Ecodesign Directive

ENER/C3/2012-523

By:
João Fong (ISR – University of Coimbra)
Corinna Fischer (Őko-Institut)
Edith Molenbroek (Ecofys)

Date: June **6th,** 2014

Project number: BUINL13345

Table of contents

1 Introduction

One of the key priorities in the evaluation of the Energy Labelling and Ecodesign Directives regards the scope of these directives. This report sets out to analyse the possibility to extend the scope of both directives to non-energy related products, product systems and means of transport.

While the working plan for 2012-2014 did not include non-energy related products, it did mention power generating equipment under 50MW as being one target to investigate the opportunity for establishing Ecodesign and energy labelling requirements, since the savings potential may be substantial. It has, therefore, been included in Lot 1 of the upcoming preparatory studies for implementing measures under the Ecodesign Directive, and is not addressed in this report.

The analysis is built on existing studies such as the 2011 CSES evaluation study of the Ecodesign Directive (CSES 2012). The findings of this task do not replace future steps in the Ecodesign and energy labelling regulatory process such as the preparation of the next Working Plan, or Ecodesign Preparatory Studies. Instead, it assesses the feasibility of including the above mentioned products in the scope of the Energy Labelling or the Ecodesign Directives.

To assess which product groups are appropriate and feasible for energy labelling and Ecodesign requirements, the following criteria will be taken into consideration:

- Sales and trade volumes;
- Key environmental impacts and improvement potentials;
- Appropriateness of Ecodesign in realising these potentials considering aspects such as:
- Necessity for regulation (market failure);
- Possibility to regulate the aspect on a product level;
- Possibility to address the impact successfully at a design stage;
- Coverage by existing legislation;
- Feasibility, e.g. with respect to conformity assessment, administrative burden and cost.

2 Methodology[1]

To access the appropriateness and feasibility of extending the product scope above the following methodology is followed:

1. Reduce the Prodcom list;
2. Aggregate the remaining product groups to form higher-level categories;
3. Refine / modify the list using other categorizations such as COICOP, or categorizations used in other studies (EIPRO, 2006, CSES, 2012);
4. For the resulting categories, develop a scoring system based on:
    a. an assessment of market size (especially if expressed in other terms than unit sales);
    b. a first rough (and, if necessary, qualitative) assessment of environmental impact and improvement potential, based on literature (EIPRO 2006, IMPRO, UNEP 2010, TNO 2011);
    c. a first rough assessment of suitability for Ecodesign and Labelling legislation (as opposed to alternative instruments or voluntary initiatives);
    d. a first rough assessment of the feasibility of Ecodesign and Labelling legislation (data availability, methodological and verification issues)
    e. a first rough assessment of the possible costs / risks and benefits of Ecodesign and Labelling legislation (bureaucratic / cost burden, risks to the existing process, consumer benefit / acceptance);
5. Based on the scoring system, develop a first tentative ranking;
6. Choose 5 case studies based on the criteria:
    a. coverage of different categories of products / systems / means of transport;
    b. rank high within their category;
    c. sufficiently different from those covered by the CSES study;
7. Conduct case studies;
8. Research additional information and data (on environmental impact and improvement potential, feasibility, appropriateness, stakeholder views etc.) for the top product groups in each category, all in all 20 product groups;
9. Refine ranking based on the insights from the case studies (as far as they can be extended to similar products from the same category) and the additional information and data;
10. Make recommendations on potential scope expansion based on the ranking and the product categories to be covered, and on the analysis of any theoretical or practical limitations to the possible scope expansions.

[1] Identical to the text in the First Findings and Recommendations report

3 Selection of Product Groups

In this first step, a preliminary list of non ErP groups and systems (see Box 1 for the definition of system) and means of transport, excluding those product groups dealt with in the Study on Amended Ecodesign Working Plan under the Ecodesign Directive[2], is compiled. The identification of product groups will initially be based on the product categories described in the Prodcom database (see Box 2).

Box 1 Definition of Product system

In a Life Cycle Assessment (LCA) there is a need to consider, not only the product it-self, but all the stages of a product's life from-cradle-to-grave (i.e., from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).

The definition of product system according to the ISO 14044 standard, which specifies requirements and provides guidelines for LCA, is:" collection of unit processes with elementary and product flows, performing one or more defined functions, and which models the life cycle of a product." In practice the product system consists of all included processes in the life cycle.

The goal and scope definition of an LCA provides a description of the product system in terms of the system boundaries and a functional unit (what the product does). The functional unit is a measure of the function of the studied system and it provides a reference to which the inputs and outputs can be related. The system boundary determines which unit process shall be included within the LCA. The selection of the system boundary shall be consistent with the goal of the study.

The product system can be desegregated into unit processes. Flows of intermediate products connected these unit processes together. In addition each unit can have inputs or extractions from the environmental (consumption of resources, energy,…) and outputs or emissions to the environmental(to water, air, soil…) also called elementary flows.

The clear definition of the product system and its boundaries facilitates the collection of data and the quantification of inputs (use of resources, raw materials, electricity, etc.) ant outputs (Emissions to air, water and land, waste, etc.) (Rebitze et al., 2004; Joillet, O.,Norris, G., 2003).

[2] http://www.ecodesign-wp2.eu/

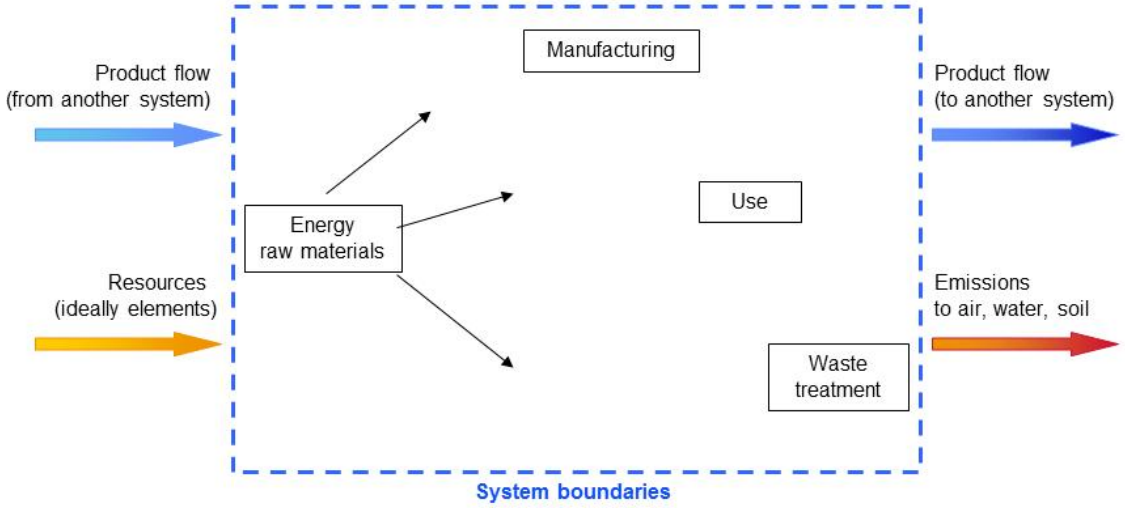


Figure 1 Inputs and outputs of a product system (Joillet, O., Norris, G., 2003)

Box 2 Description of the Prodcom database

The Prodcom list is essentially a database of 'economic activities' structured according to product categories. The database presents per product category data on production - and for some product groups also import and export - expressed in value (euros) or quantities (kg or units), for each Member State, over multiple years and allows the EU to keep track of its economic activities inside the EU and across its borders.

The economic activities may cover the placing of products on the market, but may also refer to activities (such as service and maintenance) that fall outside the scope of the Directive and this study.

At its highest level of detail (group numbering using 8 digits) Prodcom 2013 uses 3900 product categories, with descriptions ranging from basic ores, to complex products like nuclear reactors and services like repair and maintenance of products. Obviously, not all of these 3900 product categories fit the scope of the ED and EL Directives. This section explains how the products that fall outside the scope have been identified and exempted from further analysis.

3.1 Reducing the Prodcom list

In a first step a list of non-energy related product groups was created. For that, the overall list of economic activities in the European Community, the Prodcom 2011 list, was reduced from 3900 product categories to 2872 categories by excluding the energy-related products. The remaining list of product categories was further reduced to 1215 categories by applying previously defined 'exclusion - rules' (

Table 1).

The following groups were excluded:

- Energy related products
- Services (e.g. installation, repair and maintenace)
- product groups that are intrinsically not suitable for this type of legislation, such as raw materials or 'intermediate/semi-finished' products (e.g. because there are no design-related improvement options, they are not sold to the final customer, or the variation in environmental impact is very low)
- products clearly falling into the domain of some other legislation, such as chemicals, which are covered by REACH
- product groups that clearly do not fulfil one of the criteria "number of sales", "environmental impact" or "potential for improvement"

Figure 2 ilustrates the approach followed.

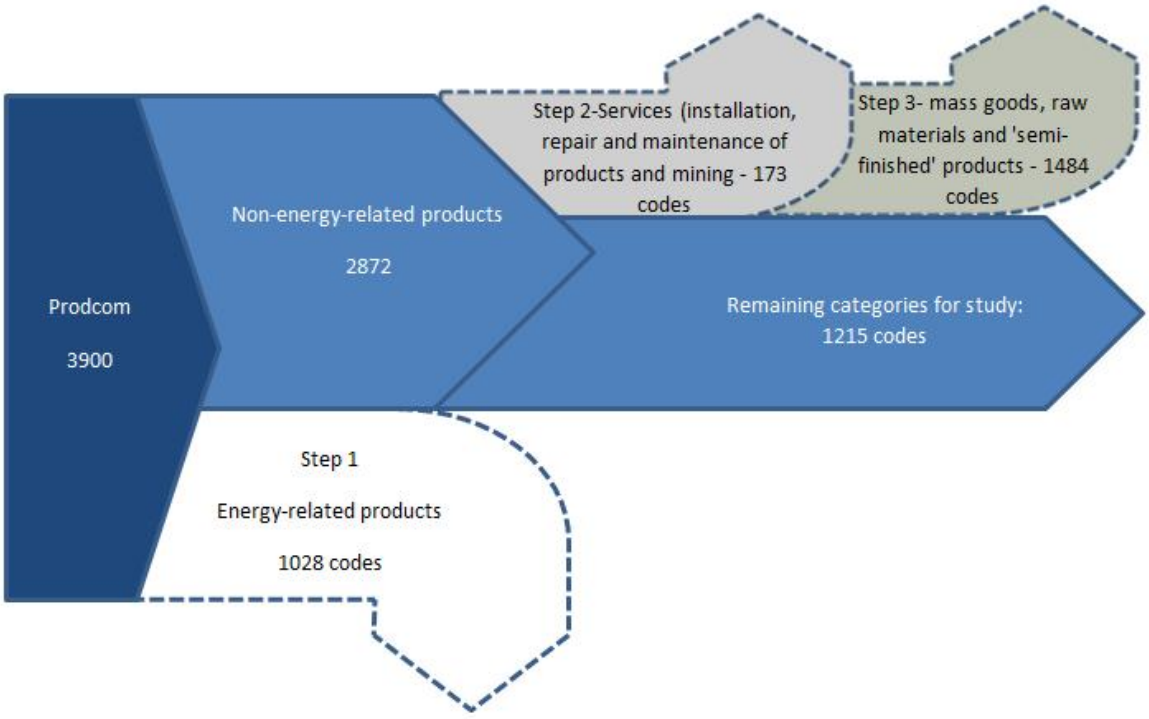


Figure 2. Selection of non-energy-related products

Table 1 Reduced list of Prodcom codes

Prodcom CPA heading	n. of codes
Processing and preserving of meat	28
Processing and preserving of poultry meat	18
Production of meat and poultry meat products	19
Processing and preserving of fish, crustaceans and molluscs	30
Processing and preserving of potatoes	6
Manufacture of fruit and vegetable juice	12
Other processing and preserving of fruit and vegetables	30
Manufacture of oils and fats	33
Manufacture of margarine and similar edible fats	2
Operation of dairies and cheese making	29
Manufacture of ice cream	1
Manufacture of grain mill products	21
Manufacture of starches and starch products	15
Manufacture of bread; manufacture of fresh pastry goods and cakes	2
Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	12
Manufacture of macaroni, noodles, couscous and similar farinaceous products	3
Manufacture of sugar	7
Manufacture of cocoa, chocolate and sugar confectionery	31
Processing of tea and coffee	8
Manufacture of condiments and seasonings	8
Manufacture of prepared meals and dishes	6
Manufacture of homogenised food preparations and dietetic food	5
Manufacture of other food products n.e.c.	13
Manufacture of prepared feeds for farm animals	5
Manufacture of prepared pet foods	2
Distilling, rectifying and blending of spirits	8
Manufacture of wine from grape	10
Manufacture of cider and other fruit wines	1
Manufacture of other non-distilled fermented beverages	1
Manufacture of beer	2
Manufacture of soft drinks; production of mineral waters and other bottled waters	5
Manufacture of tobacco products	5
Manufacture of made-up textile articles, except apparel	33
Manufacture of carpets and rugs	5
Manufacture of cordage, rope, twine and netting	12
Manufacture of workwear	10
Manufacture of other outerwear	41

Prodcom CPA heading	n. of codes
Manufacture of underwear	23
Manufacture of other wearing apparel and accessories	33
Manufacture of articles of fur	2
Manufacture of knitted and crocheted hosiery	5
Manufacture of other knitted and crocheted apparel	10
Manufacture of luggage, handbags and the like, saddlery and harness	9
Manufacture of footwear	24
Manufacture of assembled parquet floors	2
Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting	16
Manufacture of paper and paperboard	54
Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	7
Manufacture of household and sanitary goods and of toilet requisites	11
Manufacture of paper stationery	15
Manufacture of wallpaper	1
Manufacture of other articles of paper and paperboard	11
Printing of newspapers	1
Other printing	17
Manufacture of pesticides and other agrochemical products	25
Manufacture of paints, varnishes and similar coatings, printing ink and mastics	17
Manufacture of soap and detergents, cleaning and polishing preparations	21
Manufacture of perfumes and toilet preparations	19
Manufacture of glues	4
Manufacture of builders' ware of plastic	10
Manufacture of hollow glass	18
Manufacture of ceramic tiles and flags	7
Manufacture of ceramic household and ornamental articles	8
Manufacture of ceramic sanitary fixtures	2
Manufacture of other ceramic products	4
Manufacture of cement	3
Manufacture of lime and plaster	6
Manufacture of cutlery	14
Manufacture of locks and hinges	16
Manufacture of tools	79
Manufacture of agricultural and forestry machinery	11
Manufacture of motor vehicles	21
Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	11

Prodcom CPA heading	n. of codes
Building of ships and floating structures	22
Building of pleasure and sporting boats	4
Manufacture of railway locomotives and rolling stock	9
Manufacture of air and spacecraft and related machinery	19
Manufacture of motorcycles	7
Manufacture of bicycles and invalid carriages	10
Manufacture of other transport equipment n.e.c.	1
Manufacture of office and shop furniture	5
Manufacture of kitchen furniture	1
Manufacture of mattresses	4
Manufacture of other furniture	6
Manufacture of jewellery and related articles	7
Manufacture of imitation jewellery and related articles	11
Manufacture of sports goods	12
Manufacture of games and toys	6
Manufacture of medical and dental instruments and supplies	24
Manufacture of brooms and brushes	10
Other manufacturing n.e.c.	41

The Prodcom database and the resulting list of products have some limitations, which necessitates an aggregation of the resulting list of products. For example, the sector-orientation of the Prodcom database, and its inability to fit in with functional product descriptions can pose difficulties to this assessment. Moreover, despite the rather detailed description provided it is not always possible to distinguish between products directed towards consumer use and those that have an industrial application (e.g. cleaners of surfaces, adhesives).

Therefore, the remaining product groups are aggregated to form higher-level categories. This aggregation is based on primary product functions. The Prodcom product group descriptions that have been identified were compared to COICOP category descriptions to find the closest match. This was the basis for aggregating the remaining product groups to form higher-level categories.

3.2 First ranking of product groups

The elaboration of the rank combined an analysis of market, existing life cycle environmental impact and improvement potential studies, availability of information, and Suitability for Ecodesign (ED) and Labelling legislation (ELD). The ranking was made based on a basic scoring system (0, 1 or 2) as follows:

Economic and Market Analysis - The Eurostat PRODCOM database was used as a starting point for sales and trade level data. The data provided for the great majority of the products are in units sold, weight (kg) or volume (litres or m3). So for this parameter:

- Weight
  - Above $1.0x10^7$ kg: 2 points
  - $4.0x10^5$ - $1.0x10^7$:1 point
  - Below $4.0x10^5$: 0 points
- Volume:
  - Above $1.0x10^8$:2 points
  - $1.0x10^6$-$1.0x10^8$:1 point
  - Below $1.0x10^6$: 0 points
- Units
  - Above $2.0x10^6$:2 points
  - $4.0x10^5$-$2.0x10^6$: 1 point
  - Below $4.0x10^5$: 0 points

Main environmental impact – The EIPRO study is the most exhaustive in terms of its presentation of environmental impacts for almost all product families, and hence was used as the main data source to determine product categories with the highest environmental impacts. The rule used in this step was to score the different environmental impacts categories and then sum these points to obtain the final score. So for:

- Global Warming Potential
  - 5%-12%: 2 points
  - 0.2%-5%:1 point
  - Below 0,2%:0 points
- Photochemical oxidation
  - 1%-10%:2 points
  - 0,3%-1%:1 point
  - Below 0,3: 0 points
- Eutrophication
  - 10%-23%: 2 points
  - 0.7%-10%: 1 point
  - Below 0.7%:0 points
- Acidification
  - 5%-14%: 2 points
  - 1%-5%: 1 point
  - Below 1%: 0 points

Then, if the total of points is:

- Between 5-8: 2 points;
- Between 2-4:1 point;
- Below 2: 0 points.

LCA relevant information available - Life-cycle assessment (LCA), is a technique to assess environmental impacts associated with all the stages of a product's life. The main environmental impacts of the products covered and in some cases, the improvement potential were identified by supporting studies (EIPRO 2006; IMPRO 2008; UNEP 2010; TNO 2011) and eco-labels (European Eco-label, the Nordic Eco-label (Nordic Swan), the German Blaue Engel and the Dutch Milieukeur) and specially by the work conducted by the Joint Research Centre in the context of the Sustainable Production and Consumption project (IPTS)[3]. So, for those products that:

- have information about their LCA in studies like IPTS, EIPRO, eco-label and POBRAS or other studies available 2 points are given;
- only have eco-label information or only EIPRO information 1 point is given;
- no information available 0 points are given.

Suitability for Ecodesign (ED) and Labelling legislation (ELD) - ED and ELD share objectives, but use a different policy mechanism. ED pushes the market, while ELD provides for a market pull. In addition, ED concerns all life cycle phases and multiple environmental impacts, while ELD requirements only concern energy consumption during the use phase. Clearly there are many overlapping objectives between ED/ELD and other EU Policies (Energy Efficiency Directive, Energy Performance of Buildings Directive, Tyre Labelling, Ecolabel, Energy Star, the F-gas regulation, the Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), Restriction of Hazardous Substances Directive (RoHS), Waste Electrical and Electronic Equipment Directive (WEEE), and General Product Safety Directive (GPSD)).
When specific information is not available, the presence of an Eco-label or Organic label can be considered as one indication that there is potential for improvement for the specific product category. Eco-labelled products perform, in principle, much better than the average product in the market. Products that are covered by Eco-labels are, in general, better candidates for the development of generic or specific eco-design requirements since some of the requirements, even though not always product specific, have already been developed and tested in practice. Therefore these products will be awarded 2 points.
In particular protection goals may conflict between ED and ELD on the one hand and other environmental legislation (CO_2 Directive, RoHS, and F-gas regulation) on the other, a situation that calls for specific attention when setting minimum standards or label requirements. This is the case of energy saving lamps using mercury. Compared to conventional lighting these have a reduced energy consumption but a higher mercury content. This type of conflict does not necessarily mean that these products are not suitable for Ecodesign. However, it means that some of the relevant aspects are already being dealt with, and that the space for Ecodesign is reduced. Therefore, this type of products will receive 0 point.
To sum up: For those products that already have:

- labels (European Eco-label, the Nordic Eco-label (Nordic Swan), the German Blaue Engel, Dutch Milieukeur, EU Organic Label) are attributed 2 point;

[3] IPTS, Environmental improvement of products, http://susproc.jrc.ec.europa.eu/activities/IPP/impro.html

- o some of the relevant aspects are already being dealt with by other legislation, 0 points are attributed
- o none of the above 1 points are attributed.

For the assessment of the possible costs/risks and benefits of Ecodesign and Labelling legislation (bureaucratic/cost burden, risks to the existing process, consumer benefit / acceptance), the following questions and considerations specifying possible costs / risks or benefits function as a scoring guide:

a) Bureaucratic / cost burden

for both Ecodesign and Label:

Any regulation adds cost for both regulators and regulated (manufacturers), so this aspect needs to be discussed on a general rather than product-specific level. However, there are also product-specific aspects:

- specific difficulties in conducting preparatory studies and setting up criteria?
- specific difficulties in market surveillance?
- high costs of improvement for manufacturers?
- Rapid technological development – would frequent relabeling or updating of minimum standards be necessary?

b) Risks to the existing process

for both Ecodesign and Label:

Any new regulation would compete with the existing process in terms of time and resources, as long as there are no extra resources assigned. The issue should therefore be discussed on a general rather than product-specific level.

c) Consumer benefit / acceptance

for both Ecodesign and label:

- Would improvement of the product create a monetary benefit?
- Would improvement of the product create a non-monetary benefit? (health, comfort, security…)
- If there is additional cost for the improved product: would the non-monetary benefit be likely to outweigh it?

For Ecodesign:

- Monetary benefit: Is the LCC approach feasible?
- What would be the added value of Ecodesign as compared to other, existing environmental policies, in ensuring consumer benefit?

For label:

- Would a label work?
- Does the product vary enough that a label could be helpful?
- Who is the consumer? (e.g. individual consumer vs. procurer)? What kind of guidance does he need – would a label be helpful?

- Would a label possibly be considered in the purchase process?
- What would be the added value of the label compared to existing information sources? (especially other labels)? (E.g. through its compulsory nature or staged approach)?

d) Societal benefit

For Ecodesign:

- What would be the added value of Ecodesign, as compared to other policies, in achieving environmental improvement?
- What would be the added value of Ecodesign, as compared to other policies, in stimulating innovation?

For label:

- What would be the added value of the label, as compared to other policies, in achieving environmental improvement?
- What would be the added value of the label, as compared to other policies, in stimulating innovation?

Depending on the applicability and answer to these questions, an overall score of 0 to 2 points was given based on their overall evaluation. When a product group was very heterogeneous technically, functionally or in terms of the market (such as “Materials for the maintenance and repair of the dwelling”), the score for the highest ranking subcategory was applied (in this case, 2 for Ecodesign (for paints and varnishes) and 1 for the label (for wallpaper)).

The detailed assessment of each of these aspects is shown in table 1 and a ranking of the product groups is made as shown in the table below

Table 2 Assessment of product groups

Product group/category (COICOP)	Prodcom categories	Relevant Prodcom codes	Sold Volume (Prodcom)	Main environmental impact areas(EIPRO)	LCA relevant information available	Cost / benefit assessment of Ecodesign	Cost / benefit assessment of Labelling
FOOD							
Meat	Processing and preserving of meat	10111140-10116090 (28 codes)	37400000 kg	Global Warming Potential (11,9%); photochemical oxidation(9,2%); eutrophication(22,5%); acidification(13.4%)	JRC – IPTS studies on environmental impact and improvement potential, PROBAS	Improvement would bring some non-monetary benefits to consumers (less so to society), but probably at higher cost; LCC approach not applicable; other policies such as food law (for products) or EMAS (for production processes) might be more suitable; in part: different verification methods needed (audit). Sausages already covered by CSES	Little added value as compared to e.g. organic label (organic label is mandatory for packaged food)
	Processing and preserving of poultry meat	10121010-10125000 (18 codes)	13500000 kg				

	Production of meat and poultry meat products	10131120-10139100 (19 codes)	17500000 kg			Improvement would bring high non-monetary benefits to both consumers and society, but probably at higher cost; LCC approach not applicable; other policies such as agricultural policy or food law might be more suitable; verification issues.	
Fish and seafood	Processing and preserving of fish, crustaceans and molluscs	10201100-10204100 (29 codes)	4250000 kg	Global Warming Potential (0,7%); photochemical oxidation(0,4%); eutrophication(22,5%); acidification(0,5%)	EIPRO study on environmental impact, PROBAS (probably focusing on production)	Relatively little benefit for consumers and society in relation to cost; might be addressed by other policies such as food law (product related) or EMAS (production related)	Little added value; EU Organic label already mandatory for processed food; voluntary MSC label for fisheries (instead of mandatory label, general improvement of fishery policy would

	production of fish – either fishery or aqua-culture				PROBAS and others	Improvement would bring high non-monetary benefits mainly to society in case of fisheries and to both consumers and society in case of aquaculture, but probably at higher cost; LCC approach not applicable; other policies might be more suitable; important verification issues.	be preferable)
Fruit and Vegetables	Manufacture of fruit and vegetable juice	10321100-10321930 (12 codes)	10500000 l	Global Warming Potential (1,2%); photochemical oxidation(1,2%); eutrophication(1,5%); acidification(0,6%)	EIPRO study on environmental impact, PROBAS (probably focusing on agricultural production)	Improvement would bring important non-monetary benefits to both consumers and society (environmental impact, health). However, other policies such as food law (for products) or EMAS (for production	Little added value as compared to EU Organic label

						processes) might be more suitable; in part: different verification methods needed (audit)	
	Other processing and preserving of fruit and vegetables	10391100-10399100 (30 codes)	23000000 kg				
	Processing and preserving of potatoes	10311110-10311460 (6 codes)	7050000 kg	Global Warming Potential (0,7%); photochemical oxidation(0,5%); eutrophication(N.A.%); acidification(0,5%)	EIPRO study on environmental impact, PROBAS (probably focusing on agricultural production)	Improvement would bring important non-monetary benefits to both consumers and society (environmental impact, health). However, other policies such as food law (for products) or EMAS (for production processes) might be more suitable; in part: different verification methods needed (audit)	Little added value as compared to EU Organic label

Oils and fats	Manufacture of oils and fats	10411100-10417200 (33 codes)	53000000 kg	Global Warming Potential (1,3%); photochemical oxidation(1,2%); eutrophication(1,8%); acidification(1%)	EIPRO study on environmental impact, PROBAS: butter and edible oils (no margarine)	Improvement would bring important non-monetary benefits to both consumers and society (environmental impact, health). However, other policies such as food law (for products) or EMAS (for production processes) might be more suitable; in part: different verification methods needed (audit)	Little added value as compared to EU Organic label
	Manufacture of margarine and similar edible fats	10421030 10421050 (2 codes)	3070000 kg				
Milk, cheese and eggs	Operation of dairies and cheese making	10511133-10515600 (29 codes)	82500000 kg	Global Warming Potential (5,6%); photochemical oxidation(4,8%); eutrophication(11,2%); acidification(6%)	JRC – IPTS studies on environmental impact and improvement potential for dairy products, PROBAS; various	Improvement would bring important non-monetary benefits to both consumers and society (environmental impact, health). However, other policies such as food law (for	Little added value as compared to EU Organic label

					(probably focusing on agricultural production)	products) or EMAS (for production processes) might be more suitable; in part: different verification methods needed (audit)	
Bread and cereals	Manufacture of grain mill products	10521000-10614090 (21 codes)	60500000 kg	Global Warming Potential (1,4%); photochemical oxidation(1,8%); eutrophication(10%); acidification(1,6%)	EIPRO study on environmental impact, PROBAS: bread, rolls flour, oat flakes, pasta, pizza; Oeko has some studies on biscuits	Improvement would bring important non-monetary benefits to both consumers and society (environmental impact, health). However, other policies such as food law (for products) or EMAS (for production processes) might be more suitable; in part: different verification methods needed (audit)	Little added value as compared to EU Organic label
	Manufacture of starches and starch products	10621111-10621200 (15 codes)	17000000 kg				
	Manufacture of bread; manufacture of fresh pastry goods and cakes	10711100 10711200(2 codes)	24300000 kg				
	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	10721130-10721990 (12 codes)	7661921				
	Manufacture of macaroni, noodles, couscous and similar farinaceous products	10731130 10731150 10731200 (3 codes)	5000000 kg				
Sugar, jam, honey, chocolate and	Manufacture of ice cream	10521000 (1 code)	3050000 l	eutrophication(1%) with High	EIPRO study on	Improvement would bring	Little added value as compared to EU

confectionery	Manufacture of sugar	10811230 10811290 10811300 (3 codes)	16300000 kg	environmental impacts per Euro of consumption (EIPRO)	environmental impact	important non-monetary benefits to both consumers and society (environmental impact, health). However, other policies such as food law (for products) or EMAS (for 0production processes) might be more suitable; in part: different verification methods needed (audit)	Organic label
Coffee, tea and cocoa	Manufacture of cocoa, chocolate and sugar confectionery	10821100-10822400 (31 codes)	9200000 kg	Global Warming Potential (0,7%); photochemical oxidation(0,7%); eutrophication(0,9%); acidification(0,5%)	EIPRO study on environmental impact, Oeko-Institut has some studies (focusing on agricultural production)	Improvement would bring important non-monetary benefits to both consumers and society (environmental impact, health). However, other policies such as food law (for products) or EMAS (for production	Little added value as compared to EU Organic label
	Processing of tea and coffee	10831130-10831300 (7 codes)	2650000 kg				

						processes) might be more suitable; in part: different verification methods needed (audit)	
Food products n.e.c.	Manufacture of condiments and seasonings	10841210-10843000 (5 codes)	7570000 kg	N.A.	Oeko-Institut has a study on frozen food; unpublished.	Improvement would bring important non-monetary benefits to both consumers and society (environmental impact, health). However, other policies such as food law (for products) or EMAS (for production processes) might be more suitable; in part: different verification methods needed (audit)	Little added value as compared to EU Organic label
	Manufacture of prepared meals and dishes	10851100-10851900 (6 codes)	5700000 kg				
	Manufacture of homogenised food preparations and dietetic food	10861010-10861070 (5 codes)	1500000 kg				
	Manufacture of other food products n.e.c.	10891100-10891940 (13 codes)	810000 kg				
Pets and related products	Manufacture of prepared feeds for farm animals	10911010-10911039 (5 codes)	1300000 00 kg	N.A.	PROBAS has a lot on feed for farm animals; Oeko is	Feed for farm animals is a subordinate aspect to meat production;	There might be limited value in a mandatory organic label for pet food (as this product
	Manufacture of prepared pet foods	10921030 10921060 (2	1020000 0 kg				

		codes)			conducting a study on cat food	therefore no additional value. Pet food: bad cost-benefit relation because data would be difficult to get; overlap with meat and other food products	group addresses individual consumers). Feed for farm animals is covered by organic food policies.
Tobacco							
Tobacco	Manufacture of tobacco products	12001130 12001150 (2 codes)	6850000 00 units	Global Warming Potential (0,7%); photochemical oxidation(0,8%) ; acidification(0,6 %)	EIPRO study on environment al impact	Improvement would bring important non-monetary benefits mainly to society (environ-mental impact). However, other policies might be more suitable; in part: different verification methods needed (audit)	Already heavily regulated; it should not be suggested there is a “good” alternative
Beverages							
Spirits	Distilling, rectifying and blending of spirits	11011020-11011080 (8 codes)	1820000 l alc 100%	N.A.	No study identified	Improvement would bring important non-monetary benefits	Little added value as compared to EU Organic label

						mainly to society (environ-mental impact). However, other policies might be more suitable; in part: different verification methods needed (audit)	
Wine	Manufacture of wine from grape	11021130-11021230 (9 codes)	6300000 l	Global Warming Potential (0,6%); photochemical oxidation(0,6%); eutrophication(0,5%); acidification(0,5%)	EIPRO study on environmental impact, various	Improvement would bring important non-monetary benefits mainly to society (environmental impact). However, other policies might be more suitable; in part: different verification methods needed	Little added value as compared to EU Organic label
	Manufacture of cider and other fruit wines	11031000 (1 code)	2320000 l				
	Manufacture of other non-distilled fermented beverages	11041000 (1 code)	480000 l				
Mineral waters, soft drinks, fruit and vegetable juices	Manufacture of soft drinks; production of mineral waters and other bottled waters	11071130-11071970 (5 codes)	108000000 l	Global Warming Potential (0,9%); photochemical oxidation(1,2%); eutrophication(0	EIPRO study on environmental impact; fruit and vegetable juice:	Improvement would bring important non-monetary benefits mainly to society (environmental impact). However,	Little added value as compared to EU Organic label

				,8%); acidification(0,9 %)	PROBAS	other policies might be more suitable; in part: different verification methods needed (audit)	
Beer	Manufacture of beer	11051000 (1 code)	38400000 I	N.A.	PROBAS; Various	Improvement would bring important non-monetary benefits mainly to society (environ-mental impact). However, other policies might be more suitable; in part: different verification methods needed (audit)	
Clothing and footwear							

Garments	Manufacture of knitted and crocheted hosiery	14311033-14311090 (5 codes)	1550000 units of Panty hose and tights and 1360000 pairs of Knitted or crocheted hosiery	Global Warming Potential (1,8%); photochemical oxidation(2,4%); eutrophication(3,9%); acidification(1,9%)	EIPRO study and ecolabel study, a little on cot-ton in PROBAS; Blue Angel Textiles	Already covered by CSES study. (More general considerations would rather point to 1): Especially if it includes impacts in earlier stages of the value chain (e.g. manufacture of yarns and tis-sues), improvement would bring high benefits mostly to society (less so to individual consumers). These would however mostly occur in third countries. These would somewhat increase cost but not too much. LCC approach not feasible. Important verification issues and probably cost if verification is	Already covered by CSES study. (More general considerations: A label would be valuable be-cause currently there is little consumer in-formation as to LC impact of textiles. However verification would be difficult and probably costly. Must re-late to non-energy issues and not be confused with current energy label)
	Manufacture of other knitted and crocheted apparel	14391031-14391090 (10 codes)	232000 units				
	Manufacture of workwear	14121120-14123023 (10 codes)	178000 units				
	Manufacture of other outerwear	14131110-14133569 (41 codes)	525000 units				
	Manufacture of underwear	14141100-14143000 (23 codes)	1310000 units				

						taken seriously, because impacts often occur in third countries and are often not measurable on the product itself.)	
Other articles of clothing and clothing accessories	Manufacture of other wearing apparel and accessories	14191100-14194300 (33 codes)	417000 units	N.A.	Blue Angel (criteria for textiles cover many of the articles)	Already covered by CSES study. (More general considerations: Especially if it includes impacts in earlier stages of the value chain, improvement would bring high benefits mostly to society (less so to individual consumers) and mostly occur in third countries. Cost would somewhat in-crease.. Important verification issues.	Already covered by CSES study. (More general considerations: A label would be valuable be-cause currently there is little consumer in-formation as to LC impact of textiles. However verification would be difficult and probably costly. Must re-late to non-energy issues and not be con-fused with cur-rent energy label
	Manufacture of articles of fur	14201030 14201090 (2 codes)	N.A.		No study identified	Environmental impacts / benefits similar to leather	Same arguments as for Ecodesign apply

						items, but a relatively unimportant product group compared to, p.ex. shoes. Is-sue: animal protection would have to be addressed by other policies.	
	Manufacture of luggage, handbags and the like, saddlery and harness	15121100-15121300 (7 codes)	75000 units		Tchibo: PCF sports bag;	Nature of environmental impact and improvement potential would depend heavily on material (textile, leather, metal, plastics?). Bad cost / benefit ratio because very detailed differentiations and provisions would have to be foreseen for a relatively small product group	Same arguments as for Ecodesign apply, although a label might have added value to customers as there is so far no LCA information on bags. Must relate to non-energy is-sues and not be confused with current energy label

Shoes and other footwear	Manufacture of footwear	15201100-15204080 (24 codes)	505000 pairs	Global Warming Potential (0,3%); photochemical oxidation(0,4%); eutrophication(0,3%); acidification(0,2%)	European and Dutch Eco-label, Blue Angel	Important product group and environmental impacts. However, the nature of impact and improvement potential would depend heavily on material (textile, leather, plastics?). Detailed differentiations and provisions would have to be foreseen. Impacts partly in third countries, verification issues as in textiles.	A label would be valuable because currently there is little consumer information as to LC impact of shoes. However verification would be difficult and probably costly. Must relate to non-energy issues and not be confused with current energy label
Furnishings, household equipment and routine maintenance of the house							
Furniture and furnishings	Manufacture of office and shop furniture	31011110-31011300 (5 codes)	75000 units	Global Warming Potential (0,6%); photochemical oxidation(1,1%); eutrophication(0,8%); acidification(0,4	Eco-label study; Nordic Swan eco-label; Dutch Eco-label; EIPRO study, Blue Angel	Improvement would bring relevant benefits to both society and individual consumers (health issues); additional cost unclear. For case study	A label would be valuable be-cause currently there is little consumer in-formation as to LC impact of furniture. Must relate to non-energy issues and not be con-fused
	Manufacture of kitchen furniture	31021000 (1 code)	106000 units				
	Manufacture of other furniture	31091230-31091450 (5 codes)	327000 units				

				%)		purposes, would suggest separation from mattresses (qualitatively different product group). Criteria development and verification probably difficult / costly as product group is very varied	with cur-rent energy label
	Manufacture of mattresses	31031230-31031290 (4 codes)	51000 units			Improvement would bring relevant benefits to both society and individual consumers (health issues); additional cost unclear. For case study purposes, would suggest separation from furniture (qualitatively different product group).	A label would be valuable because currently there is little consumer information as to LC impact of mattresses. Must relate to non-energy issues and not be confused with current energy label

Carpets and other floor coverings	Manufacture of carpets and rugs	13931100-13931990 (5 codes)	855000 m2	Global Warming Potential (0,3%); photochemical oxidation(0,6%); eutrophication(0,7%); acidification(0,3%)	EIPRO study; Blue Angel	Floor coverings covered by CSES study. (More general considerations point to 1: Improvement would bring relevant benefits to both society and individual consumers (health issues); additional cost unclear.)	Floor coverings covered by CSES study. (More general considerations point to 1: A label would be valuable because currently there is little consumer information as to LC impact of carpets. Must relate to non-energy issues and not be confused with current energy label
Household textiles	Manufacture of made-up textile articles, except apparel	13921130-13922990 (33 codes)	380000 kg and 23000 units of blankets	Global Warming Potential (0,1%); photochemical oxidation(0,3%); eutrophication(0,4%); acidification(0,5%)	EIPRO study; Blue Angel Textiles	Especially if it includes impacts in earlier stages of the value chain, improvement would bring high benefits mostly to society (less so to individual consumers) and mostly occur in third countries.	A label would be valuable because currently there is little consumer information as to LC impact of textiles. However verification would be difficult and probably costly.
	Manufacture of cordage, rope, twine and netting	13941130-13941280 (12 codes)	327000 kg				

						Cost would somewhat in-crease. Important verification issues.	
Glassware, tableware and household utensils	Manufacture of hollow glass	23131110-23131400 (18 codes)	81300000 units	Global Warming Potential (0,3%); photochemical oxidation(0,5%); eutrophication(0,1%); acidification(0,2%)	EIPRO study and ecolabel study; Blue Angel floor coverings	Heterogeneous product groups with relatively small impact, therefore bad cost-benefit ratio	Heterogeneous product groups with relatively small impact, therefore bad cost-benefit ratio
	Manufacture of builders' ware of plastic	22231155 22231159 22231190 22231250 (4 codes)	310000 m2				
	Manufacture of ceramic household and ornamental articles	23411130-23411350 (8 codes)	370000 units				
	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting	16291130-16292500 (16 codes)	506000 kg				
	Manufacture of other ceramic products	23491100 23491230 23491255 23491259(4 codes)	13600000 kg				
	Manufacture of ceramic sanitary fixtures	23421030 23421050 (2 codes)	43000 units			According to EIPRO there might be a benefit (check definition of product groups); cost un-clear	Seldom purchased by end consumer

	Manufacture of assembled parquet floors	16221030 16221060 (2 codes)	104000 m2			Floor coverings covered by CSES study. (More general considerations point to 1: Environmental benefit mainly to society and in third countries (wood, logging). Some health issues for consumers (toxic substances). Additional manufacturing cost unclear; verification issues might be solved by relying on e.g. FSC standards	Floor coverings covered by CSES study. Overlap with FSC, although the label does not cover all LC environmental aspects and is voluntary. Alternative: strengthening of FSC?
Small tools and miscellaneous accessories	Manufacture of cutlery	25711115-25711500 (14 codes)	5420000 units	N.A.	EIPRO for cutlery and some tools	No known relevant impacts	No known relevant impacts

	Manufacture of locks and hinges	25721130-25721480 (16 codes)	1000000 units of metal locks and 2040000 kg of other metal articles				
	Manufacture of tools	25731010-25736090 (79 codes)	2170000 kg				
Non-durable household goods/Adhesive and sealants	Manufacture of essential oils	20521020 20521040 20521060 20521080 (4 codes)	3400000 kg	Global Warming Potential (0,5%); photochemical oxidation(0,8%); eutrophication(0,8%); acidification(0,5%)	Eco-label study; Nordic Swan eco-label; Dutch Eco-label; EIPRO study for Dishwasher detergents; Nordic Swan eco-label for adhesives and sealants	No known relevant impacts	No known relevant impacts
	Manufacture of soap and detergents, cleaning and polishing preparations	20413120-20414389 (15 codes)	12200000 kg			Covered by CSES study. (More general considerations point to 2: Improvement would provide relevant benefit to both consumers and society (eutrophication, hazardous	Covered by CSES study. (More general considerations point to 1: Some label might be helpful to pro-vide an aggregate idea of environmental impact (as detailed declarations are not always

						substances, health issues); additional cost unclear; no relevant verification issues; synergies with Ecolabels	understandable). Focus on non-energy impacts, not to be con-fused with Energy label
	Manufacture of pesticides and other agrochemical products	20201130-20201980 (25 codes)	1380000 kg act. Subst.			Relevant impact, but would probably be regulated in different policy framework	Some label might be helpful to provide an aggregate idea of environmental impact (as de-tailed declarations are not al-ways understandable). Focus on non-energy impacts, not to be con-fused with Energy label
Materials for the maintenance and repair of the dwelling	Manufacture of ceramic tiles and flags	23311010-23311079 (8 codes)	1000000 m2	N.A.	Eco-label study; Nordic Swan eco-label; Dutch Eco-label; EIPRO study; Blue Angel paint, wallpaper; PROBAS	As floor coverings covered by CSES study. Important embedded energy in manufacturing phase. However, no verification on the product possible. Ceramics: Other	As floor coverings covered by CSES study. probably little added value (in relation to cost) of labelling embedded energy because it is would not be a relevant factor in the
	Manufacture of cement	23511100 23511210 23511290 (3 codes)	200000000 kg				

					paint, cement	impacts to check? But would pose problems / cosed because of lack of data	purchasing decision
	Manufacture of wallpaper	17241200 (1 code)	2000 kg			See other paper products. Some impact that could successfully regulated by Ecodesign (energy use during production phase, additives etc.). Main difference is between fresh fibre paper and recycled pa-per though => how to deal with system question?	A label that clearly indicates the difference in environmental impact (water use, energy use, logging) could make sense. Should be clearly distinguished from current energy label
	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	20302170-20302470 (15 codes)	9000000 kg			Improvement would provide relevant benefit to both consumers and society (hazardous sub-stances, health issues); addition-al cost unclear; no relevant	Overlap with voluntary labels (check how widely they are used though; paint label is used widely in Germany)

						verification issues; synergies with Eco-labels	
Miscellaneous goods and services							
Other appliances, articles and products for personal care	Manufacture of perfumes and toilet preparations	20421150-20421990 (19 codes)	120000 l of perfume and 1120000 kg of soap	Global Warming Potential (0,8%); photochemical oxidation(1,3%); eutrophication(0,3%); acidification(0,6%)	EIPRO study; Eco-label study for soaps and shampoos	Improvement would provide relevant benefit to both consumers and society (eutrophication, hazardous substances, health issues); additional cost unclear; no relevant verification issues; synergies with Ecolabels. Too close to CSES study?	Some label might be helpful to provide an aggregate idea of environmental impact (as de-tailed declarations are not always understandable). Focus on non-energy impacts, not to be confused with Energy label. Too close to CSES study?
	Manufacture of household and sanitary goods and of toilet requisites	17221120-17221300 (11 codes)	10000000 kg			Mainly paper products (hygiene papers / tissues, paper trays etc.), therefore the considerations for paper apply: Some impact that could successfully	Mainly paper products (hygiene papers / tissues, paper trays etc.), therefore the considerations for paper apply: A label that clearly indicates the

						regulated by Ecodesign (energy use during production phase, additives etc.). Main difference is be-tween fresh fibre paper and recycled paper though => how to deal with system question?	difference in environmental impact (water use, energy use, logging) could make sense. Should be clearly distinguished from current energy label
Jewellery, clocks and watches	Manufacture of jewellery and related articles	32121100-32121400 (7 codes)	N.A.	Global Warming Potential (0,1%); photochemical oxidation(0,2%); eutrophication(0,1%); acidification(0,2%)	EIPRO (named “Jewelry”) Various others for gold and gem-stones	Improvement would bring noticeable benefits (human- and eco-toxicity) mostly to society (less so to individual consumers) and mostly in third countries (mining and processing of gemstones / precious metals). Impact on cost unclear. Important verification issues. Other policies more suitable? If	no good cost-benefit relation of mandatory label as it would probably have little impact on purchase decision; voluntary label makes more sense

						approach should be tested, prefer-ably with textiles (more sales)	
	Manufacture of imitation jewellery and related articles	32201110 -32201600 (10 codes)	4000 units			No evidence for relevant impact	No evidence for relevant impact
Equipment for sport, camping and open-air recreation	Manufacture of sports goods	32301131-32301600 (12 codes)	78000 units	photochemical oxidation(0,1%); acidification(0,1%)	EIPRO table; Blue Angel for textile toys; phased-out Blue Angel for wooden toys	No strong impact according to EIPRO => little benefit	No strong impact according to EIPRO => little benefit
Games, toys and hobbies	Manufacture of games and toys	32403100-32404210 (5 codes)	400000 kg of Playing cards and 145000 units of other toys			Some impact, but extremely heterogeneous product group; Ecodesign approach would not seem feasible or cause enormous effort / cost	Some impact, but extremely heterogeneous product group; comprehensive labelling approach would not seem feasible or cause enormous effort / cost
Health							
Therapeutic appliances and equipment	Manufacture of medical and dental instruments and supplies	32501311-32505030 (24 codes)	4200000 units	Global Warming Potential (0,1%); photochemical oxidation(0,1%); acidification(0,1%)	EIPRO study	Very heterogeneous product group where functional considerations dominate	Little to no impact on purchasing decision expected
Recreation and culture							

Stationery and drawing materials	Manufacture of paper stationery	17231100-17231400 (15 codes)	2300000 kg	N.A.	Nordic Swan eco-label for paper envelopes; Dutch Eco-label for paper and candles; PROBAS (paper); Blue An-gel (many paper products);	Some impact that could successfully regulated by Ecodesign (energy use during production phase, additives etc.). Main difference is between fresh fibre paper and recycled paper though => how to deal with system question?	A label that clearly indicates the difference in environmental impact (water use, energy use, logging) could make sense. Should be clearly distinguished from current energy label
	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	17211100-17211550 (7 codes)	3860000 kg				
	Manufacture of paper and paperboard	17121100-17127970 (54 codes)	8500000 kg				
	Manufacture of other articles of paper and paperboard	17291120-17291985 (11 codes)	3700000 kg				
	Other manufacturing n.e.c.	32991210 -32991350 and 32995400 (6 codes)	5800000 units of pens and pencils and 600000 candles			extremely heterogeneous product group with no evidence for relevant impact	extremely heterogeneous product group with no evidence for relevant impact
	Manufacture of brooms and brushes	32911110-32911970 (10 codes)	3700000 units			no evidence for relevant impact	no evidence for relevant impact
Miscellaneous printed matter	Other printing	18121100-18121990 (17 codes)	4000000 kg	N.A.	Dutch Eco-label and Eco-	As Ecodesign is a product-related approach, it could	As Ecodesign is a product-related approach, it could

					label study	rather be applied on the paper (and maybe ink) than the printing itself	rather be applied on the paper (and maybe ink) than the printing itself
Newspapers and periodicals	Printing of newspapers	18111000 (1 code)	4200000 kg	N.A.	Dutch Eco-label; Blue Angel newspaper printing paper	As Ecodesign is a product-related ap-proach, it could rather be applied on the paper (and maybe ink) than the print-ing itself	As Ecodesign is a product-related approach, it could rather be applied on the paper (and maybe ink) than the printing itself
Means of transport							
Motorized road transport	Manufacture of agricultural and forestry machinery	28302100-28302390 (6 codes)	300 units	N.A.	No study identified	For all motorized means of transport: High impact, especially in use phase, high benefits to expect mainly for society (less so individual users); experience exists because problem structure similar to EuP. However, Agricultural machines are very specific and not sold in great numbers;	Would probably not affect purchasing decision

						therefore probably not efficient tool.	
	Manufacture of motor vehicles	29102100-29105950 (18 codes)	20000 units	EIPRO: High level of impact per Euro spent for all environmental impact categories for passenger cars	JRC – IPTS studies on environmental impact and improvement potential	For all motorized means of transport: High impact, especially in use phase, high benefits to expect mainly for society (less so individual users); experience exists because problem structure similar to EuP.	Might be merged with / replace CO2 label to have consistent approach
	Manufacture of motorcycles	30911100 30911200 (2 codes)	1358 units	N.A.	No study identified		
	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	29202230 29202250 (2 codes)	128 units	N.A.	No study identified		
Water transport	Building of pleasure and sporting boats	30121100 30121200 30121930 30121970 (4 codes)	187 units	N.A.	No study identified	For all motorized means of transport: High impact, especially in use phase, high benefits to expect mainly for society (less so individual users); experience exists because problem structure similar to EuP.	Would probably little or not affect purchasing decision
	Building of ships and floating structures	30112130-30113350 (17 codes)	2817 units	N.A.	No study identified		

						However, ships are quite specific and not sold in great numbers; therefore probably not efficient tool. Also, data problems	
Rail transport	Manufacture of railway locomotives and rolling stock	30201100 30201200 30201300 30202000 (4 codes)	4 units	N.A.	Various (Allianz Pro Schiene, Oeko-Institut, Umweltbundesamt)	For all motorized means of transport: High impact, especially in use phase, high benefits to expect mainly for society (less so individual users); experience exists be-cause problem structure similar to EuP. However, rail-way stock are quite specific and not sold in great numbers; therefore probably not efficient tool.	Would probably not affect purchasing decision
Air transport	Manufacture of air and spacecraft and related machinery	30301100-30303400 (11 codes)	36 units		VascoLopez, Airbus		Would probably not affect pur-chasing deci-sion

Non-motorized road transport	Manufacture of bicycles and invalid carriages	30921030 30921050 30924030 (3 codes)	12670 units	N.A.	Oeko-Institut, bicycles	No relevant impact	No relevant impact
	Manufacture of other transport equipment n.e.c.	30991000 (1 code)	13117 units	N.A.	No study identified	Unclear what it is, no evidence for relevant impact	Unclear what it is, no evidence for relevant impact

Table 3 Ranking of product groups

Product group/category (COICOP)	PRODCOM categories	Sold Volume	Main environmental impact areas	LCA relevant information available	Suitability for ED and ELD	Assessment of the possible costs / risks and benefits of Ecodesign	Assessment of the possible costs / risks and benefits of Labelling	Total
Meat	Processing and preserving of meat	2	2	2	2	1	0	9
	Processing and preserving of poultry meat							
	Production of meat and poultry meat products							
Bread and cereals	Manufacture of grain mill products	2	2	2	2	1	0	9
	Manufacture of starches and starch products							
	Manufacture of bread; manufacture of fresh pastry goods and cakes							
	Manufacture of rusks and biscuits; manufacture of							

Product group/category (COICOP)	PRODCOM categories	Sold Volume	Main environmental impact areas	LCA relevant information available	Suitability for ED and ELD	Assessment of the possible costs / risks and benefits of Ecodesign	Assessment of the possible costs / risks and benefits of Labelling	Total
	preserved pastry goods and cakes							
	Manufacture of macaroni, noodles, couscous and similar farinaceous products							
Fruit and Vegetables	Manufacture of fruit and vegetable juice	2	2	2	2	1	0	9
	Other processing and preserving of fruit and vegetables							
	Processing and preserving of potatoes							
Materials for the maintenance and repair of the dwelling	Manufacture of ceramic tiles and flags	2	0	2	2	2	1	9
	Manufacture of paints, varnishes and similar coatings, printing ink and mastics							
	Manufacture of cement							
	Manufacture of wallpaper							

Product group/category (COICOP)	PRODCOM categories	Sold Volume	Main environmental impact areas	LCA relevant information available	Suitability for ED and ELD	Assessment of the possible costs / risks and benefits of Ecodesign	Assessment of the possible costs / risks and benefits of Labelling	Total
Other appliances, articles and products for personal care	Manufacture of perfumes and toilet preparations	2	1	1	2	2	1	9
	Manufacture of household and sanitary goods and of toilet requisites							
Motorized road transport	Manufacture of agricultural and forestry machinery	0	2	2	0	2	2	8
	Manufacture of motorcycles							
	Manufacture of motor vehicles							
	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers							

Product group/category (COICOP)	PRODCOM categories	Sold Volume	Main environmental impact areas	LCA relevant information available	Suitability for ED and ELD	Assessment of the possible costs / risks and benefits of Ecodesign	Assessment of the possible costs / risks and benefits of Labelling	Total
Mineral waters, soft drinks,fruit and vegetable juices	Manufacture of soft drinks; production of mineral waters and other bottled waters	2	1	2	2	1	0	8
Garments	Manufacture of knitted and crocheted hosiery	2	2	2	2	0	0	8
	Manufacture of other knitted and crocheted apparel							
	Manufacture of workwear							
	Manufacture of other outerwear							
	Manufacture of underwear							
Shoes and other footwear	Manufacture of footwear	1	1	2	2	1	1	8
Non-durable household goods/Adhesive and sealants	Manufacture of essential oils	2	1	2	2	0	1	8
	Manufacture of soap and detergents, cleaning and polishing							

Product group/category (COICOP)	PRODCOM categories	Sold Volume	Main environmental impact areas	LCA relevant information available	Suitability for ED and ELD	Assessment of the possible costs / risks and benefits of Ecodesign	Assessment of the possible costs / risks and benefits of Labelling	Total
	preparations							
	Manufacture of pesticides and other agrochemical products							
Furniture and furnishings	Manufacture of office and shop furniture	1	1	2	2	1	1	8
	Manufacture of kitchen furniture							
	Manufacture of mattresses							
	Manufacture of other furniture							
Oils and fats	Manufacture of oils and fats	2	1	2	2	1	0	8
	Manufacture of margarine and similar edible fats							
Coffee, tea and cocoa	Manufacture of cocoa, chocolate and sugar confectionery	2	1	2	2	1	0	8
	Processing of tea and							

Product group/category (COICOP)	PRODCOM categories	Sold Volume	Main environmental impact areas	LCA relevant information available	Suitability for ED and ELD	Assessment of the possible costs / risks and benefits of Ecodesign	Assessment of the possible costs / risks and benefits of Labelling	Total
	coffee							
Fish and seafood	Processing and preserving of fish, crustaceans and molluscs	1	1	2	2	1	0	7
	production of fish – either fishery or aqua-culture							
Stationery and drawing materials	Manufacture of paper stationery	1	0	2	2	1	1	7
	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard							
	Manufacture of paper and paperboard							
	Other manufacturing n.e.c.							
	Manufacture of brooms and brushes							

Product group/category (COICOP)	PRODCOM categories	Sold Volume	Main environmental impact areas	LCA relevant information available	Suitability for ED and ELD	Assessment of the possible costs / risks and benefits of Ecodesign	Assessment of the possible costs / risks and benefits of Labelling	Total
	Manufacture of other articles of paper and paperboard							
Household textiles	Manufacture of made-up textile articles, except apparel	1	0	2	2	1	1	7
	Manufacture of cordage, rope, twine and netting							
Other articles of clothing and clothing accessories	Manufacture of other wearing apparel and accessories	1	0	2	2	1	1	7
	Manufacture of articles of fur							
	Manufacture of luggage, handbags and the like, saddlery and harness							
Glassware, tableware and household utensils	Manufacture of hollow glass	2	1	2	2	0	0	7
	Manufacture of builders' ware of plastic							

Product group/category (COICOP)	PRODCOM categories	Sold Volume	Main environmental impact areas	LCA relevant information available	Suitability for ED and ELD	Assessment of the possible costs / risks and benefits of Ecodesign	Assessment of the possible costs / risks and benefits of Labelling	Total
	Manufacture of ceramic household and ornamental articles							
	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting							
	Manufacture of assembled parquet floors							
	Manufacture of ceramic sanitary fixtures							
	Manufacture of other ceramic products							
Wine	Manufacture of wine from grape	1	1	2	2	1	0	7
	Manufacture of cider and other fruit wines							

Product group/category (COICOP)	PRODCOM categories	Sold Volume	Main environmental impact areas	LCA relevant information available	Suitability for ED and ELD	Assessment of the possible costs / risks and benefits of Ecodesign	Assessment of the possible costs / risks and benefits of Labelling	Total
	Manufacture of other non-distilled fermented beverages							
Carpets and other floor coverings	Manufacture of carpets and rugs	1	1	2	2	0	0	6
Sugar, jam, honey, chocolate and confectionery	Manufacture of ice cream	2	0	1	2	1	0	6
	Manufacture of sugar							
Tobacco	Manufacture of tobacco products	2	1	1	0	1	0	5
Miscellaneous printed matter	Other printing	2	0	1	2	0	0	5
Food products n.e.c.	Manufacture of condiments and seasonings	2	0	0	2	1	0	5
	Manufacture of prepared meals and dishes							
	Manufacture of homogenised food preparations and dietetic food							
	Manufacture of other							

Product group/category (COICOP)	PRODCOM categories	Sold Volume	Main environmental impact areas	LCA relevant information available	Suitability for ED and ELD	Assessment of the possible costs / risks and benefits of Ecodesign	Assessment of the possible costs / risks and benefits of Labelling	Total
	food products n.e.c.							
Beer	Manufacture of beer	1	0	2	1	1	0	5
Pets and related products	Manufacture of prepared feeds for farm animals	2	0	0	1	0	1	4
	Manufacture of prepared pet foods							
Small tools and miscellaneous accessories	Manufacture of cutlery	2	0	1	1	0	0	4
	Manufacture of locks and hinges							
	Manufacture of tools							
Newspapers and periodicals	Printing of newspapers	1	0	1	2	0	0	4
Therapeutic appliances and equipment	Manufacture of medical and dental instruments and supplies	2	0	1	1	0	0	4
Spirits	Distilling, rectifying and blending of spirits	1	0	0	2	1	0	4
Games, toys and hobbies	Manufacture of games and toys	0	0	1	2	0	0	3
Jewellery, clocks and watches	Manufacture of jewellery and related articles	0	0	1	1	0	0	2

Product group/category (COICOP)	PRODCOM categories	Sold Volume	Main environmental impact areas	LCA relevant information available	Suitability for ED and ELD	Assessment of the possible costs / risks and benefits of Ecodesign	Assessment of the possible costs / risks and benefits of Labelling	Total
	Manufacture of imitation jewellery and related articles							
Equipment for sport, camping and open-air recreation	Manufacture of sports goods	0	0	0	1	0	0	1
Water transport	Building of ships and floating structures	0	0	0	1	0	0	1
	Building of pleasure and sporting boats							
Rail transport	Manufacture of railway locomotives and rolling stock	0	0	0	1	0	0	1
Air transport	Manufacture of air and spacecraft and related machinery	0	0	0	1	0	0	1
Non-motorized road transport	Manufacture of bicycles and invalid carriages	0	0	0	1	0	0	1
	Manufacture of other transport equipment n.e.c.							

3.3 Case Studies[4]

Based on the ranking, market-size of the individual product, coverage of different product groups, data availability, competences and experiences in the consortium, and sufficient difference to case studies conducted in the CSES study, five case-studies were selected. The rationales for choosing the case studies are the following:

- The product has a high market share, or high identified environmental impact, within the higher level product group
- the product represents the product group as a whole in the sense that it poses similar issues than other products in this group
- The different products selected reflect different activities (transportation, farming (animal raising and crop raising) and industrially produced products)
- good data available
- not too close to the PG already dealt with by CSES
- existing expertise in the consortium.

The following 5 case-studies were selected which are thought to be representative of the entire product group they belong to:

1. Motorized road transport: Trucking / Heavy-Duty Vehicles;
2. Milk, cheese and eggs: Dairy products;
3. Bread and cereals: Fresh bread;
4. Materials for the maintenance and repair of the dwelling: Manufacture of paints and varnishes;
5. Garments: T-Shirts

[4] Identical to the text in the First Findings and Recommendations report

4 Final ranking

The evaluation carried out in the previous steps led to the conclusion that there is a need to consider three main issues in the selection of products to be covered: necessity, feasibility, and added value. As an aid to the final ranking of products and to the future evaluation of the possibility for scope expansion of individual products groups, a decision tree was developed (also taking into account lessons learned from the case-studies[5]). If a decision is made to expand the scope a decision tree similar to the one shown below should be used for the selection of products to be covered. Although there are considerable similarities for certain broad product groups (higher level), steps must, in principle, be followed for each lower level product group separately, as results can be very different for different products within the same broad categories.

In principle, this assessment has to be conducted twice, at two regulatory levels:

1) In order to decide whether the Framework Directives should be extended to non-ErP at all, it must be checked whether a sufficient number of products exists for which the application of ELD and ED would be worthwhile. This is what the current study attempts at. Naturally, it does so in a rather broad way because no detailed assessment for all individual product groups was possible.
2) Once the general decision has been made at the level of the Framework Directive, Workplan Studies must decide which product groups to include. At this stage, the exercise will have to be repeated in more detail and based on solid data by the consultants doing the Workplan Studies.

Although the questions are set in a Yes / No format, answers may not be straightforward and often need some kind of judgment, involving a balancing of pros and cons or the comparison against other known values. The balance between each of the issues - necessity, feasibility and added value - must also be considered carefully. For example, even if necessity is there for some products, and feasibility can be assured, added value will have to be carefully considered, thinking about the suitability of the instrument and possible alternatives, and the available resources. Therefore, a scoring model has been developed from the questions of the decision tree. It is presented in more detail below.

The main issues relating to the necessity of a regulation are the existence of an identified relevant environmental impact and a potential for improvement that has not been realized so far due to market failures. Both impact and improvement potential are also linked to sold volume. The fact that the main impacts may already be covered by other existing measures may also influence the decision on necessity.

[5] Please note that the decision tree was not applied to the case-studies

Environmental impact and improvement potential have been identified for a number of product groups, particularly for food and drink products, private transportation and housing which were found to cause 70-80% of the various environmental impacts of total private consumption in the EU-25, based on a life cycle analysis. Food and drink account for 20-30% of those impacts. Within this consumption area, meat and meat products (including meat, poultry, sausages or similar) are the most important, followed by dairy products. For private transportation the total environmental impacts ranges from 15 to 35% of all private consumption impacts, depending on the impact category, and the largest contribution comes from passenger cars. The products under the heading of housing include buildings, furniture, domestic appliances, and energy for purposes such as room and water heating. Together they make up 20 to 35% of the impacts of all products for most impact categories (IPTS 2006).

If necessity is acknowledged, the question of feasibility then arises and a number of challenges may present themselves, such as:

- Methodologies for determining impacts of other use phases and aggregate them on a label (including harmonized standards, data availability)
- Enforceability: Measurability of impacts on the product; alternative methods of verification
- Priority setting in the face of limited resources (MS, Commission)
- Heterogeneity of product groups
- Impact of including life cycle impacts in energy label on manufacturers/importers

The added value of setting ecodesign requirements or labels is very dependant of factors that are not so straightforward to evaluate, such as:

- Are the impacts better tackled by other instruments?
- Will the introduction of new legislation impair existing regulation (e.g. by adding confusion)?
- Is the burden introduced to manufacturers manageable?

For each of the identified product groups an analysis is carried out and the necessity, feasibility and added value are evaluated. As an information basis, we use the results obtained from the case studies, as far as they can be generalized to other, similar products, and stakeholder input we received during the consultation. The results are shown in Table 4.

In Table 5, the assessment is further developed into a final ranking. An evaluation of these three broad criteria was carried out for the product groups identified in the initial selection. This evaluation produced a final ranking of products which sorts products according to their suitability for the inclusion in the scope of the ED and the ELD. The ranking does not imply a judgement on whether or not scope expansion is recommended in general but highlights which products are most suitable in case a political decision for scope expansion should be taken.
It should be noted that the analysis carried out here is limited to readily available information and to the time constraints of a study of this nature and does not replace an in-depth analysis for each product group, based on the decision tree (or a similar approach) that is presented here, if and when there is a decision to expand the scope to non-ErPs.

The ranking has been developed according to the following scoring model:

Necessity
> Environmental impact: a “yes” answer scores 2 points, a “limited” answer scores 1, a “no” answer scores 0 points
> Improvement potential: a “yes” answer scores 2 points, a “limited” answer scores 1 point, a “no” answer scores 0 points
> Sold volume: a “yes” answer scores 2 points, a “no” answer scores 0 points
> Existence of other legislation: a “no” answer scores 2 points, a “yes” answer scores 0 points, a “partly” answer scores 1 point

Feasibility
> Measurability of impact: a “yes” answer scores 2 points, a “smaller part” answer scores 1 point, a “no” answer scores 0 points
> Existence of methodology: a “yes” answer scores 2 points, a “no standard methodology” answer scores 0 points
> Possibility to define meaningful scope: “meaningful scope can be defined” scores 2 points, “heterogeneous” scores 1 point, a “very heterogeneous” scores 0 points
> Stakeholder attitude: “mostly critical” scores 0 points, “some in favour” scores 1 point, “mostly in favour” scores 2 points. When the stakeholder attitude on a specific product is unknown, the general attitude on scope extension has been used.
> Regulatory burden: “high” scores 0 points, “medium” scores 1 point, “low” scores 2 points

Added value (cost-benefit ratio)
> Has been ranked negative (0 points), moderately positive (1 point) or strongly positive (2 points) according to the qualitative arguments put forward above.

In a second step, the points for each of the categories were aggregated in order to give them equal weight.

Necessity: 0-2 points: overall “0”; 3-5 points: overall “1”, 6-8 points: overall “2”. In addition, aggregated necessity scored 0 if environmental impact, improvement potential, or sold volume scored 0.
Feasibility: 0-2 points: overall “0”; 3-6 points: overall “1”, 7-10 points: overall “2”
Added value: 0 points: overall “0”; 1 point: overall “1”, 2 points: overall “2”

A product group was excluded if any of the three aggregated categories scored 0 (meaning no necessity, no feasibility, or no added value). Excluded product groups are shown at the end of the ranking.

The remaining product groups were ranked according to the sum of the individual sub-categories (as this provides more differentiation than the sum of the three aggregated categories. It should be noted that in the final ranking, and apart from transportation, feasibility is considered relatively low (maximum score 4/10) mainly due to measurability and methodological limitations.

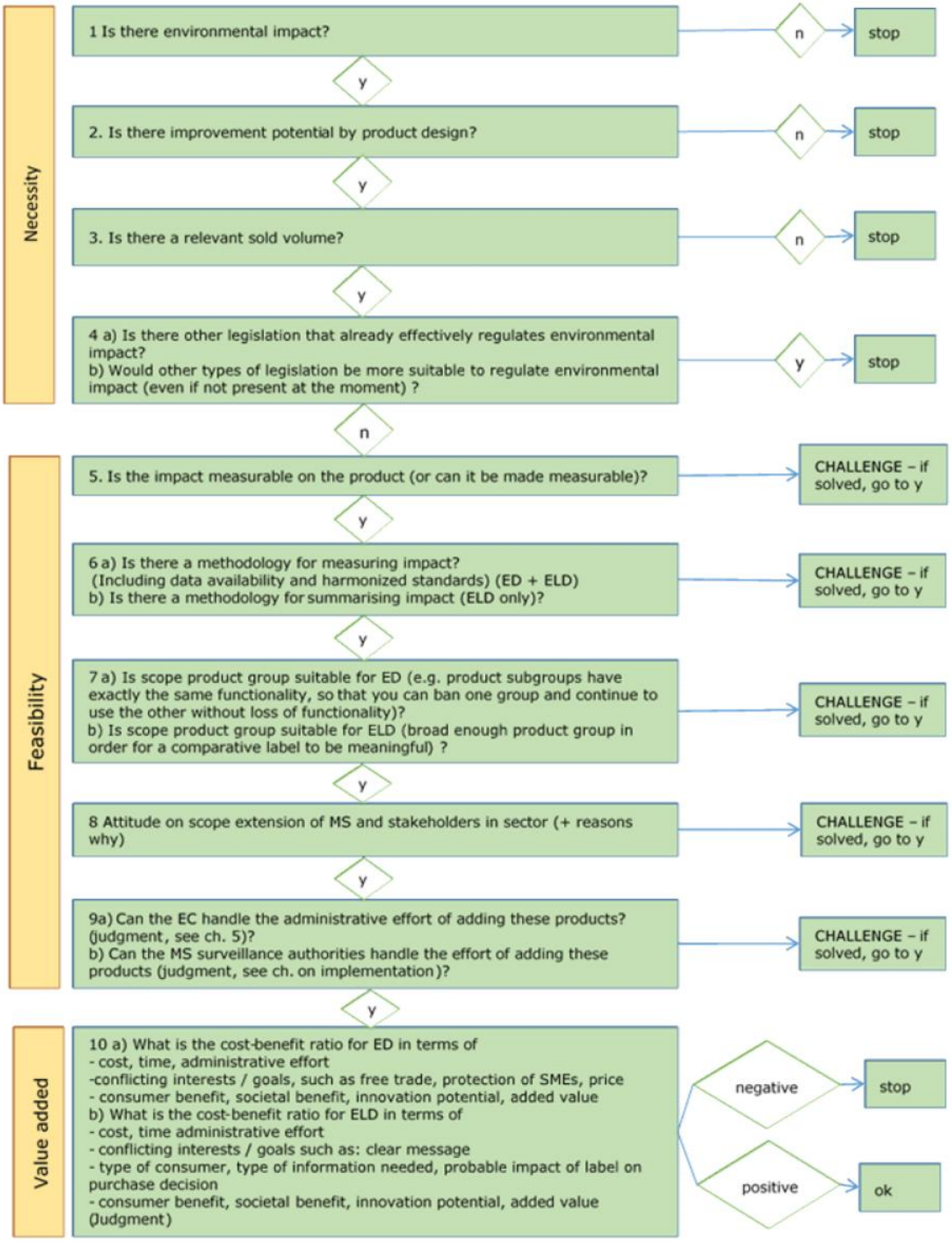


Figure 3 Decision tree for the selection of product groups

Table 4 Assessment of necessity, feasibility and value added

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
Milk, cheese and eggs-label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of organic label)
Milk, cheese and eggs-ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of existing legislation) BUT: maybe for products used in the manufacturing phase (refrigerators, etc…). Improvement would bring some non-monetary benefits to consumers (less so to society), but probably at higher cost
Meat – label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of organic label)
Meat – ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of existing legislation) BUT: maybe for products used in the manufacturing phase (orefrigerators, etc…). Improvement would bring some non-monetary benefits to consumers (less so to society), but probably at higher cost
Bread and cereals – label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of organic label)

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
Bread and cereals - ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of existing legislation) BUT: maybe for products used in the manufacturing phase (ovens, refrigerators…). Improvement would bring some non-monetary benefits to consumers (less so to society), but probably at higher cost
Fruit and Vegetables – label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of organic label)
Fruit and Vegetables - ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of existing legislation) Improvement would bring some non-monetary benefits to consumers (less so to society), but probably at higher cost
Materials for the maintenance and repair of the dwelling - label	yes	limited	yes	No	smaller part (components)	no standard methodology	Very heterogeneous	mostly critical	high	Limited (Probably little added value (in relation to cost) of labelling embedded energy)
Materials for the maintenance and repair of the dwelling - ecodesign	Yes	limited	yes	Partial (e.g. REACH; Regulation 305/2011)	smaller part (components)	no standard methodology	Very heterogeneous	mostly critical	high	Some impact that could successfully regulated by Ecodesign (energy use during production phase, additives etc.). Improvement would provide relevant benefit to both consumers and society (hazardous sub-stances, health issues); synergies with Eco-labels

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
Other appliances, articles and products for personal care-label	yes	limited	yes	No	smaller part (components)	no standard methodology	Very heterogeneous	mostly critical	high	Some label might be helpful to provide an aggregate idea of environmental impact (as detailed declarations are not always understandable). Focus on non-energy impacts, not to be confused with Energy label.
Other appliances, articles and products for personal care - ecodesign	Yes	limited	yes	No	smaller part (components)	no standard methodology	Very heterogeneous	mostly critical	high	Improvement would provide relevant benefit to both consumers and society (eutrophication, hazardous substances, health issues). Mainly paper products (hygiene papers / tissues, paper trays etc.), therefore the considerations for paper apply: Some impact that could successfully regulated by Ecodesign (energy use during production phase, additives etc.).
Motorized road transport-label	yes	yes	yes	partly (CO2 and tyre labelling); could be integrated	Yes	Yes	meaningful scope can be defined	mostly critical	medium (partly in place for existing legislation)	As in this product group, the purchasing decision is almost exclusively determined by functional aspects and necessities, a label would probably not affect purchasing decision. Might be merged with / replace CO2 label to have consistent approach
Motorized road transport-ecodesign	Yes	Yes	yes	partly (emission standards); integration	Yes	yes	meaningful scope can be defined	mostly critical	medium (partly in place for existing legislatio	For all motorized means of transport: High impact, especially in use phase, high benefits to expect mainly for society (less so

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
				difficult					n)	individual users); experience exists because problem structure similar to EuP.
Mineral waters, soft drinks,fruit and vegetable juices-label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (little added value as compared to EU Organic label)
Mineral waters, soft drinks,fruit and vegetable juices - ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of existing legislation) Improvement would bring some non-monetary benefits to consumers (less so to society), but probably at higher cost
Garments-label	yes	limited	yes	No	smaller part (components)	no standard methodology	heterogeneous	partly in favor	high	A label could be valuable be-cause currently there is little consumer in-formation as to LC impact of textiles. However verification would be difficult and probably costly. Must re-late to non-energy issues and not be confused with current energy label)
Garments-ecodesign	Yes	limited	yes	No	smaller part (components)	no standard methodology	heterogeneous	partly in favor	high	Limited (Especially if it includes impacts in earlier stages of the value chain (e.g. manufacture of yarns and tis-sues), improvement would bring high benefits mostly to society (less so to individual consumers).

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
Shoes and other footwear-label	yes	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	A label could be valuable be-cause currently there is little consumer in-formation as to LC impact of textiles. However verification would be difficult and probably costly. Must re-late to non-energy issues and not be confused with current energy label)
Shoes and other footwear-ecodesign	Yes	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	Limited (Important product group and environmental impacts. However, the nature of impact and improvement potential would depend heavily on material (textile, leather, plastics?). Detailed differentiations and provisions would have to be foreseen. Impacts partly in third countries, verification issues as in textiles.)
Non-durable household goods/Adhesive and sealants-label	yes	limited	yes	No	smaller part (components)	no standard methodology	Very heterogeneous	partly in favour (detergent)	high	Some label might be helpful to pro-vide an aggregate idea of environmental impact (as detailed declarations are not always understandable). Focus on non-energy impacts, not to be con-fused with Energy label
Non-durable household goods/Adhesive and Sealants-	Yes	limited	yes	No	smaller part (components)	no standard methodology	Very heterogeneous	partly in favour (detergent)	high	Improvement would provide relevant benefit to both consumers and society (eutrophication, hazardous substances,

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
ecodesign										health issues)
Furniture and furnishings-label	yes	limited	yes	No	smaller part (components)	no standard methodology	Heterogeneous	partly in favour (mattresses, furniture)	high	A label could be valuable be-cause currently there is little consumer in-formation as to LC impact of furniture. Must relate to non-energy issues and not be con-fused with cur-rent energy label
Furniture and furnishings-ecodesign	Yes	limited	yes	No	smaller part (components)	no standard methodology	Heterogeneous	partly in favour (mattresses, furniture)	high	Improvement would bring relevant benefits to both society and individual consumers (health issues); additional cost unclear.
Oils and fats-label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	Heterogeneous	mostly critical	high	limited (in the face of organic label)
Oils and fats-ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	Heterogeneous	mostly critical	high	limited (in the face of existing legislation) Improvement would bring some non-monetary benefits to consumers (less so to society), but probably at higher cost
Coffee, tea and cocoa-label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of organic label)

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
Coffee, tea and cocoa-ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of existing legislation) Improvement would bring some non-monetary benefits to consumers (less so to society), but probably at higher cost
Fish and seafood-label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of organic label)
Fish and seafood-ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of existing legislation) Improvement would bring high non-monetary benefits mainly to society in case of fisheries and to both consumers and society in case of aquaculture, but probably at higher cost
Stationery and drawing materials-label	yes	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	A label that clearly indicates the difference in environmental impact (water use, energy use, logging) could make sense. Should be clearly distinguished from current energy label
Stationery and drawing materials-ecodesign	Yes	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	Some impact that could successfully regulated by Ecodesign (energy use during production phase, additives etc.).
Household textiles-label	yes	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	partly in favor	high	A label could be valuable because currently there is little consumer in-formation as to LC impact of textiles. However

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
										verification would be difficult and probably costly.
Household textiles-ecodesign	Yes	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	partly in favor	high	Especially if it includes impacts in earlier stages of the value chain, improvement would bring high benefits mostly to society (less so to individual consumers) and mostly occur in third countries. Cost would somewhat in-crease.
Other articles of clothing and clothing accessories-label	yes	limited	yes	No	smaller part (components)	no standard methodology	Heterogenous	partly in favor	high	Some label might be helpful to provide an aggregate idea of environmental impact (as de-tailed declarations are not always understandable). Focus on non-energy impacts, not to be confused with Energy label. Mainly paper products (hygiene papers / tissues, paper trays etc.), therefore the considerations for paper apply: A label that clearly indicates the difference in environmental impact (water use, energy use, logging) could make sense.
Other articles of clothing and clothing accessories-ecodesign	Yes	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	partly in favor	high	Improvement would provide relevant benefit to both consumers and society (eutrophication, hazardous substances, health issues). Mainly

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
										paper products (hygiene papers / tissues, paper trays etc.), therefore the considerations for paper apply: Some impact that could successfully regulated by Ecodesign (energy use during production phase, additives etc.).
Glassware, tableware and household utensils-label	yes	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	Heterogeneous product groups with relatively small impact, therefore bad cost-benefit ratio
Glassware, tableware and household utensils-ecodesign	Yes	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	Heterogeneous product groups with relatively small impact, therefore bad cost-benefit ratio
Wine-label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of organic label)
Wine-ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of existing legislation) maybe for products used in the manufacturing phase Improvement would bring some non-monetary benefits to consumers (less so to society), but probably at higher cost
Carpets and other floor coverings-label	yes	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	A label would be valuable be-cause currently there is little consumer information as to LC impact of carpets. Must

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
										relate to non-energy issues and not be confused with current energy label
Carpets and other floor coverings-ecodesign	Yes	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	Improvement would bring relevant benefits to both society and individual consumers (health issues);
Sugar, jam, honey, chocolate and confectionery-label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of organic label)
Sugar, jam, honey, chocolate and confectionery-ecodesign	yes	limited (processing stage)	Yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of existing legislation) BUT: maybe for products used in the manufacturing phase Improvement would bring some non-monetary benefits to consumers (less so to society), but probably at higher cost
Tobacco-label	yes	limited (processing stage)	yes	yes	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	Already heavily regulated
Tobacco-ecodesign	Yes	limited (processing stage)	yes	yes	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of existing legislation)

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
Miscellaneous printed matter-label	No	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	No known relevant impacts
Miscellaneous printed matter-ecodesign	No	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	As Ecodesign is a product-related approach, it could rather be applied on the paper (and maybe ink) than the printing itself
Food products n.e.c.-label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	Very Heterogenous	mostly critical	high	limited (in the face of organic label)
Food products n.e.c.-ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	Very Heterogenous	mostly critical	high	limited (in the face of existing legislation) BUT: maybe for products used in the manufacturing phase (ovens, refrigerators…). Improvement would bring some non-monetary benefits to consumers (less so to society), but probably at higher cost
Beer-label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of organic label)
Beer-ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of existing legislation) BUT: maybe for products used in the manufacturing phase Improvement would bring some non-monetary benefits to consumers (less so to society), but probably at

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
										higher cost
Pets and related products-label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	Very heterogeneous	mostly critical	high	limited (in the face a mandatory organic label for pet food (as this product group addresses individual consumers)
Pets and related products-ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	Very heterogeneous	mostly critical	high	limited (in the face of Feed for farm animals is a subordinate aspect to meat production) : bad cost-benefit relation because data would be difficult to get; overlap with meat and other food products
Small tools and miscellaneous accessories-label	No	limited	yes	No	smaller part (components)	no standard methodology	Very heterogeneous	mostly critical	high	No known relevant impacts
Small tools and miscellaneous accessories-ecodesign	No	limited	yes	No	smaller part (components)	no standard methodology	Very heterogeneous	mostly critical	high	No known relevant impacts
Newspapers and periodicals-label	No	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	No known relevant impacts
Newspapers and periodicals-ecodesign	No	limited	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	As Ecodesign is a product-related ap-proach, it could rather be applied on the paper (and maybe ink) than the print-ing itself

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
Therapeutic appliances and equipment-label	limited	limited	yes	No	smaller part (components)	no standard methodology	Very heterogeneous	mostly critical	high	As in this product group, the purchasing decision is almost exclusively determined by functional aspects and necessities, little to no impact on purchasing decision is expected
Therapeutic appliances and equipment-ecodesign	limited	limited	yes	No	smaller part (components)	no standard methodology	Very heterogeneous	mostly critical	high	Very heterogeneous product group where functional considerations dominate
Spirits-label	yes	limited (processing stage)	yes	partly (organic label)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of organic label)
Spirits-ecodesign	Yes	limited (processing stage)	yes	partly (CAP, food law)	smaller part (ingredients)	no standard methodology	meaningful scope can be defined	mostly critical	high	limited (in the face of existing legislation) BUT: maybe for products used in the manufacturing phase
Games, toys and hobbies-label	No	limited	yes	Yes	smaller part (components)	no standard methodology	Very heterogeneous	partly in favour (toys)	high	Little impact but high consumer sensitivity; however existing impact already regulated by safety legislation
Games, toys and hobbies-ecodesign	No	limited	yes	Yes (Dir 2009/48)	smaller part (components)	no standard methodology	Very heterogeneous	partly in favour (toys)	high	Little impact but high consumer sensitivity; however; existing impact is already regulated by safety legislation
Jewellery, clocks and watches-label	Limited	limited	No	No	smaller part (components)	no standard methodology	Very heterogeneous	mostly critical	high	no good cost-benefit relation of mandatory label. In this product group, consumer choice is highly determined by design and lifestyle aspects and there is no

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
										public awareness for environmental issues. Therefore the impact of a label on purchase decision would likely be limited. A. ; voluntary label makes more sense
Jewellery, clocks and watches-ecodesign	limited	limited	No	No	smaller part (components)	no standard methodology	Very heterogeneous	mostly critical	high	Improvement would bring noticeable benefits (human- and eco-toxicity) mostly to society (less so to individual consumers) and mostly in third countries (mining and processing of gemstones / precious metals). Impact on cost unclear. Important verification issues.
Equipment for sport, camping and open-air recreation-label	No	limited	No	No	smaller part (components)	no standard methodology	Very heterogeneous	mostly critical	high	No known relevant impacts
Equipment for sport, camping and open-air recreation-ecodesign	No	limited	No	No	smaller part (components)	no standard methodology	Very heterogeneous	mostly critical	high	No known relevant impacts
Water transport-label	yes	No	No	No	Yes	no standard methodology	meaningful scope can be defined	mostly critical	high	Commercial ships are not purchased by private end consumers, therefore a simplified tool like the label would be of little use. The purchase of pleasure and sporting boats is generally determined by functional and lifestyle

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
										considerations and there is no public awareness of environmental issues, therefore a label would probably little or not affect purchasing decision
Water transport-ecodesign	yes	No	No	No	Yes	no standard methodology	meaningful scope can be defined	mostly critical	high	Ships are quite specific and not sold in great numbers; therefore probably not efficient tool.
Rail transport-label	yes	No	No	No	Yes	no standard methodology	meaningful scope can be defined	mostly critical	high	Railway equipment is not purchased by private end consumers, therefore a simplified tool like the label would be of little use. and would probably not affect purchasing decision
Rail transport-ecodesign	yes	No	No	No	Yes	no standard methodology	meaningful scope can be defined	mostly critical	high	For all motorized means of transport: High impact, especially in use phase, high benefits to expect mainly for society (less so individual users); experience exists be-cause problem structure similar to EuP. However, rail-way stock are quite specific and not sold in great numbers; therefore probably not efficient tool.
Air transport-label	yes	No	No	No	Yes	no standard methodology	meaningful scope can be defined	mostly critical	high	Aviation equipment is not purchased by private end consumers, therefore a simplified tool like the label would be of little use. and would probably not affect pur-chasing deci-sion

	Necessity				Feasibility					Value added
	Environmental impact	Improvement potential by design?	Sold volume	Existing / more suitable legislation?	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Cost-benefit
Air transport-ecodesign	yes	No	No	No	Yes	no standard methodology	meaningful scope can be defined	mostly critical	high	No application
Non-motorized road transport-label	No	limited (processing stage)	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	No relevant impact
Non-motorized road transport-ecodesign	No	limited (processing stage)	yes	No	smaller part (components)	no standard methodology	meaningful scope can be defined	mostly critical	high	No relevant impact

Table 5: Scoring based on necessity, feasibility, and added value

	Necessity						Feasibility							Value added	Grand total
	Env impact	Improvement potential	Sold volume	Existing / legislation?	Total	Weighted	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Total	Weighted	Cost-benefit	
Motorized road transport-label	2	2	2	1	7	2	2	2	2	0	1	7	2	1	15
Motorized road transport-ecodesign	2	2	2	1	7	2	2	2	2	0	1	7	2	1	15
Furniture and furnishings-ecodesign	2	1	2	2	7	2	1	0	2	1	0	4	1	2	13
Furniture and furnishings-label	2	1	2	2	7	2	1	0	2	1	0	4	1	1	12
Household textiles-label	2	1	2	2	7	2	1	0	2	1	0	4	1	1	12
Household textiles-ecodesign	2	1	2	2	7	2	1	0	2	1	0	4	1	1	12
Carpets and other floor coverings-label	2	1	2	2	7	2	1	0	2	0	0	3	1	2	12

	Necessity						Feasibility							Value added	Grand total
	Env impact	Improvement potential	Sold volume	Existing / legislation?	Total	Weighted	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Total	Weighted	Cost-benefit	
Carpets and other floor coverings-ecodesign	2	1	2	2	7	2	1	0	2	0	0	3	1	2	12
Garments-label	2	1	2	2	7	2	1	0	1	1	0	3	1	1	11
Garments-ecodesign	2	1	2	2	7	2	1	0	1	1	0	3	1	1	11
Stationery and drawing materials-label	2	1	2	2	7	2	1	0	2	0	0	3	1	1	11
Stationery and drawing materials-ecodesign	2	1	2	2	7	2	1	0	2	0	0	3	1	1	11
Other articles of clothing and clothing accessories-label	2	1	2	2	7	2	1	0	1	1	0	3	1	1	11
Other articles of clothing and clothing accessories-ecodesign	2	1	2	2	7	2	1	0	1	1	0	3	1	1	11
Milk, cheese and eggs-	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10

	Necessity						Feasibility							Value added	Grand total
	Env imp act	Improv ement potenti al	Sol d vol um e	Existi ng / legisl ation ?	To tal	Weig hted	Impact measur able on produc t	Metho dology	Scope product group	Stake holder attitu de	Regul atory burde n	To tal	Weig hted	Cost-benefit	
label[6]															
Milk, cheese and eggs- ecodesign	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Meat – label	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Meat – ecodesign	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Bread and cereals – label	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Bread and cereals - ecodesign	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Fruit and Vegetables – label	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Fruit and Vegetables - ecodesign	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10

[6] General remark for food products: The possible feasibility of Ecodesign relates to the processes / machinery in the manufacturing phase, not the products themselves. The idea of labeling builds on the ideas of the JRC study on an Ecolabel for food and should be seen in this context.

	Necessity						Feasibility							Value added	Grand total
	Env impact	Improvement potential	Sold volume	Existing / legislation?	Total	Weighted	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Total	Weighted	Cost-benefit	
Mineral waters, soft drinks,fruit and vegetable juices-label	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Mineral waters, soft drinks,fruit and vegetable juices - ecodesign	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Oils and fats-label	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Oils and fats-ecodesign	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Coffee, tea and cocoa-label	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Coffee, tea and cocoa-ecodesign	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Fish and seafood-label	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10

	Necessity						Feasibility							Value added	Grand total
	Env impact	Improvement potential	Sold volume	Existing / legislation?	Total	Weighted	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Total	Weighted	Cost-benefit	
Fish and seafood-ecodesign	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Wine-label	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Wine-ecodesign	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Sugar, jam, honey, chocolate and confectionery-label	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Sugar, jam, honey, chocolate and confectionery-ecodesign	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Beer-label	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Beer-ecodesign	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10

	Necessity						Feasibility							Value added	Grand total
	Env impact	Improvement potential	Sold volume	Existing / legislation?	Total	Weighted	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Total	Weighted	Cost-benefit	
Spirits-label	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10
Spirits-ecodesign	2	1	2	1	6	2	1	0	2	0	0	3	1	1	10

Excluded Product groups (one category scored 0)															
	Env impact	Improvement potential	Sold volume	Existing / legislation?	Total	Weighted	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Total	Weighted	Cost-benefit	
Non-durable household goods/Adhesive and Sealants-ecodesign	2	1	2	2	7	2	1	0	0	1	0	2	0	2	11
Non-durable household goods/Adhesive and sealants-label	2	1	2	2	7	2	1	0	0	1	0	2	0	1	10
Shoes and other footwear-ecodesign	2	1	2	2	7	2	1	0	1	0	0	2	0	1	10

Excluded Product groups (one category scored 0)															
	Env imp act	Improv ement potenti al	Sol d vol um e	Existi ng / legisl ation ?	To tal	Weig hted	Impact measur able on produc t	Metho dology	Scope product group	Stake holder attitu de	Regul atory burde n	To tal	Weig hted	Cost-benefit	
Shoes and other footwear-label	2	1	2	2	7	2	1	0	1	0	0	2	0	1	10
Glassware, tableware and household utensils-label	2	1	2	2	7	2	1	0	2	0	0	3	1	0	10
Glassware, tableware and household utensils-ecodesign	2	1	2	2	7	2	1	0	2	0	0	3	1	0	10
Other appliances, articles and products for personal care - ecodesign	2	1	2	2	7	2	1	0	0	0	0	1	0	2	10
Other appliances, articles and products for personal care-label	2	1	2	2	7	2	1	0	0	0	0	1	0	1	9
Materials for the maintenance and repair of the dwelling -ecodesign	2	1	2	1	6	2	1	0	0	0	0	1	0	2	9
Materials for the maintenance and repair of the dwelling	2	1	2	2	7	2	1	0	0	0	0	1	0	0	8

Excluded Product groups (one category scored 0)															
	Env imp act	Improv ement potenti al	Sol d vol um e	Existi ng / legisl ation ?	To tal	Weig hted	Impact measur able on produc t	Metho dology	Scope product group	Stake holder attitu de	Regul atory burde n	To tal	Weig hted	Cost-benefit	
- label															
Newspapers and periodicals-label	0	1	2	2	5	1	1	0	2	0	0	3	1	0	8
Newspapers and periodicals-ecodesign	0	1	2	2	5	1	1	0	2	0	0	3	1	0	8
Miscellaneous printed matter-label	0	1	2	2	5	2	1	0	2	0	0	3	1	0	8
Miscellaneous printed matter-ecodesign	0	1	2	2	5	2	1	0	2	0	0	3	1	0	8
Tobacco-ecodesign	2	1	2	0	4	1	1	0	2	0	0	3	1	0	8
Food products n.e.c.-label	2	1	2	1	6	2	1	0	0	0	0	1	0	1	8

Excluded Product groups (one category scored 0)															
	Env imp act	Improv ement potenti al	Sol d vol um e	Existi ng / legisl ation ?	To tal	Weig hted	Impact measur able on produc t	Metho dology	Scope product group	Stake holder attitu de	Regul atory burde n	To tal	Weig hted	Cost-benefit	
Food products n.e.c.-ecodesign	2	1	2	1	6	2	1	0	0	0	0	1	0	1	8
Non-motorized road transport-label	0	1	2	2	5	1	1	0	2	0	0	3	1	0	8
Non-motorized road transport-ecodesign	0	1	2	2	5	1	1	0	2	0	0	3	1	0	8
Pets and related products-label	2	1	2	1	6	2	1	0	0	0	0	1	0	1	8
Pets and related products-ecodesign	2	1	2	1	6	2	1	0	0	0	0	1	0	0	7
Therapeutic appliances and equipment-label	1	1	2	2	7	2	1	0	0	0	0	1	0	0	7
Therapeutic appliances and equipment-ecodesign	1	1	2	2	7	2	1	0	0	0	0	1	0	0	7

Excluded Product groups (one category scored 0)															
	Env impact	Improvement potential	Sold volume	Existing / legislation?	Total	Weighted	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Total	Weighted	Cost-benefit	
Water transport-ecodesign	0	0	0	2	2	0	2	0	2	0	0	4	1	1	7
Rail transport-ecodesign	0	0	0	2	2	0	2	0	2	0	0	4	1	1	7
Small tools and miscellaneous accessories-label	0	1	2	2	5	1	1	0	0	0	0	1	0	0	6
Small tools and miscellaneous accessories-ecodesign	0	1	2	2	5	1	1	0	0	0	0	1	0	0	6
Games, toys and hobbies-ecodesign	0	1	2	0	3	0	1	0	0	1	0	2	0	1	6
Water transport-label	0	0	0	2	2	0	2	0	2	0	0	4	1	0	6
Rail transport-label	0	0	0	2	2	0	2	0	2	0	0	4	1	0	6

Excluded Product groups (one category scored 0)															
	Env impact	Improvement potential	Sold volume	Existing / legislation?	Total	Weighted	Impact measurable on product	Methodology	Scope product group	Stakeholder attitude	Regulatory burden	Total	Weighted	Cost-benefit	
Air transport-label	0	0	0	2	2	0	2	0	2	0	0	4	1	0	6
Air transport-ecodesign	0	0	0	2	2	0	2	0	2	0	0	4	1	0	6
Jewellery, clocks and watches-ecodesign	1	1	0	2	4	0	1	0	0	0	0	1	0	1	6
Jewellery, clocks and watches-label	1	1	0	2	4	0	1	0	0	0	0	1	0	0	5
Equipment for sport, camping and open-air recreation-label	0	1	0	2	3	0	1	0	0	0	0	1	0	0	4
Equipment for sport, camping and open-air recreation-ecodesign	0	1	0	2	3	0	1	0	0	0	0	1	0	0	4

Although necessity based on environmental impact and improvement potential exists for several product groups these impacts are sometimes covered by existing legislation. Low feasibility presents itself as an issue mainly due to the prevalence of impacts not measurable on the products and the inexistence of methodologies to quantify them.

5 Assessment of scope expansion (non-ErP) – ELD[7]

Necessity on the basis of environmental impact and improvement potential has been identified for a number of product groups, particularly for food and drink products, private transportation and housing (see above section 4).

With regard to feasibility, possible methodologies for the labelling of the environmental impact of non-ErPs include the Product Carbon Footprint (PCF) and the Product Environmental Footprint PEF.

Labelling of the Product Carbon Footprint (PCF)

The term 'carbon footprint' has become tremendously popular over the last few years. A variety of different CO_2 or climate protection labels partly tailored to certain product groups is meanwhile available at the international level – e.g. Carbon Reduction Label/UK; Carrefour Initiative (France), Stop Climate Change Label/Germany; KRAV Climate Marking Sweden (KRAV Sweden); Climatop-Migros Switzerland, Carbon Label Initiatives or programs in Japan (Japan Environmental Management Association for Industry), Korea (Korea Eco-Products Institute), Thailand (Thailand Greenhouse Gas Management Organization). Interestingly, the main focus lies on foods although individual foods are clearly less relevant to the climate than other product groups, i.e. household appliances or automobiles.

With climate change high up on the political and corporate agenda, carbon footprint calculations are in strong demand. Nevertheless the focus on CO_2-emissions does not only provide possibilities, but also bears some risks that might as well weaken environmental labelling approaches in the future. In a study conducted on behalf of ANEC, the European consumer voice in standardisation, Oeko-Institut has recently analysed Requirements on Consumer Information about Product Carbon Footprint[8]. The conclusions we drew in this study are, in our opinion, still valid and are presented below:

Other environmental effects should not be disregarded

The narrow approach to only focus on greenhouse gas emissions bears the risk to overlook other relevant environmental impacts or even lead to wrong conclusions that increase negative environmental effects in the worse case. Therefore screening analyses of other environmental impacts must be included in a PCF.

[7] Identical to the text in the First Findings and Recommendations report

[8] See: http://www.anec.eu/attachments/anec-r&t-2010-env-001final.pdf

Drawing up of Product Category Rules for particularly relevant products is essential

The main challenge of PCF meant for communication is to define the whole framework in a way that all products belonging to one product group can be calculated as accurately as possible to assure the same approach even if the studies are performed by different experts. This requires e.g. the same goals, the same system boundaries, the same calculation rules and similar data quality for different studies. It is essential for the future that product category rules (PCRs) will be developed that ensure a comparable proceeding within one product group. Such PCRs would have to be defined and adopted at the European level.

It is currently not possible to perform product comparisons of multiple products based on PCFs carried out on behalf of different clients and by different practitioners, or public comparison with competing products in ways that are acceptable under competition law (e.g. through reporting of CO_{2e} values or use of CO_{2e} labels).

CO_2 labels would have to take into account consumer comprehensibility, benchmarks and indication of excellence

In order to be useful to consumers a CO_2 label would have to

> be comprehensible, e.g. by a well structured display, aggregation of the information, concentration on the gist. Additionally, they would have to have a standardised look thus enabling consumers to quickly comprehend the information, compare different products and include the information on the climate impact in their purchasing decision.

> include a rating scheme, enabling consumers to recognise if the products' Carbon Footprint represents a relatively low greenhouse gas emission for the respective product group or a relatively high emission. It must be possible for consumers to recognise excellent products. Only then an effective reduction of the climate impact due to "the right" purchasing decision can be achieved. Consumers are already well acquainted with the A-G labelling scheme of the EU energy label, so this could be a promising starting point.

> be third party certified. As credibility is of high importance for consumers, it is crucial that a third party review should be requested for the PCF when used in product-related communication.

> be backed-up by easy to access and transparent documentation of the PCF study the label is based on. This includes the motivation for calculating a PCF and assumptions and quantifiers used in the calculations. Any publication of the data must be clear, understandable, conclusive and open to scrutiny. It should be noted to what extent PCF calculations are reliable and/or uncertain and whether other important environmental impacts have been taken into consideration.

Single number CO_2 labels make no sense

A static PCF stand-alone label providing a total CO_2 footprint on products does not make sense and is not very relevant for consumer decision making. Although consumers are increasingly aware of the relevance of climate impacts resulting from their purchasing behaviour and usage of products, the display of a total CO_{2e} footprint figure alone would not be of much help to them. It has to be stressed that a figure of this kind suggests a precision and conclusiveness which cannot be achieved using the current state of methodology. At the current state with only few products being labelled this even bears the risk that the sheer display of such a label makes consumers believe that the product might be better than another one without a label.

To conclude, labelling the Product Carbon Footprint is currently of little value to consumers because it disregards other environmental impacts, cannot be easily interpreted without some benchmark or comparative frame, and lacks harmonized methodology (PCRs) that would allow a comparison across products. Once the methodological problems are solved and if the PCF is presented within a comparative frame (e.g. a scale), it can be helpful tool for consumer information. It should be clearly communicated though that it is not a comprehensive environmental label and does not indicate, by its presence alone, that a product in environmentally superior or inferior to another.

Labelling of the Product Environmental Footprint (PEF)

Basing the labelling on the Product Environmental Footprint (PEF) would be another possible step which, unlike the PCF, would include other environmental impacts.

In its conclusion on the „Sustainable materials management and sustainable production and consumption" (December 2010), the European Council invited the Commission to „develop a common methodology on the quantitative assessment of environmental impacts of products, throughout their life-cycle, in order to support the assessment and labelling of products".[9]

On this basis, DG Environment together with the European Commission's Joint Research Centre (JRC IES) and other Commission services developed the environmental footprint methodology which is recommended to be used by Member States, companies, private organisations and the financial community.

According to DG Environment[10], a three-year testing period (EF European pilot phase) was launched with the following objectives:

> to set up and validate the process of the development of product group-specific rules in case of products (Product Environmental Footprint Category Rules – PEFCRs), including the development of performance benchmarks

> to test different compliance and verification systems, in order to set up and validate proportionate, effective and efficient compliance and verification systems

> to test different business-to-business and business-to-consumer communication vehicles for Product Environmental Footprint information in collaboration with stakeholders (individual companies, industrial associations or any other private, non-governmental or public organisation both from the EU and outside of the EU).

The PEFCRs resulting from the EF pilot phase will become the product rules valid under the PEF, to be used by all stakeholders in the sector in the EU or internationally who decide to measure the performance of their products based on PEF.

A second wave of pilots will be launched in the end of 2013 or early 2014 addressing food/feed/drink products.

[9] Source: http://www.pef-world-forum.org/eu-environmental-footprinting/

[10] Source: http://ec.europa.eu/environment/eussd/smgp/product_footprint.htm

The added value of a label which includes other environmental impacts other than energy (and resources) use in the use-phase is not consensual. Although it is clear that consumer choice can be influenced by the environmental performance of the product they are buying, uncertainty remains as to best way to convey this information in an effective and influential way (see discussion of the PCF and PEF above). We consider the use of other policy instruments that tackle the impacts directly, as better options at this time, while efforts to further consolidate available information on the true impact of including additional environmental information, and in what form, on a label should continue. Once the PCF and PEF are more mature, after extensive consumer testing, and with the caveats listed above, they could be used for labelling purposes. However, it does not seem conclusive to us that integrating them into the framework of the Energy Labeling Directive would bring added value instead of complicating things. Furthermore, there is still untapped potential within the current product scope of the ELD:

First, the focus of the ELD's implementation has been kept on domestic products (direct to consumer) and there are no plans to develop labelling requirements for a range of product groups for which Ecodesign requirements were being produced, including almost all non-domestic equipment including (e.g. Motor systems, Commercial refrigeration, Transformers, etc.). The only exception being the labelling of lamps, where the new regulation 847/2012 has specific provisions on where and how to indicate the label classes of business-to-business lamps. Business-to business products are therefore an important area of untapped potential, one example being lifts (elevators) which already have a methodology for labelling in place in Germany (VDI 4707) and an ISO standard for measuring and classifying of lifts being developed (ISO 25747) that is in the final stages of publication.

Second, including information on best-practices for sustainable product use, either in the product information or in a label on the product itself, can positively influence user-behaviour which has a significant impact on the environmental performance of some products. One example is clothing where small behavioural changes such as reducing washing temperature, washing at full load, avoiding tumble-drying whenever possible, purchasing eco-friendly fibres, and donating clothes not used anymore can be achieved by improving user awareness to this issues.

Including information on best-practices for sustainable product use can positively influence user-behaviour which has a significant impact on the environmental performance of some products. One example is clothing where small behavioural changes such as reducing washing temperature, washing at full load, avoiding tumble-drying whenever possible, purchasing eco-friendly fibres, and donating clothes not used anymore can be achieved by improving user awareness to this issues.

6 Assessment of Scope Expansion (non-ErP) - ED[11]

Similarly to what has been said above for the ELD, the scope expansion for the ED should be discussed around the issues of necessity, feasibility and added value.

Although the Ecodesign Directive already addresses impacts for the entire product lifecycle it currently only covers energy related products. The necessity for regulation of non ErP presents itself due the existence of relevant environmental impacts and improvement potential of these products that has been identified by previous studies (e.g. IPTS 2006).
However, it remains unclear if it is feasible to tackle these environmental impacts through the ED. Because product groups are very heterogeneous, it is difficult to develop and apply a common methodology that adequately covers different product specificities similarly to what is done now for ErPs with the MEErP methodology. Additionally, due to the nature of the current scope of products covered, the MEErP methodology focuses mainly on technological aspects of the product itself, which in the case of non-ErPs are often not the cause for environmental impact or the basis for improvement (rather, impacts occur at the stage of resource extraction as side-effects of mining or agriculture, or at the end-of-life stage due to insufficient recycling and disposal practices). These impacts would have to be assessed by dealing with, for example, resource efficiency in more detail.

Currently, a limited number of material options is available in the EcoReport. For ErPs, this does not negatively impact the validity of the overall results of the assessment since the use-phase has by far the highest contribution to the environmental impact. This is not the case for non ErPs where the production phase is often the highest contributor to the environmental impact of the product. Although the option exists to manually introduce extra materials into the database, available Life Cycle Inventory (LCI) information on materials is scarce. Current LCAs tend to systematically underestimate impacts that occur at the resource extraction stage (mining) or at the end of life stage (such as land use, pollution to air, soil, and water and health hazards to workers, caused e.g. by using acids to win the raw materials, or by burning of waste in Third World countries). LCAs tend to either cut off the end of life stage or assume that recycling takes place while, in fact, the products are not recycled or not well recycled. The reason is generally a lack of data, or of suitable indicators. Other impacts that tend to be not properly reflected in LCAs are impacts on biodiversity, land use, or depletion of biotic resources. This would, for example, concern wood or paper products. This lack of information makes it difficult to estimate the real environmental impact from the material content of a product.

[11] Identical to the text in the First Findings and Recommendations report, except for the 5th and 6th paragraphs

The EcoReport tool also does not take into account transportation issues specific to different product groups. The regional origin of the raw material should also be taken into account in EcoReport as some products are included in a global supply chain. These challenges are beginning to be tackled in current project such as JRC and Bio IS studies (Ardente et al. 2011, Ardente / Mathieux 2012, Bio IS 2013) but are still far from being resolved.
In addition to methodological issues, there is the issue of the most appropriate instrument. Although measures could be implemented through the Ecodesign Directive, in some cases other existing instruments are better suited to tackle the environmental impacts of non-ErP which target these impacts directly and have fully developed and proven methodologies (e.g REACH, Regulation 1107/2009 on plant protection products, regulation on pesticide residues, IED Directive).

For example, for food products, policies, standards and legislation related to certain life cycle stages include:

- Raw materials: the common EU agriculture policy, the water framework policy, the soil thematic strategy, the European Action Plan for organic food and farming, the biodiversity Action Plan for agriculture; the thematic strategy on the sustainable use of pesticides; the regulation on pesticide residues and the nitrates Directive;
- Manufacture / plant processes: the IPPC Directive; the Environmental Technologies Action Plan;
- Distribution: the Directive on packaging and packaging waste; Euro standards for light-duty road vehicles and high-duty vehicles; EuP Directive for cold storage;
- Use: the health claim Directive;
- End-of-life: the landfill Directive; the Green Paper on the management of bio-waste in the EU.

For each product where other legislation exists, the added value of treating them (additionally) under Ecodesign would have to be carefully evaluated, considering aspects such as the following:

- õ If products are already covered elsewhere, it would seem efficient to continue to deal with them coherently under that existing single framework.
- õ If environmental impacts are covered by horizontal regulations (e.g. RoHs, REACH, Water Framework Policy), uncertainty remains to the advantages of developing individual requirements for each product. Although a vertical approach could be slightly more effective due to the differences between product groups, which can lead to different levels of impacts, it might also involve analysis of possible improvements –through in-depth product specific analysis-, development of new methodologies and verification procedures for each individual product group..This problem would be much more salient than in the current scope because non ErP are more heterogeneous.

Our current conclusion is that the significant extra costs for carrying out such a product-specific analysis would probably outweigh the added value of a vertical approach.

Additionally, since for most of non-ErPs the impact is not measurable on the product itself, conformity with any Ecodesign Directive requirements would have to rely on the provision of information by suppliers to ensure that products comply with set specifications. The information (and certification) requirements would have to be based on environmental impact analysis and assessment, continuous

measurement, targets, and monitoring procedures for each step in the supply chain. The producers or importers of these products would need to be able to certify that the inputs used in their products have been produced by their supplier in certain ways so that the final product meets the minimum requirements set while ensuring traceability, possibly through chain of custody certification schemes.

For this purpose, for each process within the supply chain, all inputs, outputs, byproducts, and resources would have to be identified, as well as production methods and an environmental performance measurement system would have to be developed for each process. Given the complexity of most supply chains, a methodology for calculating the composite performance of the entire supply chain would also have to be developed.

In the case of specific minimum requirements producers may also need to know the values of the relevant environmental impact indicators. Thus, unless there is direct control of the upstream production stages, it would require producing and exchanging more environmental information across the operators in the supply chain which would lead to increased bureaucratic burden. It would also require the use of declaration or certification programs and monitoring schemes to ensure that all parts of the supply chain are compliant to the set requirements. This would be particularly difficult for some products which have global supply chains. Therefore, market surveillance on such requirements would probably require considerable resources to be effective with a higher risk of non-compliance in comparison to current Ecodesign Directive requirements based on product testing. Market surveillance authorities are not experienced in this type of monitoring. This is also the reason why most existing schemes of this type (such as fair trade, sustainable palm oil, sustainable cotton etc.) are voluntary and are conducted by scheme owners that are specialized on the product or sector, passing the price premium for the monitoring efforts on to the consumer. There are only a few examples of mandatory schemes such as the Timber Regulation and the sustainability requirement for biofuels. The latter, however, relies on existing voluntary schemes for monitoring compliance, too). Furthermore, most schemes and definitely all mandatory ones relate to primary products where the supply chain is relatively easy to monitor as compared to complex industrial products.

Therefore, we conclude that the monitoring and verification process would in most cases be too complicated and too different from current Ecodesign practice to include it in the ED. However, the experience on compliance systems gained through the ongoing PEF project (see previous section) should be monitored and taken into account.

This does however not preclude other specialized product-specific policies (such as the Timber Regulation) from being developed. However, it casts doubt on the added value of using the Ecodesign Framework for this purpose. Product-specific frameworks may be in a better position for developing the complex institutional setup needed for this kind of monitoring.

7 Assessment of scope expansion to transport – ELD and ED[12]

General issues

The case study for trucks shows there is an identified large potential for improvement of the environmental performance, with reasonable payback times.

Both labelling and minimum performance requirements have been identified as possible policy options to improve the environmental performance of these vehicles. They have been implemented in other economies (e.g. Japan, USA). Because these are energy using products, the implementation of such policies could be done through the Energy Labelling Directive and the Ecodesign Directive or, alternatively, through another policy instrument as has been done with passenger cars.
However, most important environmental impacts in the road transportation sector (including light vehicles) are already covered by existing legislation[13], Passenger cars already have reusability, recyclability and recoverability requirements set by Directive 2009/1/EC and Directive 2000/53/EC on end-of life vehicles. The pollutant emissions from road vehicles (CO, THC, NMHC, NOx, HC+NOx, PM) are regulated separately for light-duty vehicles (cars and light vans) and for heavy-duty vehicles (trucks and buses). For light-duty vehicles, the emission standard currently in force is Euro 4, as defined by Directive 98/70/EC which is one of the Directives amending Directive 70/220/EEC. Following the CAFE programme and the resulting Thematic Strategy on air pollution, new Euro 5 and Euro 6 standards have already been agreed by Council and Parliament). The legislation currently in force for heavy-duty vehicles is Directive 2005/55/EC (agreed in co-decision) and Directive 2005/78/EC (implementing provisions).

Therefore, the burden of including these issues in the scope of ELD and ED is probably greater than its added value. The environmental added value would be limited to aspects not currently covered, to avoid overlap or repetition, which seem to have a small improvement potential. Existing regulation could be completely integrated or absorbed by the ED or the ELD, which would have the advantage of having everything covered by a single regulatory framework, but it would entail extra-cost in preparatory work, studies, preparing information for manufacturers and consumers, and possible changes to existing structures. This would also mean an extra burden to manufacturers which would have to readjust current practices, which are well accepted, to the new regulatory framework. Furthermore, for the inclusion of Trucks (or other road transportation vehicle) in the Ecodesign Directive some changes would have to be made to the MEErP Methodology to take into account the

[12] Identical to the text in the First Findings and Recommendations report
[13] See Case-Study: Trucks

existing differences between these products and the products already covered, particularly in the EcoReport tool (e.g. vehicle energy use is calculated by kilometre covered instead of hours of use).

Electric bicycles are a group that is not yet extensively regulated. However, their environmental impact is very small when compared to other means of transportation and its use is clearly beneficial when compared to other products that fulfil the same function. For comparison, while an electric bicycle consumes energy and releases emissions to manufacture and operate, the amount is the same order of magnitude as a human's breathing activities during a brisk walk[14]. Another concern would be the lead content of the batteries used in electric bicycles but this is tackled by the Battery Directive (2006/66/EC). Therefore, the introduction of ecodesign or labelling requirements for these products would be an unnecessary burden to producers with very little improvements achievable.

The stakeholder consultation and literature review have not produced evidence pointing to the need of setting individual ecodesign or energy labelling requirements on transport product groups such as trains, boats, airplanes.

Labeling

An EU harmonised comparative label for passenger cars would be very useful as a visual aid to increase consumer understanding of the existing information requirements under the CO_2 Labelling Directive[15], which is currently being revised. The numerical measure of grams of CO2 per km without a basis for comparison is difficult to interpret as anything other than a random number. The same is also true, but to a lesser extent, for the measure of fuel consumption. Furthermore, such a label would result in easier handling and lower cost for car manufacturers. Such a measure should not pose any major problems, as existing standards are in place and similar labels have been established in e.g. UK, Japan, Australia, etc. For example, the label in the UK has a similar design as the Energy label or the tyre label. Instead of using the ELD for this purpose, this label could be set under the existing information requirement which would reduce the administrative burden to both the Commission and manufacturers.

This has not been realized yet because Member States may wish to calculate ratings based on their national average fleet performance, which varies across Europe; or they may wish to link the bands to national tax systems based on CO2 emissions, which also vary across Europe.

A common label that took into account all transportation methods would be difficult to develop, even if it did not take into account life-cycle considerations for which some data would be difficult to obtain (e.g. production phase of airplanes or trains) and it remained focused on the use-phase. Such a label would include for example, trains(B), airplanes(B), bikes(A), cars (D). One of the difficulties is the large number of variables would have to be taken into account, the extent of which could be more or

[14] Shreya Dave, "Life Cycle Assessment of Transportation Options for Commuters" , Massachusetts Institute of Technology (MIT), February 2010

[15] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0094:EN:HTML

less limited depending on the methodology developed. One could for instance only consider the fuel consumption per passenger km, or go as far as considering the energy spent on the maintenance and conservation of infrastructures such as airports, roads, etc. or of the vehicles themselves. The additional consideration of environmental impacts such as emissions to air (CO_2, NO_x, SO_x, PM, VOCs), acidification, land use, noise would also increase the number of variables involved. Variability between products within each mode of transport would also have to be taken into account (not all cars have the same environmental performance nor all trains, etc.). In addition, the impact of such a label on consumer choice would have to be evaluated as other factors, such as travel time, comfort, etc. might be more important in the decision making process. Furthermore, consumers are not used to labels that apply across different products, as would be this case, and therefore uncertainty exists as to how they would understand it if at all. Confusion might also be increased by the introduction of such a label, e.g. how it would be understood against the existing CO2 car labelling scheme,.

Minimum requirements

Requirements for GHG emissions do currently exist. However, they relate to fleet performance and not to the performance of a specific model. To set requirements for specific models, categories would have to be developed according to vehicle characteristics and use.

It is important to notice that the auxiliary equipment of vehicles (e.g. air conditioning, lighting, ventilators), which are a growing load in modern vehicles, are not taken into account in existing testing procedures. This equipment can have a significant impact on the fuel consumption and emissions of the vehicle and, therefore, should be addressed, by including them in the duty cycle.

8 Conclusions for Scope Extension[16]

General issues

- Suitability should be evaluated based on three main issues: necessity, feasibility and added value.
- Significant environmental impact and improvement potential has already been identified by previous studies for some product groups.
- Most of the identified improvement options relate to production practices that cannot be verified in the final product and cannot easily be included in a ranking of environmental impacts. Other instruments based on best-practices regulation might be more effective. These include certification schemes (e.g. organic food products) and horizontal measures such as the IED Directive or the European Action Plan for Organic Food and Farming.
- For impacts that cannot be verified on the product itself, methodologies for certification covering the entire supply chain would have to be developed. Some product groups (e.g. garments) have very long supply chains covering different non-EU countries which would make it difficult to develop such methodologies. Furthermore, market surveillance on such requirements would probably require considerable resources to be effective with a higher risk of non-compliance in comparison to current Ecodesign Directive requirements based on product testing. However, the experience gained through the ongoing PEF project should be taken into account.
- Allocation of efforts on market surveillance of the existing regulated products would probably be more valuable.
- The use of electric bicycles is clearly beneficial when compared to other products that fulfil the same function and, therefore, the introduction of ecodesign or labelling requirements for these products would be an unnecessary burden to producers with very little improvements achievable.

Energy Labelling Directive

- There is still untapped potential for savings from labelling of ErPs within the current scope, such as the labelling of B2B products. One example are lifts (elevators) which already have a methodology for labelling in place in Germany (VDI 4707) and an ISO standard for measuring and classifying of lifts being developed (ISO 25747) that is in the final stages of publication.
- Labelling schemes based on production best-practices and supply chain certification have, so far, been of voluntary nature due to the huge burden they impose on manufacturers and market surveillance authorities.
- Because much of the impact of non-ErPs are not related to energy consumption the possibility of labelling other impacts, aggregated into an index (e.g. carbon footprint, environmental

[16] Identical to the text in the First Findings and Recommendations report

footprint, water footprint, etc.) would have to be evaluated. However, an aggregated index can also means a loss of information and it is difficult to establish transparency and consumer trust. If methodology and communication issues are solved, such an index could be a consumer information tool, but the added value of introducing it under the Energy Labeling Framework is doubtful.

- For means of motorized transportation by road, because they are energy using products and because there are already standardized methodologies for measuring GHG emissions, fuel consumption and other emissions to air, which are already part of the information requirements for passenger cars, the introduction of an energy label or environmental label would not present itself as a major burden. However, the option of doing so through the already implemented legal framework (Emissions and CO2 Regulations) presents itself as a better option.
- A single label for all transport modes would be difficult to develop due to the large amount of variables to consider and its impact would have to be evaluated particularly in what regards consumer understanding.
- The stakeholder consultation and literature review have not produced evidence pointing to the need of setting individual ecodesign or energy labelling requirements on transport product groups such as trains, boats, airplanes.

Ecodesign Directive

- There is still untapped potential for savings from setting ecodesign requirements to ErPs, as identified in the Ecodesign Working Plan (2012-2014), particularly relating to impacts in other phases than the use-phase (e.g. mobile phones).
- Although measures could be implemented through the Ecodesign Directive, in some cases other existing instruments are better suited to tackle the environmental impacts of non-ErP which target these impacts directly and have fully developed and proven methodologies (e.g REACH, Regulation 1107/2009 on plant protection products, regulation on pesticide residues). For example, since some products are already covered elsewhere, it would seem reasonable to continue to deal with them coherently under that existing single framework. Furthermore, since other impacts are covered by horizontal regulations (e.g. RoHs, REACH, Water Framework Policy), uncertainty remains to the advantages of developing individual requirements for each product.
- Due to the nature of the current scope of products covered, the MEErP methodology focuses mainly on technological aspects of the product itself, which in the case of non-ErPs are often not the cause for environmental impact or the basis for improvement but, for example, more relevance should be given to the way they are produced.. Furthermore, it also does not address other aspects such as toxicity, land-use, impact on biodiversity, or depletion of biotic resources.
- For ErPs, the limited number of material options available in the EcoReport tool does not negatively impact the validity of the overall results of the assessment since the use-phase has by far the highest contribution to the environmental impact. This is not the case for non ErPs where the production phase is sometimes the highest contributor to the environmental

impact of the product. Although the option exists to manually introduce extra materials into the database, available LCI information on materials is scarce: Current LCAs tend to systematically underestimate impacts that (a) occur at the resource extraction stage (mining) and (b) end of life stage (e.g. land use, pollution to air, soil, and water and health hazards to worker). Particularly, the recycling rate of products is most often overestimated, as a simplifying assumption, and in reality products are not well recycled (or not at all). This lack of information makes it difficult to estimate the real environmental impact from the material content of a product.

- The EcoReport tool also does not take into account transportation issues specific to different product groups.
- The regional origin of the raw material should also be taken into account in EcoReport as some products are included in a global supply chain.
- Substantial resources would have to be allocated to the updating of the methodology for applicability to non-ErPs. The projects that have recently been finished have not yet been able to thoroughly solve the issues.
- To set minimum performance requirements for specific car models, further categories would have to be developed according to vehicle characteristics and use.

On the basis of the preconditions set out (necessity, feasibility and added value) it seems premature to expand the scope of the Directives particularly if limited resources are available.

Nevertheless, since conditions are constantly changing, and experience is gained through existing smaller scale schemes, the use of a decision tree such as the one developed and applied within Task 3 the study is recommended for the evaluation of future inclusion of product groups.

9 References

Ardente, F.; Wolf, M—A.; Mathieux, F.; Pennington, D.; Integration of resource efficiency and waste management criteria in the implementing measures under the Ecodesign Directive. Final Executive Summary. JRC, July 2011

Ardente, F.; Mathieux, F.; Integration of resource efficiency and waste management criteria in European product policies – Second phase. Final Executive Summary with logbook of comments from stakeholders. JRC, December 2012.

Bio Intelligence Service, Material-efficiency Ecodesign Report and Module to the Methodology for the Ecodesign of Energy-related Products (MEErP), Part 1: Material efficiency for Ecodesign, Final report to the European Commission - DG Enterprise and Industry, 5 December 2013, https://sites.google.com/a/biois.com/meerp/documents/ecodesign-BIO-IZM-WI-material-efficiency-meerp_en.pdf?attredirects=0&d=1

CSES (2012) Evaluation of the Ecodesign Directive (2009/125/EC)- Final Report, , Centre for Strategy&Evaluation Services, March 2012.

IPTS (2006) Environmental Impact of Products (EIPRO). s.l. : Joint Research Centre (DG JRC) Institute for Prospective Technological Studies, 2006. EUR 22284 EN.

Tukker et al. Environmental Impacts of Products, A Detailed Review of Studies, , Journal of Industrial Technology, 2006 by the Massachusetts Institute of Technology and Yale University www.mitpressjournals.org/jie.

UNEP (2010) Assessing the Environmental Impacts of Consumption and Production: Priority Products and Materials, A Report of the Working Group on the Environmental Impacts of Products and Materials to the International Panel for Sustainable Resource Management. Hertwich, E., van der Voet, E., Suh, S., Tukker, A., Huijbregts M., Kazmierczyk, P., Lenzen, M., McNeely, J., Moriguchi, Y.

VHK (2012), Study on Amended Ecodesign Working Plan under the Ecodesign Directive (remaining energy-using and new energy-related products)

ECOFYS

sustainable energy for everyone

ECOFYS Netherlands B.V.

Kanaalweg 15G
3526 KL Utrecht

T: +31 (0) 30 662-3300
F: +31 (0) 30 662-3301

E: info@ecofys.com
I: www.ecofys.com

ECOFYS

sustainable energy for everyone

Case Study: Dairy Products

Evaluation of the Energy Labelling Directive

and specific aspects of the Ecodesign Directive – Task 3-

ENER/C3/2012-523

Case Study: Dairy Products

Evaluation of the Energy Labelling Directive

and specific aspects of the Ecodesign Directive – Task 3 -

ENER/C3/2012-523

- Confidential –

By: Bruno Santos (ISR-University of Coimbra)

Date: 28-05-2014

Project number: BUINL13345

ECOFYS
sustainable energy for everyone

Table of contents

1 Introduction

In a scoring exercise that considered sold Volume, environmental impact, the availability of LCA relevant information, the suitability for Ecodesign and Labelling instruments, and an assessment of the possible costs / risks and benefits of both Ecodesign and Labelling, several food-and drink related product groups received the highest score. Dairy products stands out with one of the biggest score.

The case study examines the feasibility of developing requirements within the context of the Ecodesign Directive or the Energy Labelling Directive for the product category of dairy products. This product category has been selected as representative of the broader food and beverages product group. According to EIPRO study (IPTS, 2006), food and drink products represent around 20-30% of the total impact for most environmental impacts categories. Within the product group, dairy products represent the second most important category in almost all environmental impact categories. This includes the full food production and distribution chain 'from farm to fork'.

2 Scope

2.1 Brief definition of the product group

The dairy sector is of great importance to the European Union (EU) in a variety of ways. Its most striking feature is that milk is produced in every single EU Member State without exception. Furthermore the EU is a major player in the world dairy market and is a leading exporter of many dairy products.
According to Regulation (EC) No 853/2004[1], 'Dairy products' means processed products resulting from the processing of raw milk or from the further processing of such processed products.
Dairy products consist of:

- Fresh milk;
- Cream;
- Butter;
- Yoghurt;
- Cheese;
- Whey;
- Ice creams;
- Sorbets.

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:139:0055:0205:EN:PDF

Table 1 gives an overview on ProdCom codes related with dairy products.

Table 1-Overview on Prodcom codes related to the manufacture of dairy products.

Prodcom code	Definition
10511133	Milk and cream of a fat content by weight of <= 1%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of a net content <= 2 l
10511137	Milk and cream of a fat content by weight of <= 1%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of a net content > 2 l
10511142	Milk and cream of a fat content by weight of > 1% but <= 6%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of a net content <= 2 l
10511148	Milk and cream of a fat content by weight of > 1% but <= 6%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of a net content > 2 l
10511210	Milk and cream of a fat content by weight of > 6% but <= 21%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of <= 2 l
10511220	Milk and cream of a fat content by weight of > 6% but <= 21%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of > 2 l
10511230	Milk and cream of a fat content by weight of > 21%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of <= 2 l
10511240	Milk and cream of a fat content by weight of > 21%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of > 2 l
10512130	Skimmed milk powder (milk and cream in solid forms, of a fat content by weight of <= 1,5%), in immediate packings of <= 2,5 kg
10512160	Skimmed milk powder (milk and cream in solid forms, of a fat content by weight of <= 1,5%), in immediate packings of > 2,5 kg
10512230	Whole milk powder or full cream powder (milk and cream in solid forms, of a fat content by weight of > 1,5%), in immediate packings of <= 2,5 kg
10512260	Whole milk powder or full cream powder (milk and cream in solid forms, of a fat content by weight of > 1,5%), in immediate packings of > 2,5 kg
10513030	Butter of a fat content by weight <= 85%
10513050	Butter of a fat content by weight > 85% and other fats and oils derived from milk (excluding dairy spreads of a fat content by weight < 80%)
10513070	Dairy spreads of a fat content by weight < 80%
10514030	Unripened or uncured cheese (fresh cheese) (including whey cheese and curd)
10514050	Grated, powdered, blue-veined and other non-processed cheese (excluding fresh cheese, whey cheese and curd)
10514070	Processed cheese (excluding grated or powdered)
10515104	Condensed or evaporated milk, unsweetened
10515108	Condensed or evaporated milk, sweetened
10515241	Curdled milk, cream, yogurt and other fermented products
10515245	Flavoured liquid yoghurt or acidified milk (curdled milk; cream; yoghurt and other fermented products flavoured or containing added fruit; nuts or cocoa)
10515263	Buttermilk powder
10515265	Buttermilk
10515300	Casein and caseinates
10515400	Lactose and lactose syrup (including chemically pure lactose)

Prodcom code	Definition
10515530	Whey and modified whey in powder, granules or other solid forms, whether or not concentrated or containing added sweetening matter
10515560	Whey and modified whey in liquid or paste forms; whether or not concentrated or containing added sweetening matter
10515600	Products consisting of natural milk constituents, n.e.c.

3 Standards and Legislation

As part of the case study the current policy framework related to the environmental impact areas identified in the previous section is scanned. We considered existing regulations that directly or indirectly address the environmental impacts of dairy products as a whole and also looked into existing standards and industry initiatives that address one or more aspects. Table 2 summarizes such legislation applied to dairy products.

The Common Agricultural Policy and the relevant regulation 1782/2003 set requirements linking the payment to producers of agricultural products to compliance with certain environmental and other standards.

Water framework Directive 2000/60/EC – Aims to ensure that all water basins meet good status by 2015 and required the reduction and control of pollution from agriculture, industry and urban areas setting water pricing mechanisms on the basis of the polluter pays principle. For the dairy production, the Directive has a direct relevance in relation to dairy wastewater treatment.

Council Regulation (EC) No 834/2007 on **organic production and labelling of organic products** sets principles and general rules for organic production and providing that foods (including dairy products) may only be marked as "organic" if at least 95% of their agricultural ingredients are organic. The key issue is the restriction in the use of external inputs such as fertilisers and certain types of food additives in the products. It also makes provisions for the use of the EU organic logo.

Industrial Emissions Directive (2010/75/EC) - The IED (successor of the IPPC Directive) aims to minimise pollution from industrial sources and covering emissions to air, soil and water. The IPPC Directive applies to treating and processing milk, the quantity of milk received being greater than 200 tonnes per day (average value on an annual basis). Plants are required to apply for permits to the national authorities that are provided on the basis that all necessary measures are taken against pollution and no significant pollution is caused, that waste production is avoided, energy is used efficiently and that measures for accidents are avoided. The emission limits are set in terms on the best available techniques (BAT) identified. BAT reference documents (BREFs) have been developed and are periodically revised to assist authorities to assist authorities and companies. IED and the former IPPC Directive are plant specific rather than product specific regulations that addresses most of the environmental aspects related to milk processing.

Packaging and packaging waste Directive (94/62/EC): This Directive refers to all packaging placed on the market and all packaging waste. It sets requirement in relation to the weight and volume of packaging taking also into consideration hygiene, safety and acceptability, to reduce the hazardous content of packaging and to design reusable and recoverable packaging. Member States are expected to take measures at the national level to reduce packaging waste and increase recovery with certain targets set.

The Directive addresses some key aspects related to food processing sector, namely dairy products, is a major user of packaging and its use has implication on the amount of waste (packaging and food waste) is produced at the end of life stage. The Packaging Directive is complemented and extended by the **Waste Framework Directive** that requires Member States to develop waste management policies on the basis of a policy that gives priority to waste prevention and reuse before recycling, recovery and disposal. The producers of waste are expected to assume the costs of waste management thus providing an incentive to reduce waste created in the production process.

The EU Directives setting standards on light and heavy duty commercial vehicles (98/69/EC, 2005/55/EC and 2005/78/EC) address the greenhouse gas and other emissions related to the transportation of dairy products and the distribution of final products to the points of sale.

Landfill Directive (1999/31/EC) - The Landfill Directive aims to prevent or reduce the adverse effects of the landfill of waste on the environment, in particular on surface water, groundwater, soil, air and human health. It defines the different categories of waste (municipal waste, hazardous waste, non-hazardous waste and inert waste) and applies to all landfills, defined as waste disposal sites for the deposit of waste onto or into land. The Directive declares that some waste types may not be accepted in landfills. Products made from biomass (e.g. food) are to be avoided as they are flammable/biodegradable.

Table 2-Summary of main relevant regulation and main issues addressed in dairy products.

	EU legislation	Main aspects regulated
Raw materials	Common Agricultural Policy	Agriculture and livestock breeding processes and relevant impact
	Water Framework Policy (2000/60/EC)	Emissions to water during the crop, livestock breeding, meat slaughtering and processing phases
	Regulation on organic production and labelling of organic products (834/2007)	Agriculture and livestock breeding process and relevant impacts
Manufacturing	IED Directive (2010/75/EC)	Air, water and soil emissions and energy use in milk treatment and processing processes
	Regulation on organic production and labelling of organic products (834/2007)	Agriculture and livestock breeding process and relevant impacts
Distribution	Directive on Packaging and Packaging Waste (94/62/EC)	Package creation and processing
	Legislation related to Transport	Greenhouse gas emissions during production and distribution phase
Use	Ecodesign of EuP Directive	Energy used during refrigeration and processing during the use

	EU legislation	Main aspects regulated
	(2005/32/EC) (for freezers, fridges, etc.)	phase
End-of-Life	Directive on Packaging and Packaging Waste (94/62/EC)	Package creation and processing
	Landfill Directive (99/31/EC)	Set limits on the amount of biomass to be disposed in landfills.

4 Market

Milk is one of the most important agricultural products and is produced in every single EU Member State without exception. Additionally, milk is the number one single product sector in terms of value of agricultural output. Furthermore, the EU is a major player in the world dairy market and is a leading exporter of many dairy products.

The EU's dairy sector operates within the framework of milk quotas, which were introduced in 1984 to address problems of surplus production but are set to expire in April 2015. Each EU Member State has two quotas, one for deliveries to dairies and the other for direct sales at farm level. Milk production data are used for signalling imbalances in the market that, if serious enough, trigger public intervention (of butter and skimmed milk powder) and/or private storage. When national quotas are overrun then punitive 'super-levies' are recovered from the farmers or dairies involved (Eurostat, 2013). No shocks are expected in terms of production at the end of quotas in 2015.

In 2011, dairy farmers in Europe have produced 156 million tons of milk, worth 53.1 billion Euros at farm level, representing about 13 percent of the value of EU agricultural output in 2011. The turnover of the dairy processing sector is 132 billion Euros. For the total production of milk an estimated 153 million tonnes (or 98 %) was cows' milk, the rest being milk from ewes, goats and buffalos. The vast majority (91 % in 2011) of the milk produced on farms was delivered to dairies, the rest being used on the farm (FoodDrinkEurope, 2013).

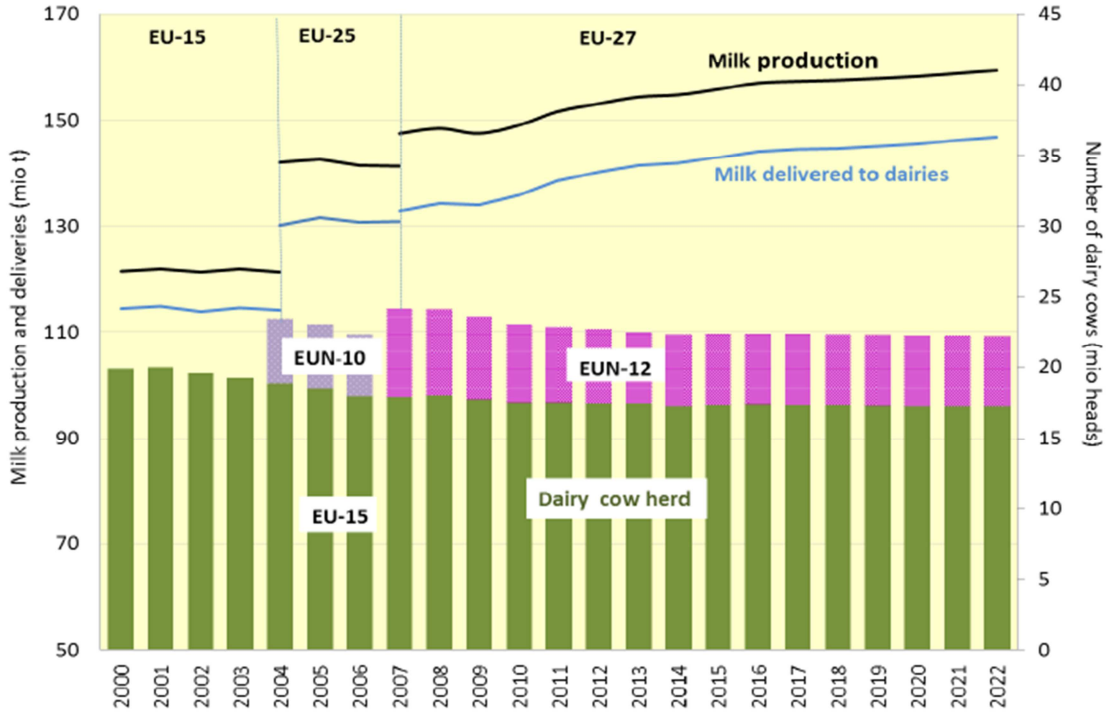
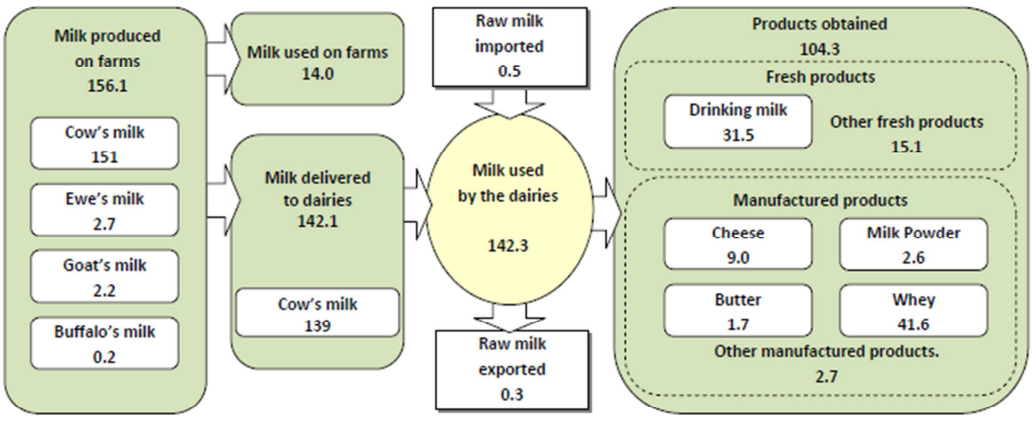


Figure 1-EU milk production (VERSTEIJLEN, 2013).

The milk delivered to dairies is converted into a number of fresh products and manufactured dairy products. Some 67.1 million tonnes of raw milk were used to produce 9.1 million tonnes of cheese in the EU-27 in 2011; while 31.3 million tonnes of raw milk were turned into a similar amount of drinking milk; 19.3 million tonnes of raw milk were converted into 2.6 million tonnes of milk powder, and; 34.5 million tonnes of whole milk were used to produce an estimated 1.7 million tonnes of butter as well as associated skimmed milk and buttermilk; this explains why the amount of 'whole milk' used for producing butter was higher than the 'total' milk used as shown in Figure 2 (Eurostat, 2013).



[1]) Only the flows of raw milk are displayed, but small quantities of other products were also collected (650 tonnes) or returned (100 tonnes) by the dairies. Changes in stocks are not recorded.

Figure 2-Production and use of milk in the EU‑27, 2011 (Eurostat, 2013).

The European Union is a main actor on the international market of dairy products, being the first exporter of many dairy products, particularly for cheese. In 2011, the value of total dairy exports out of the EU was 8 billion Euros for 3,144 million tonnes of dairy products in milk equivalent[2]. European dairy product imports are insignificant compared to exports representing 233 thousand tonnes worth 768 million Euros.

Table 3- Main data on dairy products market (described above), 2011.

Indicator	Data	Source
Total size of EU market (volume)	142 million tonnes	Eurostat
Total size of EU market (value)	132 billion €	Eurostat
Imports into the EU (volume)	233 thousand tonnes	DG Agriculture and Rural Development
Imports into the EU (value)	768 million €	DG Agriculture and Rural Development
Exports from the EU (volume)	3.144 million tonnes	DG Agriculture and Rural Development
Exports from the EU (value)	8 billion €	DG Agriculture and Rural Development

5 Consumer expenditure

Agricultural commodity prices have dropped significantly after reaching a peak in 2007. In the medium term, FAPRI[3] and OECD-FAO[4] are projecting that they will be higher than the average levels seen over the past decade. After two decades of falling prices, structural factors such as global food and feed demand, and the expansion of biofuels should keep prices high.
Dairy prices will change from being supply driven to demand driven and will be more responsive to market signals and consumer demand. World demand for milk products will continue to rise as developing countries continue their economic growth, and in the medium term world dairy prices are expected to average above the levels achieved in the first half of the decade, before the price spike. High international prices of dairy products will result in a supply response from traditional and emerging exporters (Department of Agriculture, Fisheries and Food, 2009).

[2] The conversion factors for milk equivalent have been sourced from: IFCN, "A Global Review – The Supply of Milk and Dairy Products", Dr. T Hemme, A. Weers, K. Christoffers, 2005.
[3] Food and Agricultural Policy Research Institute. http://www.fapri.org/
[4] http://www.oecd.org/site/oecd-faoagriculturaloutlook/

Milk prices in the EU are determined by several factors, including:

- supply and demand on the internal EU market;
- world dairy product prices;
- currency exchange rate fluctuations;
- quality requirements and demand for specific products;
- the competition situation in the food chain;
- support for the dairy market, and to farmers, from the EU's Common Agricultural Policy (CAP).

Since the creation of the support system for milk and dairy products in the late 1960s the CAP has been a major element in determining price. However, a series of reforms to the, most recently in 2003, mean that market forces are now the main determinant (European Commission Directorate-General for Agriculture and Rural Development, 2006).
EU prices peaked in 2007 and since then have fallen back below levels experienced earlier this decade. Price volatility is a more prevalent feature and can be expected to continue as the EU reduces its levels of market intervention. Fluctuating market returns will result in cyclical milk price movements. It is expected that the milk price will be slow to recover as production increases gradually in response to additional quota being provided. However as demand for dairy products will remain strong post 2013 it is expected that prices will recover to relatively high levels.
The agreement in late 2008 on the CAP Health Check[5] confirmed the abolition of EU milk quotas in 2015 and annual increases in milk quotas in the years 2009 to 2013 in order to prepare the industry for a "soft landing" in 2015.
Figure 3 shows the EU average price of dairy products in the last ten years.

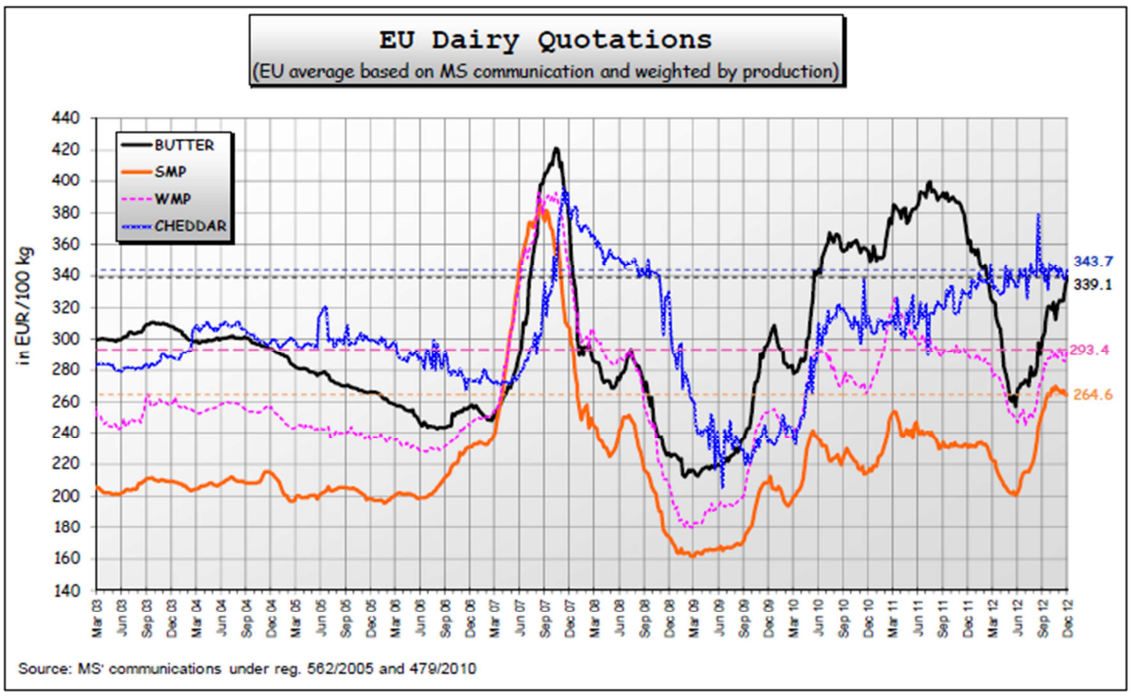


Figure 3-Dairy prices (Misonne, 2012).

[5] http://ec.europa.eu/agriculture/healthcheck/

6 Technologies

This chapter is mainly based on the World Bank document "Environmental, Health, and Safety Guidelines"[6] (International Finance Corporation - World Bank Group, 2007) with general and industry specific examples of Good International Industry Practice in dairy processing facilities.
The dairy sector converts raw milk into safe products for human consumption. Products range from pasteurized and ultra-high temperature processing (UHT) milk to value-added dairy products such as yoghurt, butter and cheese. In the past, liquid milk and fresh dairy product plants tended to be located in or near urban centres. The modern trend is for plants to be situated close to the raw milk supply, especially those producing long life products (e.g. UHT, cheese, and milk powders). The current trend toward large processing plants has provided companies with more automated and efficient equipment.
This development tends to increase the environmental impact in some areas, mainly due to high concentration of waste and increased traffic. Dairy processing plants can be divided into two categories:

- Fluid milk processing involving the pasteurization and processing of raw milk into liquid milk for direct consumption, as well as cream, flavoured milk, and fermented products such as buttermilk and yogurt.
- Industrial milk processing involving the pasteurization and processing of raw milk into value added dairy products such as cheese and casein, butter and other milk fats, milk powder and condensed milk, whey powder and other dairy ingredients, and ice cream and other frozen dairy products.

Dairy processing is continuously improving. New filtration and drying processes have increased recovery of milk solids that were previously discharged. Processes have become significantly more energy efficient and the use of electronic monitoring, control, and regulation systems has improved processing effectiveness and reduced product loss considerably. Figure 4 presents a simplified schematic diagram of the processes in a notional dairy, each of which is further described below.

[6] http://www.ifc.org/wps/wcm/connect/534a1a8048855373af34ff6a6515bb18/Final%2B-%2BDairy%2BProcessing.pdf?MOD=AJPERES

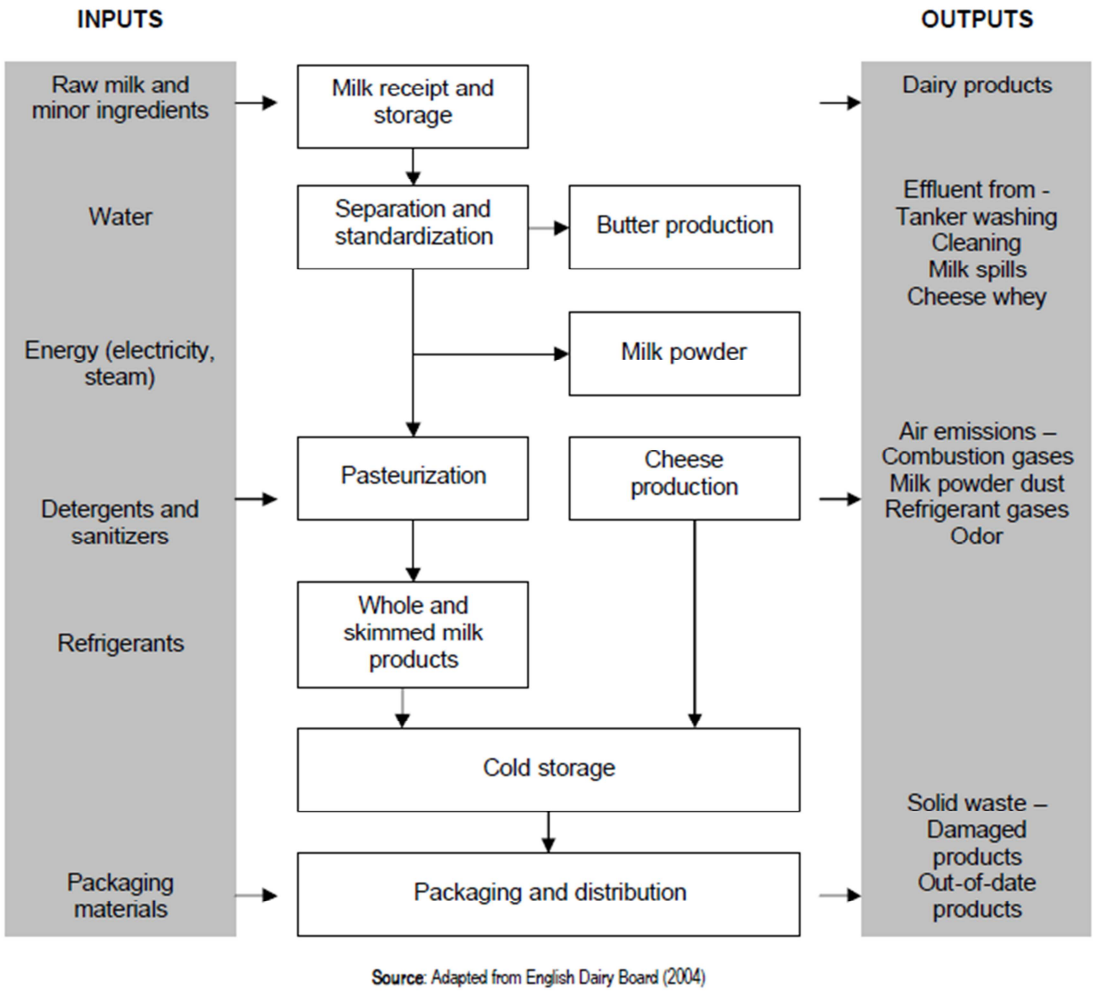


Figure 4-Dairy Processing Activities (International Finance Corporation - World Bank Group, 2007).

6.1 Raw Milk Collection, Reception and Storage

The first steps in preserving the quality of milk should be taken at the farm. To achieve the best quality raw milk at intake, milking conditions must be as hygienic as possible. The milk must be chilled to below +4℃ immediately after milking and be kept at this temperature during transport to the dairy. Best practice indicates that farms or intermediate collection centres be equipped with stainless steel refrigerated bulk storage tanks. Raw milk is collected and transported to the processing plant in stainless steel insulated or refrigerated bulk tank cars of up to 30,000 litres. Markets with a predominance of small farmers may still use aluminium or stainless steel cans of 30-50 litres which are collected by, or delivered to, the processing plant. Where water and electricity is not available the milk should be delivered to a central collecting point with cooling facilities or delivered to the dairy for processing immediately after milking. Bulk tanks or cans should be cleaned and sanitized immediately after discharge at the dairy. Water is used to rinse and clean the reception lines, road tankers, and cans. Modern plants may employ Clean in Place systems (CIP) and automated can washers. At the reception point, the raw milk is sampled for quality analysis and, after acceptance, measured by volume or by weight and cooled to a temperature below +4℃. After cooling, the milk is stored in a silo to await processing. Ice water is normally used for cooling.

6.2 Separation and Standardization

Centrifugal separation and clarification is common in dairy processing to ensure further processing of standard products avoiding quality variations. In most dairies, the cream separation and clarification is carried out using self-cleaning separators. The separator also discharges sediment consisting of dirt particles, udder cells, and bacteria, and leucocytes, which normally is collected or led to the wastewater drain. Standardization of the dry matter for fat, protein, and lactose content of the milk usually takes place in the production phase of most dairy products. The most common techniques include mixing of skimmed milk and cream, evaporation, and membrane filtration.

6.3 Homogenization

The aim of homogenization is to prevent gravity separation of the fat in the product and to improve the syneresis stability of mainly cultured products. The homogenizer consists of a high-pressure pump and homogenizing valve driven by a powerful electric motor. Milk is pumped at high pressures through narrow tubes, breaking up the fat globules into small particles which do not recombine, so that the resulting homogenised milk has a consistent texture and taste. Electricity drives the pumps, creating a pressure drop across the homogeniser tubes. This process is typically used by liquid milk processors (Carbon Trust , 2011).

6.4 Pasteurization (Heat Treatment and Cooling of Milk Products)

Regardless of what the end product will be, the milk is usually heat treated to ensure that all pathogenic microorganisms are removed. This is achieved by pasteurization or sterilization, a heating procedure that is required by law in most countries with the exception of some types of cheese made from unpasteurized milk. This is done by rapidly heating the incoming standardised milk to the pasteurisation temperature in a simple holding tube, ensuring that the pasteurisation temperature is held for the correct time (e.g. 72°C for 25 seconds) to destroy the bacteria. To save energy, the pasteurization process should involve regenerative heat exchange, which means that the already pasteurized milk is used as a heating medium for the incoming cold milk. After heating, the milk is cooled down to a temperature suitable for subsequent processing or storage at approximately 2°C (Carbon Trust , 2011).

6.5 Milk and Dairy Product Production

6.5.1 Cheese Production

Cheese is obtained by coagulation of milk and consists mainly of the protein and fat fractions of the milk. Cheese production involves several steps common to most types of cheese and includes coagulation and separation of curd, pressing, salting, ripening, and packaging. Depending on the type of cheese produced, a per cent of the original milk volume is separated as a residual liquid by-product called whey which contains the lactose fraction of the milk and some proteins. Whey can be further processed by concentration and drying to produce powders, whey protein concentrates, lactose and animal feeds. It may also be sold directly as animal feed. Membrane filtration can be used in cheese production as an effective means of limiting the loss of milk solids, but membrane cleaning requires large quantities of water, heat, and cleaning agents.

6.5.2 Butter Production

Butter can be produced as batches in churns or continuously in a continuous butter-making machine. Although churns are still used today, most of them have been replaced by continuous machines. The churning step produces buttermilk, which represents a potential waste stream unless collected for sale. Emptying and cleaning of butter-making equipment and packaging machines generate waste and wastewater containing fat.
Butter is usually packaged in bulk quantities (25 kg) for long-term storage and then re-packed into marketable portions (usually 250 g or 500 g, and single-serve packs of 10–15 g).

6.5.3 Condensed Milk, Milk Powder, and Dairy Ingredients

For these products, evaporation or membrane filtration issued to pre-concentrate skimmed milk, whole milk, buttermilk, and whey before final processing. The final drying is usually achieved by spray drying, in which an atomizer disperses the pre-concentrated milk as a fog-like mist into a large chamber through which hot air is drawn in a spiral pattern. The water in the milk spray evaporates instantly to form powder particles. Alternatively, the older drum drying process may be used, in which the water evaporates on rotating, steam-heated drumsdrums.

6.5.4 Ice cream

Ice cream manufacture involves the handling of both dry and liquid raw materials including reception of milk, cream, sugar and other ingredients; mixing operations; pasteurizing, freezing and hardening; packaging; and storage at temperatures below -180℃.

6.6 Packaging of Milk and Dairy Products

Packaging protects the product from bacteriological, light, and oxygen contamination. Liquid milk products may be packed in a beverage carton, which is mainly paperboard covered by a thin layer of food-grade polyethylene on either side. Milk cartons for long-life milk have an additional layer of aluminium foil. Many other packaging materials are also used, ranging from simple plastic pouches to glass bottles, PET laminates and PVC bottles. PET laminates are becoming increasingly popular and are blown at the plant from granulates, generating small amounts of plastic waste when the neck of the container is cut off.
Cultured products are packed in beverage cartons or plastic cups and bottles with lids of aluminium foil or paper. In some cases the containers are wrapped together in a carton as multipacks.

7 Environmental Impact

An agricultural activity is considered to be ecologically sustainable if its polluting emissions and its use of natural resources can be supported in the long term by the natural environment. The first step in the assessment of ecological sustainability is assessment of its environmental impact (Thomassen, et al., 2007). During the course of the study we were not able to identify studies that examine the environmental impact of production of dairy products on the basis of a life cycle approach and, in general, there are rather few studies examining the impact of food products across the entire life cycle. The existing research work focuses on primary production with a strong focus on energy consumption, climate change implications and eutrophication. As a result, our analysis has been based on the combination of various sources in order to develop as complete as possible a picture concerning the life cycle of processed dairy products.

7.1 Base-Case Environmental Impact Assessment

The production of milk requires large inputs of resources, while it also causes several negative environmental effects.

The first source of information is the EIPRO study (IPTS, 2006). The study does distinguish between impacts in the different life cycle stages of the product but indicates that food and drink consumption contribute between 20-30% of the total environmental impacts results from consumption in the EU. Milk and dairy products represent the second most important product group with around 5% of global warming potential, 10% of eutrophication potential and 4% of photochemical ozone creation potential across the EU. Fluid milk is one of the "top 10" contributors to total impacts for all of the environmental themes considered with the exception of ozone depletion.

Another study considering food is the IMPRO (Weidema, et al., 2008) study on Meat and Dairy Products, conducted in response to identification within the EIPRO study that food and drink is responsible for 20% to 30% of the environmental impact of private consumption in the EU, with meat and dairy products contributing most. This study provides a systematic overview of the life cycle of meat and dairy products and their environmental impacts, covering the full food chain. The study finds that the consumption of meat and dairy products contributes on average 24% of the environmental impacts from the total final consumption in EU-27, while constituting only 6% of the economic value. For the different impact categories, the contribution of meat and dairy products varies from 6% to 47% of the impacts from the total final consumption in EU-27. The four main product groups (dairy, beef, pork, and poultry products) contribute respectively 33-41%, 16-39%, 19-44%, and 5-10% to the impact of meat and dairy products consumption in EU-27 on the different environmental impact categories. Figure 5 presents the results of the IMPRO study as breakdown of the environmental impact results on these four main contributing food product categories as absolute values.

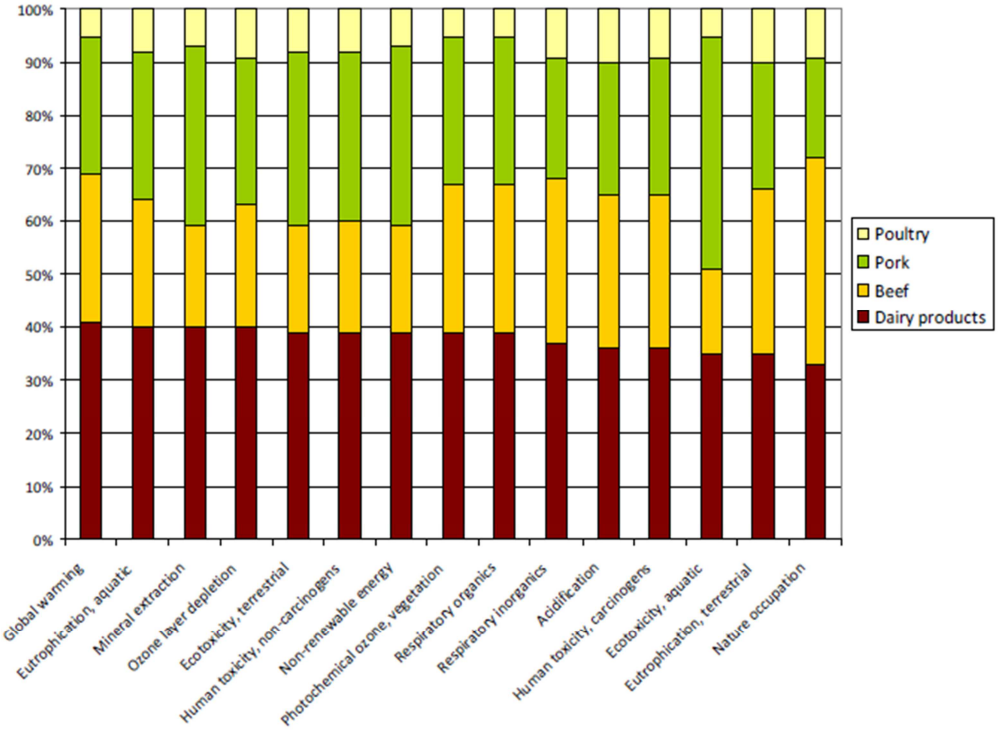


Figure 5-Results from IMPRO Meat and Dairy study – Environmental impacts from top four identified food categories (Weidema, et al., 2008).

The review of a number of LCA studies on meat products made by DEFRA (Foster, 2006) suggests the most significant environmental impact of the milk product system occurs at the primary production stage: primary production is the largest contributor to global warming, acidification and eutrophication effects, constituting around 95% of the first and over 99% of the latter two effects. In terms of inputs, primary production accounts for around 75% of electricity (e.g. refrigeration) and fossil fuel consumption across the system (e.g. natural gas for synthetic fertiliser in the production of pastures and fodder crops, diesel to power tractors and other agricultural equipment): total energy use on conventional farms accounts for approximately 3.5MJ per litre (energy corrected) milk, total water use is approx. 0.3g per litre milk.

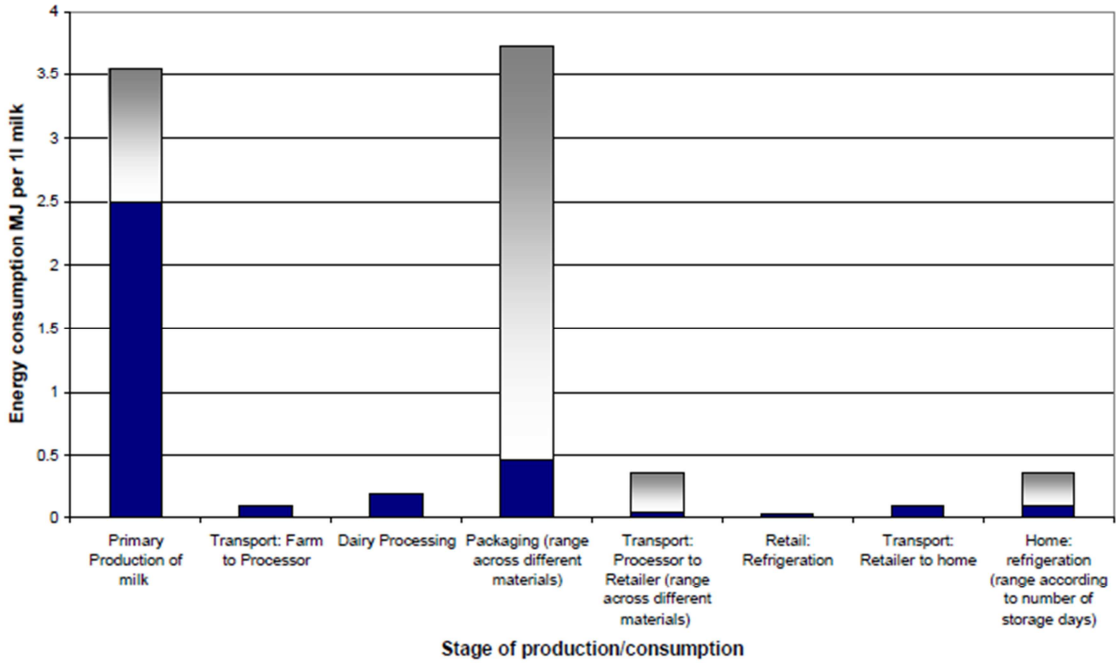


Figure 6-Energy consumption across the conventional milk production and consumption system (Foster, 2006).

The literature review on CE Delft Report[7] (Sevenster, et al., 2008) has examined three groupings of emissions: the global on-farm dairy emissions directly related to the milk production at the farm, the global cradle-to-farm-gate emissions, and the emissions per unit of milk up to the moment of consumption. Contrary to what is often thought, milk transport (from farm to dairy factory) does not have a large environmental impact: bulk milk transport appears to be quite efficient. Distribution transport of milk products is not as efficient but still play only a minor role in the life cycle. The transport by the consumer, on the other hand, can cause substantial environmental effects. Quite often consumers drive several kilometres to buy a single carton of milk. This may make the fuel use per litre of milk as much as 100 times greater than for the transport of milk (International Dairy Federation, 2005).

The global warming effect of dairy farming is especially significant. Analysing the available data on dairy livestock emissions, the CE Delft Report concludes that dairy cattle contribute 1.2% to the global greenhouse emissions.

On-farm methane emissions have also considerably decreased in Europe. The emissions from enteric fermentation in dairy cattle and those due to manure handling lowered respectively by 30% and by 20% between 1990 and 2005.

Cradle-to-farm emissions of milk contribute to 3% of total global climate emissions. Half of this 3% is due to enteric fermentation for both dairy cows and young cattle, thus being the main source of climate impact. The post-farm emissions add 10% to 20% to the life cycle of dairy.

[7] Study made on behalf of European Dairy Association (EDA).

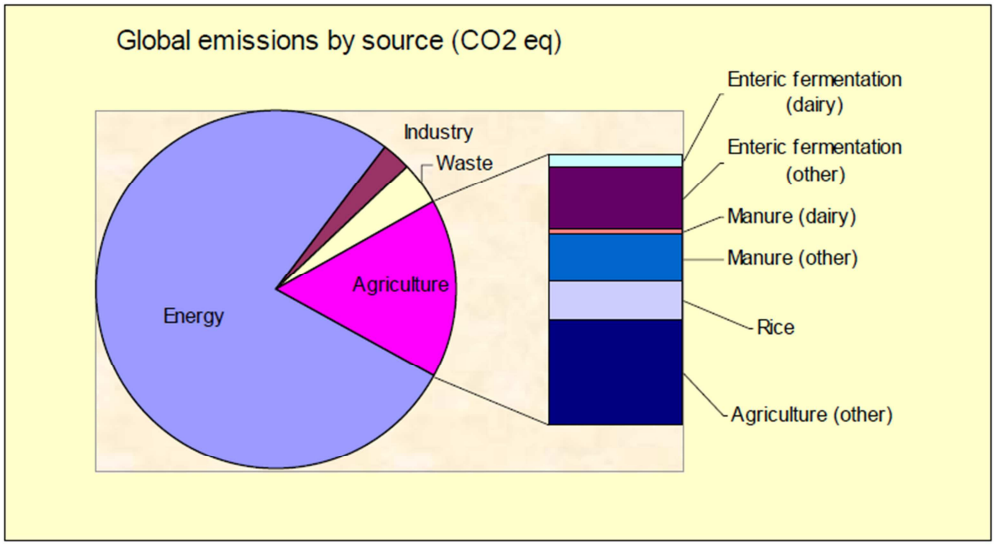


Figure 7-Global greenhouse-gas emissions by source (Sevenster, et al., 2008).

Methane is the greenhouse gas that contributes most to the climate impact of milk, followed closely by nitrous oxide. LCA studies find that greenhouse-gas emissions are 0.8-1.4 kg CO2 eq. per kg milk for the milk life cycle up to the farm.
Including post farm emissions would lead to a climate effect of 0.9-1.8 kg CO2 eq. per kg milk. These differences originate from different agricultural systems and differences in milk production per cow. The IMPRO Dairy and Meat Study (Weidema, et al., 2008) also includes household energy use and estimates cradle-to-grave emissions of 2.4 kg CO2 eq. per kg milk.

8 Product Design Options

As stated in Article 15 of the EU Ecodesign Directive, there must be significant potential for improvement of products in terms of their environmental impact, taking into account the absence of legislation or market failure forces to properly address the issue.
Improvement options of food products have been identified in three main areas in the IMPRO study (Weidema, et al., 2008) and also BIOIS report (Monier, et al., 2010):

- Agricultural improvements, mainly to reduce water and air emissions (in particular nitrate, ammonia and methane) as well as land use;
- Energy savings in farming, food industry, retail, catering, and for household appliances;
- Household improvements, mainly to reduce food losses (wastage) and to reduce car use for shopping.

Specifically, the improvement options include:

8.1 Animal husbandry

- Optimised protein feeding in pig, poultry, and cattle farming (use of low-protein diets supplemented with amino acids, and low-phosphorus diets with highly digestible inorganic

phosphates) (to reduce ammonia emissions, nitrate leaching, and phosphorous build-up in soil); (Weidema, et al., 2008), (Gerber, et al., 2013));
- Liquid manure pH reduction (to reduce ammonia emissions) (IMPRO, 2008);
- Tightening the rules of manure application (to reduce nitrate leaching and N2O emissions) (Weidema, et al., 2008)
- Heavy metal reduction in dairy cattle, pig, and poultry diets (to reduce heavy metal emissions) (Weidema, et al., 2008);
- Methane-reducing diets for dairy cattle (to reduce methane emissions) (Weidema, et al., 2008);
- Minimizing the surface of manure in contact with air – frequent collection of litter (once a week in dry seasons and twice a week in rainy seasons), closed storage (bags or closed sheds) (Gerber, et al., 2013);
- Cooling animal manure, achieved as a positive side effect of cooling the animal houses – cooling systems can be equipped with biofilters and air scrubbers that trap odours from the ventilation airflow; (Gerber, et al., 2013);
- Lowering litter's water content – achieved by the incorporation of hydrophilic products such as hashes, rice husk, peanut husk, dust or sawdust; (Gerber, et al., 2013);
- Timing and rate of manure application – this is a critical management factor; manure must be applied at the correct time of year to prevent losses to surface water, groundwater and the atmosphere, and to optimize the utilization of manure nutrients by growing plants; proper timing is a function of several variables, including weather, soil conditions and stage of crop growth; (Gerber, et al., 2013);
- Biogasification of manure from dairy cows and pigs (to reduce methane and N2O emissions) (Weidema, et al., 2008);
- Continuing and/or developing initiatives to benchmark on-farm energy and water use/water management and adopting the means to reduce usage across the sector (Foster, 2006);

8.2 Processing/Packaging

- Widespread implementation of ultra-pasteurisation and microfiltration are the two major processing technologies for extending the shelf life of chilled dairy products (Weidema, et al., 2008);
- Packaging improvements to extend product lifetime: vacuum packaging, Modified Atmosphere Packaging (MAP), where the air in the pack is replaced by a modified atmosphere (Weidema, et al., 2008);

8.3 Retail

- Home delivery of groceries (to reduce greenhouse gas and other air emissions related to car driving) ((Weidema, et al., 2008)
- Options for reducing car driving for shopping by providing alternative distribution systems (Weidema, et al., 2008);

8.4 Household storage, notably storage and food losses

- Legislative requirement for new cold appliances only A+ or A++ (to reduce electricity consumption) (Weidema, et al., 2008);
- Early replacement of cold appliances scheme (providing an economic incentive for the consumer to discard inefficient appliances 'prematurely') (Weidema, et al., 2008);
- Household meal planning tools (to reduce food losses and all environmental interventions throughout, it is estimated that food loss can generally be halved by application of better planning tools, and that these tools will be accepted by 25% of consumers, i.e. resulting in an average 12.5 % reduction in food waste, or 2.5% of the total amount of meat and dairy products) (Weidema, et al., 2008);

8.5 Improvement potential of the production process of dairy products

When all the identified environmental improvement potentials are taken together, the total improvement amounts to a reduction of 17% for nature occupation, around 25% for global warming and respiratory inorganics, 31% for acidification and terrestrial eutrophication, 43% for aquatic eutrophication, to 68% for aquatic ecotoxicity (when rebound effects and synergies have been accounted for). Since the first three impact categories make up 95% of the aggregated (monetised) environmental impact, the aggregated improvement potential amounts only to about 20% of the total environmental impact of meat and dairy products in EU-27 (and significantly less if rebound effects were not accounted for) (Monier, et al., 2010).
Figure 8 shows how much the environmental impacts may be reduced for the main environmental impact categories. Noting that the aggregated impact from meat and dairy products amount to 24% of the overall impact of EU-27 total final consumption, this implies that after all improvement options have been successfully implemented, the impact from meat and dairy products would still amount to 19% of the aggregated impact of EU-27 total final consumption. This seems to suggest that large reductions in the overall impacts from meat and dairy products cannot be obtained from the identified improvement options alone, but would require targeting the level and mode of consumption as such. One of the proposed improvement options may be applicable also for this purpose, namely household meal planning tools (Weidema, et al., 2008).

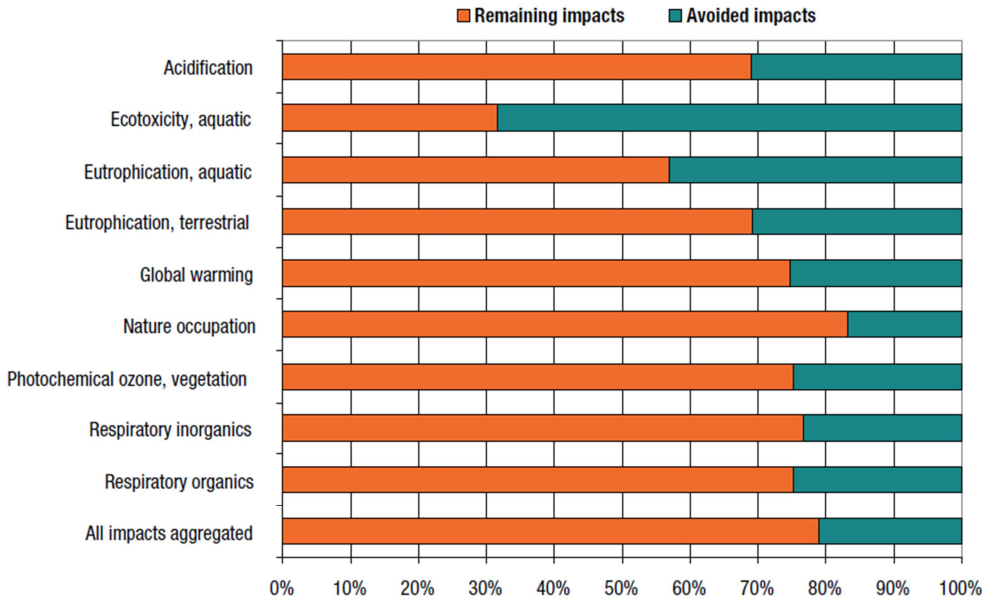


Figure 8-Remaining and avoided environmental impacts of meat and dairy products if all identified improvement options are implemented together. Rebound effects as well as synergies and dysergies between different improvement options are considered (Weidema, et al., 2008).

9 Policy analysis

9.1 Ecodesign measures

The Ecodesign Directive requires that measures taken should bring important environmental improvements. In order to fulfil this objective, the analysis of the environmental impacts made in chapter 7 shows that ecodesign measures would have to address the impacts related to the early life cycle stages of agricultural production and/or animal husbandry. According to the analysis by BIOIS of the data from the IMPRO study on meat and dairy products, even if all improvements related to crop products and animal husbandry, production, packaging and retail sales are taken into consideration the total aggregated improvements should not be expected to be more than 20%, reducing their share in the aggregated impact in the EU from 24% to 19%.

However, there are other important obstacles concerning the development of Ecodesign Directive requirements . So far, the focus has been on requirements related, primarily, to the use phase. Conformity with any Ecodesign Directive requirements for food and drink products would rely on the provision of information by suppliers to ensure that products comply with set specifications. The producers or importers of food products would need to be able to certify that the inputs used in their products have been produced by their supplier in certain ways so that the final product meets the minimum requirements set. In the case of specific minimum requirements they may also need to know the values of the relevant environmental impact indicators.

Thus, unless there is direct control of the upstream production stages, it would require producing and exchanging more environmental information across the operators in the food chain. It would also require the use of declaration or certification schemes. Therefore, market surveillance on such requirements would probably require considerable resources to be effective with a higher risk of non-compliance in comparison to current Ecodesign Directive requirements based on product testing (CSES, 2012).

Additionally, there is no example of mandatory requirements for placing food and drink product on the market relying on such declaration or certification schemes at EU or national level.

Against the possible coverage under the above Ecodesign Directive Implementing Measure the following alternative options were considered.
Business as usual - The business as usual scenario includes a combination of existing market forces, regulations related to environmental impact of production processes and certain developments on a voluntary basis towards the provision of additional information on environmental impacts to consumers.

Mandatory labelling or other mandatory information scheme could possibly include the labelling of dairy products classifying them – on a standard basis - in terms of certain key environmental impacts such as energy use or greenhouse emissions, informing consumers on the appropriate temperature for conservation and methods of disposal. Mandatory labelling may also inform consumers on the impact of the products throughout the life cycle, providing guidance on the most appropriate preservation and disposal method. Labels may be displayed on the product, on the shelve at the point of sale or on the web.

Voluntary agreement - A possible alternative is the promotion by industry of a voluntary scheme – inside or outside the context of the Ecodesign – aiming to address certain key issues such as packaging waste or, to the extent possible, issues like energy and water use throughout the product lifecycle. A voluntary agreement can also develop within the context of the Ecodesign Directive.

Financial tools –taxes on food products with higher levels of CO2 emissions (VAT or other tax) could also be used. This could focus on those products that are more CO2-intensive or those that are based exclusively on organic dairy. Other possible financial instruments include the provision of grants or a Reform of CAP promoting investments in technologies and processes used in agricultural production and dairy processing and grants for R&D activity for the development of more environmental products and processes (Ecoinnovation scheme under the Competitiveness and Innovation Programme).

9.2 Labelling measures

9.2.1 Product carbon footprint

A product carbon footprint is usually based on an LCA methodology. LCA method analyses production systems systemically to account for all inputs and outputs for a specific product and production system across a specified system boundary. The system boundary is largely dependent on the goal of the study. The reference unit that denotes the useful output is known as the functional unit and has a defined quantity and quality, for example a litre of milk of a defined fat and protein content.

The application of LCA to agricultural systems is often complex because, in addition to the main product, there are usually co-products created, such as meat, energy etc. This requires appropriate partitioning of environmental impacts to each product from the system based on an allocation rule which can be based on different criteria such as value, product properties or system expansion. Calculation of the carbon footprint of a product using LCA methodology should be based on:

- the ISO 14000 series, specifically ISO 14040, ISO 14044, and in ISO 14067;
- Greenhouse gas Protocol's Product Life Cycle Accounting and Reporting Standard developed by World Resource Institute and World Business Council for Sustainable Development;
- ILCD handbook by the European Commission, Joint Research Institute and Institute for Environment and Sustainability;
- PAS2050 by British Standard Institute.

There are many challenges in calculating a carbon footprint, and milk or a dairy products are no exception. To date, there have been several LCA studies investigating and evaluating GHG emissions from milk production. However, comparison between these different studies is difficult and it is hard to identify where meaningful reductions in GHG emissions can be made when it is not clear whether a benefit really exists or only appears to exist because of a different method of calculation.
The carbon footprint for milk and dairy products is dominated by the agricultural stage, where the major of the GHG emissions occur. This is why it is crucial to consider the variables in primary milk production that can affect the carbon footprint outcome, and to have a common approach for allocating the environmental burden from raw milk production between products such as milk, cream, cheese and butter, irrespective of the farm, system, country or even region (International Dairy Federation, 2010).

There are some sector-specific guidelines for the carbon footprinting of milk and dairy production:

- International Dairy Federation realesed in 2010 a document with internationally harmonized standards and guidelines for the methodology for calculating the carbon footprint of milk and dairy products (International Dairy Federation, 2010);
- Guideline for the carbon footprinting of dairy products (Carbon Trust , 2011);
- Product Category Rules (PCR) for processed liquid milk (Swedish Environmental Management Council, 2010).

The guidelines mentioned above have been developed in order to harmonise LCA calculations and the dairy sector has made great efforts in this work. However, there is still room for interpretation. The challenges are scientific but have implications for industry as well as for policy-makers and consumers. Industry needs robust methods to find improvement potentials, whereas policy-makers and consumers need robust science to base their decision-making on for regulations and food choice (Flysjö, 2012).

9.2.2 Labelling of the Product Environmental Footprint (PEF)

Based on the limitations of Product Carbon Footprint (PCF) labels as outlined above, the labelling of the Product Environmental Footprint (PEF) would be another adequate step.
In its conclusion on the "Sustainable materials management and sustainable production and consumption" (December 2010), the European Council invited the Commission to "develop a common methodology on the quantitative assessment of environmental impacts of products, throughout their life-cycle, in order to support the assessment and labelling of products".[8]

On this basis, DG Environment together with the European Commission's Joint Research Centre (JRC IES) and other Commission services developed the environmental footprint methodology which is recommended to be used by Member States, companies, private organisations and the financial community.
According to DG Environment[9], a three-year testing period (EF European pilot phase) was launched with the following objectives:

- to set up and validate the process of the development of product group-specific rules in case of products (Product Environmental Footprint Category Rules – PEFCRs), including the development of performance benchmarks
- to test different compliance and verification systems, in order to set up and validate proportionate, effective and efficient compliance and verification systems
- to test different business-to-business and business-to-consumer communication vehicles for Product Environmental Footprint information in collaboration with stakeholders (individual companies, industrial associations or any other private, non-governmental or public organisation both from the EU and outside of the EU).

The PEFCRs resulting from the EF pilot phase will become the product rules valid under the PEF, to be used by all stakeholders in the sector in the EU or internationally who decide to measure the performance of their products based on PEF.

A second wave of pilots will be launched in the end of 2013 or early 2014 addressing food/feed/drink products. Reasonably, the outcomes of these pilot studies should be awaited before drafting further specific policy measures on food products such as dairy products.

9.2.3 EU Ecolabel for food and feed

Besides the existing EU organic farming label, in 2010 a feasibility study[10] has been published with the following targets:

> To assess the feasibility of establishing reliable EU Ecolabel criteria covering the environmental performance of food, feed and drinks products throughout their whole lifecycle.
> To assess the impact and the added value of establishing these EU Ecolabel criteria and implementing the scheme in the various sectors, and the impact this could have on organically certified products (including the risk of consumer confusion).
> To evaluate the option of limiting the scope of the EU Ecolabel for food, feed and drinks products to organically certified products only.

[8] Source: http://www.pef-world-forum.org/eu-environmental-footprinting/
[9] Source: http://ec.europa.eu/environment/eussd/smgp/product_footprint.htm
[10] See: http://ec.europa.eu/environment/ecolabel/documents/Ecolabel_for_food_final_report.pdf

The findings of the study, reduced to those being applicable also for dairy products, can be reflected as follows:

- Finding 1: The 'extraction of resources' or the primary production stage (e.g. agriculture) is responsible for most of the significant environmental impacts of food products over their lifecycle, although this can vary between product categories. However, impacts that are not easily measured (e.g. biodiversity loss, landscape pollution, soil fertility) cannot easily be included in a ranking of environmental impacts. The same is true for ethical or social issues (e.g. labour standards, fair producer prices).
- Finding 2: The extent of the environmental impact of food products in the "extraction of resources" stage of their lifecycle results from an interaction between the practice employed and the place where the practice takes place because of the use of physical elements (land, water etc). For a particular product, on a specific site employing specific production technologies the actual environmental impacts may differ significantly.
- Finding 3: The consultants of the study found a gap in the labelling landscape which may present an opportunity for an EU Ecolabel. Even though environmental impacts may vary between product categories and lifecycle stages, most labels currently only concentrate on the environmental impacts of primary production and not, or only to a limited extent, the processing lifecycle stage. Therefore a focus on highly processed products would play to the strength of the EU Ecolabel (its lifecycle approach) by covering the environmental impacts of processing, transport and consumption, while the environmental impacts of primary production could be dealt with by cooperating with existing sufficiently strict agri labelling schemes. However the risk of a switch from existing labels to an EU Ecolabel cannot be discounted and this may lead to no net environmental improvement if the criteria used are not significantly different.
- Finding 4: Existing environmental food labels mainly employ input- or practice-based criteria, i.e. prescribing or banning certain defined practices in the production process. The disadvantages of such criteria are that they can lead to a shift of environmental burdens when practices or ingredients are substituted as well as hampering innovation. Output-based criteria can be more economically efficient and provide a transparent link with environmentally positive results. A number of initiatives are underway at the European level to develop environmental footprinting tools and multi-criteria methodologies and these may, in the future, provide the basis for developing more output based criteria for food products. They will not be without challenges, in terms of the cost of assessment and the need for co-operation and openness between market actors throughout the supply chain.
- Finding 5: A key finding from the consumer survey and workshop with stakeholders was that an environmental label for food products is expected to cover, not only environmental issues but also social and ethical issues such as fair remuneration for producers.
- Finding 6: In terms of implementing an EU Ecolabel for food, the complexity of developing criteria and then verifying compliance should not be underestimated, based on the experience of existing organic (EU) and non-organic food certification schemes (SMK). This would also require a level of expertise that is not currently present in the national competent bodies charged with the administration of the EU Ecolabel scheme. Furthermore the process of multicriteria assessment and verification is likely to be resource intensive. The costs involved could not be met from the current licence fees as these are limited by the EU Ecolabel Regulation. It is also important to recognise the costs of application, which may be particularly burdensome for SMEs.

- Finding 7: The consumer survey revealed that labels are seen as valuable tools in making purchasing decisions and the majority of respondents, when presented with a choice, indicated a preference for a product that was both EU Ecolabelled and organically labelled. However, many respondents reported that they felt confused. This is exacerbated by the fact that the term "eco" (including similar derivatives) is used in connection with organically produced foods in many jurisdictions and associated with other meanings (e.g. resource efficiency) in others. When consumers were asked which environmental impacts a possible EU Ecolabel should cover, many issues were raised that were already covered by organically certified produce (e.g. no use of chemical pesticides, no artificial fertilizers, no GMO, low number of additives). Unsurprisingly, many consumers expected a product with an EU Ecolabel to be organically produced. In addition the use of the word "eco" is legally protected in the EU and therefore there may be some difficulty in using it within the logo 'EU Ecolabel' when it is placed on food products which are not organically produced. It should be noted that consumer confusion was lessened once respondents were provided with more information about the EU Ecolabel. This would suggest a significantly resourced communications campaign would need to accompany any extension of the EU Ecolabel to the food sector.
- Finding 8: Half of the stakeholders surveyed for this study supported an EU Ecolabel for food products in one way or another, whereas the other half was against the use of such an Ecolabel at all. Moreover, the study consultants found that there was no scenario for which there was strong support. However a significant share of processors and retailers expected a positive effect and would thus form the target stakeholder group of a potential EU Ecolabel for food products. More importantly, there were a number of stakeholder groups who were clearly opposed to any scenario that included the introduction of the EU Ecolabel. These groups were food umbrella organisations, farmers' groups, the organic sector and environmental and consumer NGOs and administrations. Their reasons varied but mainly concerned the expected consumer confusion of an EU Ecolabel with organic labels and resulting adverse effects on the credibility of the organic label and its market share.

The study authors see the opportunity to extend the EU Ecolabel to food products, especially dairy products as candidate product category, depending on the possibility to resolve the following issues:

- Development of a credible multi-criteria overall outcome based assessment system for primary production – this does not currently exist.
- Clarifying the legality of using the current Ecolabel and the term "eco" in respect of food products.
- If extended to non-organic products: finding solutions to avoid consumer confusion (e.g. a distinct label) – this may involve an extensive consumer communication campaign.

An economic assessment of the full public and private costs of implementing the EU Ecolabel scheme (the costs for a consumer awareness/education campaign and costs for operators etc).

10 Conclusions

For all dairy products the impacts of the dairy farm phase dominate the total life cycle. On the dairy farm, the impacts come mainly from the feed production for all impact categories. After the dominant dairy farm phase, dairy processing has important impacts, as well as the production of packaging. The impacts of retailers and consumers are relatively limited even though refrigeration systems are often used. The transportation does not have a great environmental impact as long as the distances covered are generally not very long in the dairy product systems.
The overall conclusion of the study is that there are certain important practical and economic limitations for the implementation of Ecodesign requirements for dairy products, at least in the short term. There is significant additional preparatory work required before such requirements become operational. It is also not possible to tell whether such an approach can be more effective in comparison to an approach focusing on improving the agricultural production and livestock breeding stages in the EU through tools like the CAP, further promoting and streamlining good agricultural practices and also strengthening the requirements of existing regulations on industrial emissions and packaging waste. On the one hand, the introduction of supply chain requirements on behalf of producers can be particularly effective in terms of pushing for changes and adoption of environmental practices at a global scale.

There are certain practical, as well as economic, considerations for the development of such an approach at this stage. They include the absence at this stage of a widely accepted methodology ad standards to support a life cycle analysis.The current MEEuP methodology and the EcoReport do not seem to provide the answer but there are already efforts and projects working in this direction with the participation of multiple stakeholders.

The limited number of material options available in the EcoReport tool does not have a significant impact on the overall results of the assessment since the use-phase has by far the highest contribution to the environmental impact. This is not the case for dairy products where the dairy farm phase is the highest contributor to the environmental impact of the product.
In most cases other existing instruments besides measures implemented through the Ecodesign Directive are better suited to tackle the environmental impacts of non-ErP (e.g. REACH) due to the existence of accepted testing methods and specificity of the products covered.

The introduction of a labelling scheme could be effective in reducing some of the impacts and create demand for more products with a greener environmental profile and push producers towards the adoption of green supply chain practices. However, the effectiveness of labelling in relation to food products has certain limits as price is key and there are no other cost benefits during the life cycle. In addition, there is a danger of confusion in relation to the use of other labelling schemes that concern only certain products in the market (e.g. organic label). Currently only EU organic label and its national adaptations is mandatory for packaged food produced in the EU. All additional labelling that can emerge will have to take the existing organic labelling into account. One option would be to extend the mandatory nature of the organic label to imported food and non-packaged food. However, other instruments based on best-practices regulation would be more effective. These include certification schemes (e.g. organic food products) and horizontal measures such as the IPPC Directive.

11 References

Misonne, Brigitte. 2012. *Dairy Farms' margins.* s.l. : DG AGRI – European Commission, 2012.

Carbon Trust . 2011. *Industrial Energy Efficiency Accelerator - Guide to the dairy sector.* London : Carbon Trust , 2011. Guide to the Dairy Sector CTG033.

CSES. 2012. *Evaluation of the Ecodesign Directive (2009/125/EC)- Final Report.* s.l. : Centre for Strategy & Evaluation Services, 2012.

Department of Agriculture, Fisheries and Food. 2009. Ireland's Dairy Sector. [Online] December 2009. [Cited: 2 December 2013.] http://www.agriculture.gov.ie/media/migration/agri-foodindustry/foodharvest2020/foodharvest2020/2020strategy/2020Dairy1.doc.

European Commission Directorate-General for Agriculture and Rural Development. 2006. *MILK AND MILK PRODUCTS IN THE EUROPEAN UNION.* s.l. : European Commission, 2006. ISBN 92-79-02199-0.

Eurostat. 2013. *Agriculture, forestry and fishery statistics.* s.l. : European Union, 2013.

Flysjö, Anna . 2012. *Greenhouse gas emissions in milk and dairy product chains - Improving the carbon footprint of dairy products.* Foulum : Aarhus University, 2012.

FoodDrinkEurope. 2013. *Data & Trends of the European Food and Drink Industry 2012.* Brussels : s.n., 2013.

Foster, C., Green, K., Bleda, M., Dewick, P., Evans, B., Flynn A., Mylan, J. 2006. *Environmental Impacts of Food Production and Consumption: A report to the Department for Environment, Food and Rural Affairs.* London : Manchester Business School. Defra,, 2006.

Gerber, P.J., et al. 2013. *Tackling climate change through livestock – A global assessment of emissions and mitigation.* Rome : Food and Agriculture Organization of the United Nations (FAO), 2013.

International Dairy Federation. 2010. *A common carbon footprint approach for dairy- The IDF guide to standard lifecycle assessment methodology for the dairy sector.* s.l. : International Dairy Federation, 2010.

—. 2005. *Guide on Life Cycle Assessment towards Sustainability in the Dairy Chain.* s.l. : International Dairy Federation, 2005.

International Finance Corporation - World Bank Group. 2007. Environmental, Health, and Safety Guidelines for Dairy Processing. [Online] 2007. [Cited: 3 December 2013.] http://www.ifc.org/wps/wcm/connect/534a1a8048855373af34ff6a6515bb18/Final%2B-%2BDairy%2BProcessing.pdf?MOD=AJPERES.

IPTS. 2006. *Environmental Impact of Products (EIPRO).* s.l. : Joint Research Centre (DG JRC) Institute for Prospective Technological Studies, 2006. EUR 22284 EN.

Monier, Véronique , et al. 2010. *Technical support to identify product categories with significant environmental impact and with potential for improvement by making use of ecodesign measures.* s.l. : European Commission (DG ENV), 2010.

Sevenster, Maartje and de Jong, Femke . 2008. *A sustainable dairy sector-Global, regional and life cycle facts and figures on greenhouse-gas emissions.* CE Delft : European Dairy Association, 2008.

Swedish Environmental Management Council. 2010. *Product Category Rules (PCR) for preparing an Environmental Product Declaration (EPD) for processed liquid milk.* s.l. : PCR, 2010. PCR 2010:12..

Thomassen, M.A. , et al. 2007. *Life cycle assessment of conventional and organic milk production in the Netherlands.* s.l. : Elsevier, 2007. doi:10.1016/j.agsy.2007.06.001.

VERSTEIJLEN, Herman. 2013. *Market situation and perspectives.* s.l. : European Commission, 2013.
Weidema, B. P., et al. 2008. *Environmental improvement potential of meat and dairy products.* s.l. : JRC-IPTS, 2008.

ECOFYS

sustainable energy for everyone

ECOFYS Netherlands B.V.

Kanaalweg 15G
3526 KL Utrecht

T: +31 (0) 30 662-3300
F: +31 (0) 30 662-3301

E: info@ecofys.com
I: www.ecofys.com

ECOFYS

sustainable energy for everyone

Case Study: Fresh Bread

Evaluation of the Energy Labelling Directive

and specific aspects of the Ecodesign Directive – Task 3-

ENER/C3/2012-523

Case Study: Fresh Bread

Evaluation of the Energy Labelling Directive

and specific aspects of the Ecodesign Directive – Task 3 -

ENER/C3/2012-523

- Confidential –

By: Kathrin Graulich (Oeko-Institut)
with the support of: Marah Gattermann (Oeko-Institut)

Date: 28-05-2014

Project number: BUINL13345

Table of contents

1 Introduction

This case study shall examine the feasibility of developing ecodesign and labelling requirements for the product category “fresh bread” within the context of the Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive. This product category has been selected as representative of the broader food and beverages product group.
Products in the areas of food and drink, private transport, and housing were found to have the largest environmental impact.
According to EIPRO study[1], food and drink cause 20 – 30% of the various environmental impacts of private consumption. This includes the full food production and distribution chain ‘from farm to fork’.

In a scoring exercise that considered sold Volume, environmental impact, the availability of LCA relevant information, the suitability for Ecodesign and Labelling instruments, and an assessment of the possible costs / risks and benefits of both Ecodesign and Labelling, several food-and drink related product groups received the highest score. Among them, two product groups stand out that represent the crop raising activity in the agricultural sector: “fruit and vegetables” and “Bread and cereals”. However, “fruit and vegetables” is more heterogeneous and there is less information available. Within the “Bread and cereals”, the product group “fresh bread” was chosen because of its large market share, and because it is a final consumer product.

2 Scope

2.1 Brief definition of the product group

According to the European production and trade statistics[2], the product group is defined as “fresh bread containing by weight in the dry matter state ≤ 5 % of sugars and ≤ 5 % of fat (excluding with added honey, eggs, cheese or fruit)”. Not within the scope of this product group are cakes and pastry products, other baker’s wares with added sweetening matter as well as rusks and biscuits and preserved pastry goods and cakes with the below stated sub-categories.

[1] http://ec.europa.eu/environment/ipp/pdf/eipro_report.pdf
[2] http://www4.ssb.no/PrintResultOld.asp?ID=7141301&Language=en&Type=hierarchy&Extension=.htm; http://eur-lex.europa.eu/Notice.do?mode=dbl&lang=en&ihmlang=en&lng1=en,de&lng2=bg,cs,da,de,el,en,es,et,fi,fr,hu,it,lt,lv,mt,nl,pl,pt,ro,sk,sl,sv,&val=457075:cs

Table 1: Overview on Prodcom codes related to the manufacture of bread

Prodcom code	Definition
10.71	Manufacture of bread; manufacture of fresh pastry goods and cakes
10.71.11.00	Fresh bread containing by weight in the dry matter state ≤ 5 % of sugars and ≤ 5 % of fat (excluding with added honey, eggs, cheese or fruit)
10.71.12.00	Cake and pastry products; other baker's wares with added sweetening matter
10.72	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes
10.72.11.30	Crispbread
10.72.11.50	Rusks; toasted bread and similar toasted products
10.72.12.30	Gingerbread and the like
10.72.12.53	Sweet biscuits; waffles and wafers completely or partially coated or covered with chocolate or other preparations containing cocoa
10.72.12.55	Sweet biscuits (including sandwich biscuits; excluding those completely or partially coated or covered with chocolate or other preparations containing chocolate)
10.72.12.57 10.72.12.59	Waffles and wafers (including salted) (excluding those completely or partially coated or covered with chocolate or other preparations containing chocolate)
10.72.19.10	Matzos
10.72.19.20	Communion wafers; empty cachets of a kind suitable for pharmaceutical use; sealing wafers; rice paper and similar products
	Waffles and wafers with a water content > 10 % by weight of the finished product (excluding ice cream cornets, sandwiched waffles, other similar products)
10.72.19.40	Biscuits (excluding those completely or partially coated or covered with chocolate or other preparations containing cocoa, sweet biscuits, waffles and wafers)
10.72.19.50	Savoury or salted extruded or expanded products
10.72.19.90.	Bakers' wares, no added sweetening (including crepes, pancakes, quiche, pizza; excluding sandwiches, crispbread, waffles, wafers, rusks, toasted, savoury or salted extruded/expanded products)

According to Baking+Biscuit International[3], 'fresh bread' can be distincted against prepacked[4] bread. Fresh products include all products offered fresh to the consumer, predominately unpacked and mainly without branding. The bread is either produced by artisanal or industrial bakeries.

The Bake-Off Technology (BOT) involves producing bread from industrial refrigerated bakery goods and retailing them in downtown vending shops or sometimes in bakeries (hot points, in-store-bakery, ISB). ISB bread is bread that is baked in-store, for example of large multiple retailers. There are two methods for ISBs: scratch bakery using raw ingredients or bake-off using dough which is part-baked and frozen. Most plant bakers supply ISBs with their own part-baked and frozen products, but many of the larger ISBs now have scratch bakeries making bread fresh from raw ingredients.
However, there are discussions that due to the increasing in-store-bakery sector the use of the term 'fresh' needs to be reviewed[5]. For the purpose of this study, an in-depth analysis would be necessary to decide finally if these products would be within or out of the scope.

[3] Source: http://www.bakingbiscuit.com/id-2008/articles/bakingbiscuit-international-06-2008.html?file=tl_files/f2m-media/pdf/archiv/baking%20and%20biscuit/issue%202008-06/10_Massive_differences.pdf

[4] According to REGULATION (EU) No 1169/2011 on the provision of food information to consumers, 'prepacked food' means any single item for presentation as such to the final consumer and to mass caterers, consisting of a food and the packaging into which it was put before being offered for sale, whether such packaging encloses the food completely or only partially, but in any event in such a way that the contents cannot be altered without opening or changing the packaging; 'prepacked food' does not cover foods packed on the sales premises at the consumer's request or prepacked for direct sale.
Source: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:304:0018:0063:EN:PDF

[5] Source: http://www.just-food.com/store/samples/46491.pdf

Table 2: Distinction of fresh bread and sub-categories versus prepacked bread

	Fresh bread			Prepacked bread				
Production method	Artisanal (made from scratch on the premises; craft bakeries)	Industrial		Industrial				
Sub-categories		Bought fresh from industrial bakers (Plant bakeries)	"Bake-off" (In-store-bakeries)	Long-life bread		Part-baked bread		
				"soft" bread	"crisp" bread	ambient	refrigerated	frozen

Prepacked long life-products included all prepacked goods sold at the self-service counter. They were usually industrially produced; sometimes consumer branded and could be stored at ambient temperatures. Prepacked part-baked or frozen products were those sold directly to the consumer with the final baking/thawing done at home. These products could be ambient (modified atmosphere packed), frozen or chilled. Prepacked bread will not be within the scope of this study.

2.2 Standards and Legislation

In the context of a limited case study, the following section only presents a rough overview of standards and legislation applicable to food in general including fresh bread as specific product category. In a more detailed follow-up process, further in-depth research would be needed to provide a complete list of standards and legislation.

A general overview on standards and legislation with regard to food and feed safety as well as their specific background is provided at the website of DG Health and Consumers[6]. They divide the existing standards and legislations into the following topics:

[6] See http://ec.europa.eu/food/food/foodlaw/principles/index_en.htm

Table 3: General overview on existing European standards and legislations on food and feed safety

Topic	Directives and Regulations
General food law	> Regulation (EC) No 178/2002 of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety[7]
Organic food	> Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products[8] > Regulation (EC) No 889/2008 of 5 September 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control[9] > Regulation (EC) No 967/2008 of 29 September 2008 amending Regulation (EC) No 834/2007 on organic production and labelling of organic products[10]
Labelling and nutrition	> Regulation (EC) 1924/2006 of 20 December 2006 on nutrition and health claims made on foods[11] > Regulation (EC) No 1925/2006 of 20 December 2006 on the addition of vitamins and minerals and of certain other substances to foods[12] - Regulation (EC) No 108/2008 of 15 January 2008 amending Regulation (EC) No 1925/2006 on the addition of vitamins and minerals and of certain other substances to foods > Regulation (EU) 1169/2011 of 25 October 2011 on the provision of food information to consumers, amending Regulations (EC) No 1924/2006 and (EC) No 1925/2006, and repealing Commission Directive 87/250/EEC, Council Directive 90/496/EEC, Commission Directive 1999/10/EC, Directive 2000/13/EC, Commission Directives 2002/67/EC and 2008/5/EC and Commission Regulation (EC) No 608/2004[13] > Regulation (EU) 907/2013 of 20 September 2013 setting the rules for applications concerning the use of generic descriptors (denominations)[14] > Directive 2002/46/EC of the European Parliament and of the Council of 10 June 2002 on the approximation of the laws of the Member States relating to food supplements[15] - Directive 2006/37/EC of 30 March 2006 amending Annex II to Directive 2002/46/EC of the European Parliament and of the Council as regards the inclusion of certain substances[16] - Regulation (EC) No 1170/2009 of 30 November 2009 amending Directive 2002/46/EC and Regulation (EC) No 1925/2006 as regards the lists of vitamin and minerals and their forms that can be added to foods, including food supplements[17] - Regulation (EU) No 1161/2011 of 14 November 2011 amending Directive 2002/46/EC, Regulation (EC) No 1925/2006 and Regulation (EC) No 953/2009 as regards the lists of mineral substances that can be added to foods[18] > Directive 2003/89/EC of 10 November 2003 amending Directive 2000/13/EC as regards indication of the ingredients present in foodstuffs[19] > Regulation (EU) No 609/2013 of 12 June 2013 on food intended for infants and young children, food for special medical purposes, and total diet replacement for weight control and repealing Council Directive 92/52/EEC, Commission Directives 96/8/EC, 1999/21/EC,

[7] see: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:031:0001:0024:EN:PDF
[8] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:189:0001:0023:EN:PDF
[9] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:250:0001:0084:EN:PDF
[10] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:264:0001:0002:EN:PDF
[11] see: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2006R1924:20080304:EN:PDF
[12] see: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:404:0026:0038:EN:PDF
[13] see: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:304:0018:0063:EN:PDF
[14] see: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:251:0007:0009:EN:PDF
[15] see: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:183:0051:0057:EN:PDF
[16] see: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:094:0032:0033:EN:PDF
[17] see: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:314:0036:0042:EN:PDF
[18] see: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:296:0029:0030:EN:PDF
[19] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:308:0015:0018:EN:PDF

Topic	Directives and Regulations
	2006/125/EC and 2006/141/EC, Directive 2009/39/EC and Commission Regulations (EC) No 41/2009 and (EC) No 953/2009[20]
Biotechnology	> Directive 2001/18/EC of 12 March 2001 on the deliberate release into the environment of genetically modified organisms and repealing Council Directive 90/220/EEC[21] > Regulation (EC) No 1830/2003 of 22 September 2003 concerning the traceability and labelling of genetically modified organisms and the traceability of food and feed products produced from genetically modified organisms and amending Directive 2001/18/EC[22] > Regulation (EC) No 1829/2003 of 22 September 2003 on genetically modified food and feed[23] > Directive 90/219/EEC of 23 April 1990 on the contained use of genetically modified micro-organisms[24]
Novel food	> Regulation (EC) No 258/97 of 27 January 1997 concerning novel foods and novel food ingredients[25] (under revision)
Chemical safety	> Regulation (EEC) No 315/93 of 8 February 1993 laying down Community procedures for contaminants in food[26] > Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs[27]
Biological safety	> Regulation (EC) 852/2004 of 29 April 2004 on the hygiene of foodstuffs > Regulation (EC) No 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs[28] > Regulation (EC) No 2074/2005 of 5 December 2005 laying down implementing measures for certain products under Regulation (EC) No 853/2004 and for the organisation of official controls under Regulation (EC) No 854/2004 and Regulation (EC) No 882/2004, derogating from Regulation (EC) No 852/2004 and amending Regulations (EC) No 853/2004 and (EC) No 854/2004[29]
Food improvement agents	> Regulation (EC) No 1331/2008 of 16 December 2008 establishing a common authorisation procedure for food additives, food enzymes and food flavourings[30] > Regulation (EC) No 1332/2008 of 16 December 2008 on food enzymes and amending Council Directive 83/417/EEC, Council Regulation (EC) No 1493/1999, Directive 2000/13/EC, Council Directive 2001/112/EC and Regulation (EC) No 258/97[31] > Regulation (EC) No 1333/2008 of 16 December 2008 on food additives[32] > Regulation (EC) No 1334/2008 of 16 December 2008 on flavourings and certain food ingredients with flavouring properties for use in and on foods and amending Council Regulation (EEC) No 1601/91, Regulations (EC) No 2232/96 and (EC) No 110/2008 and Directive 2000/13/EC[33]

[20] see: http://new.eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0609&from=EN
[21] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:106:0001:0038:EN:PDF
[22] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:268:0024:0028:EN:PDF
[23] See: http://eur-lex.europa.eu/LexUriServ/site/en/consleg/2003/R/02003R1829-20070112-en.pdf
[24] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1990L0219:20050305:EN:PDF
[25] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1997:043:0001:0006:EN:PDF
[26] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1993R0315:20090807:EN:PDF
[27] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2006R1881:20100701:EN:PDF
[28] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2005:338:0001:0026:EN:PDF
[29] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2005:338:0027:0059:EN:PDF
[30] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:354:0001:0006:EN:PDF
[31] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:354:0007:0015:EN:PDF
[32] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:354:0016:0033:EN:PDF
[33] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:354:0034:0050:EN:PDF

Further, more general policies, standards and legislation related to certain life cycle stages of food products as fresh bread include[34] for example for

- Raw materials: the common EU agriculture policy, the water framework policy, the soil thematic strategy, the European Action Plan for organic food and farming, the biodiversity Action Plan for agriculture; the thematic strategy on the sustainable use of pesticides; the regulation on pesticide residues and the nitrates Directive;
- Manufacture / plant processes: the IPPC Directive; the Environmental Technologies Action Plan;
- Distribution: the Directive on packaging and packaging waste; Euro standards for light-duty road vehicles and high-duty vehicles; EuP Directive for cold storage;
- Use: the health claim Directive;
- End-of-life: the landfill Directive; the Green Paper on the management of bio-waste in the EU.

Regarding consumer information, it has to be noted that with the notable exception of allergens, no further nutrition information is requested by the EU food labelling rules for non-prepacked foods as fresh bread. However, Member States may decide that all or a part of the elements which under the new EU rules are compulsory for prepacked food should also be mandatory for non-prepacked foods[35].

3 Market

3.1 Generic economic data

3.1.1 Market data

On the basis of Eurostat Prodcom statistics[36], the following tables present the recent production, import and export data for 'fresh bread' (Prodcom code 10.71.11.00) and calculate European consumption from production, import and export. The largest national productions of fresh bread can be found in Germany and UK, followed by Italy, Poland, Spain and France. The overall production of fresh bread has been stable on average over the past years. It also becomes clear that the European consumption exceeds by far the 200.000 threshold.

[34] Source: http://ec.europa.eu/environment/eussd/pdf/BIO_Ecodesign-products.pdf
[35] Source: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/lsa/124805.pdf
[36] Source: http://epp.eurostat.ec.europa.eu/portal/page/portal/prodcom/data/database

Table 4: European production data of fresh bread (Source: Prodcom)

	Production quantity (tons)				Production value (1000 Euro)			
	2009	2010	2011	2012	2009	2010	2011	2012
Austria	341.366	354.629	383.640	407.046	715.371	737.254	784.835	824.488
Belgium	434.985	431.118	450.855	445.904	529.138	520.328	555.766	570.625
Bulgaria	357.473	350.958	366.059	341.448	147.359	145.539	173.066	159.700
Cyprus	-	-	-	-	-	-	-	-
Czech Republic	593.522	610.270	573.749	570.923	515.030	523.355	564.281	539.560
Denmark	266.886	244.753	207.316	231.800	364.432	336.159	317.036	305.782
Estonia	62.334	63.152	64.672	63.275	63.485	57.827	64.518	64.856
Finland	182.387	180.984	175.396	175.016	422.840	413.270	410.601	429.762
France	1.211.584	1.236.438	1.262.506	1.329.549	1.385.630	1.395.657	1.457.009	1.553.978
Germany	4.573.480	4.628.376	4.579.092	4.947.901	8.303.018	8.401.038	8.879.328	9.289.487
Greece	50.840	66.082	72.598	68.243	90.796	156.292	142.603	135.387
Hungary	323.477	329.988	349.119	354.607	231.985	254.049	281.900	279.747
Ireland	319.440	564.084	375.290	349.373	384.965	647.834	425.486	354.394
Italy	2.262.097	2.154.985	2.088.394	1.682.921	3.820.059	3.666.772	5.047.379	4.297.053
Latvia	95.312	90.022	88.522	91.077	87.676	76.944	79.217	85.785
Lituania	133.446	133.774	125.706	121.321	117.301	107.733	111.906	111.032
Luxemburg	0	0	0	0	0	0	0	0
Malta	0	0	0	0	0	0	0	0
Netherlands	:	755.151	790.822	733.160	1.015.233	952.058	1.011.714	970.096
Poland	1.648.374	1.631.434	1.586.248	1.614.083	1.278.814	1.412.208	1.494.214	1.554.839
Portugal	252.708	239.539	250.107	542.846	377.073	355.017	360.034	613.967
Romania	805.913	801.978	842.458	818.887	457.376	462.038	530.224	501.217
Slovakia	103.662	99.229	94.230	92.195	87.431	82.279	80.452	79.443
Slovenia	81.511	83.231	85.000	71.264	123.285	123.358	125.432	111.409
Spain	1.479.751	1.360.850	1.423.936	1.469.507	2.135.936	1.990.333	2.118.978	2.154.685
Sweden	:	:	:	:	:	:	:	:
United Kingdom	2.596.990	2.881.546	2.638.629	2.856.260	2.903.964	3.161.121	3.034.340	3.552.488
EU27 TOTALS	**19.553.594**	**19.825.003**	**19.400.965**	**19.884.507**	**26.460.411**	**27.001.049**	**29.163.815**	**29.666.177**

Table 5: European import data of fresh bread (Source: Prodcom)

	Import quantity (tons)				Import value (1000 Euro)			
	2009	2010	2011	2012	2009	2010	2011	2012
Austria	29.113	28.871	34.866	36.011	35.953	33.373	44.976	48.950
Belgium	67.587	66.606	71.422	74.892	77.489	76.634	84.849	86.947
Bulgaria	698	699	:	:	896	892	:	:
Cyprus	1.588	1.842	2.083	1.862	2.387	3.046	3.837	3.477
Czech Republic	:	:	:	20.384	:	:	:	26.066
Denmark	34.840	36.277	37.970	39.876	49.352	49.040	55.555	57.765
Estonia	:	2.720	4.019	:	:	2.811	4.338	:
Finland	14.231	15.696	19.901	24.978	22.658	23.778	29.619	36.501
France	74.811	73.747	76.339	84.832	85.375	86.656	100.618	112.540
Germany	41.494	47.543	53.840	58.037	63.900	67.851	73.460	83.924
Greece	:	4.432	:	:	:	5.204	:	:
Hungary	4.969	:	6.273	5.661	5.545	:	7.921	7.234
Ireland	36.898	51.161	42.439	34.721	43.544	44.268	49.426	46.412
Italy	41.559	47.521	48.070	54.267	43.194	48.860	55.476	67.474
Latvia	4.226	3.935	:	:	4.222	3.921	:	:
Lituania	6.852	5.939	:	6.762	4.828	3.524	:	5.705
Luxemburg	6.318	7.302	:	:	11.607	11.568	:	:
Malta	699	994	1.166	1.116	1.178	1.656	1.792	1.849
Netherlands	86.371	63.947	65.871	84.115	70.925	65.123	67.376	79.374
Poland	9.975	10.389	11.188	14.186	11.341	10.463	10.962	14.891
Portugal	15.316	17.028	21.053	24.609	15.222	17.328	21.495	21.804
Romania	5.740	5.659	:	5.259	6.504	5.776	:	6.402
Slovakia	4.606	:	45.709	:	5.450	:	11.539	:
Slovenia	:	:	:	3.005	:	:	:	4.061
Spain	19.789	20.227	11.556	15.815	24.437	24.460	16.725	23.734
Sweden	28.775	27.978	27.433	32.842	40.889	41.549	41.730	52.242
United Kingdom	92.107	99.466	94.377	104.722	141.637	145.437	140.116	165.648
EU27 TOTALS	**5.526**	**6.320**	**4.796**	**4.955**	**9.023**	**10.744**	**8.629**	**9.882**

Table 6: European export data of fresh bread (Source: Prodcom)

	Export quantity (tons)				Export value (1000 Euro)			
	2009	2010	2011	2012	2009	2010	2011	2012
Austria	12.787	13.963	16.951	11.214	24.711	26.195	26.967	22.505
Belgium	60.747	65.264	66.046	60.072	79.941	84.132	89.406	86.959
Bulgaria	556	429	792	1.258	855	462	840	1.523
Cyprus	:	17	28	28	:	39	62	64
Czech Republic	3.465	5.550	6.734	6.401	3.746	6.065	8.095	8.718
Denmark	26.424	18.785	13.578	12.822	35.090	24.485	20.565	19.413
Estonia	6.463	:	11.157	14.373	4.634	:	11.220	15.868
Finland	1.959	2.323	2.827	3.242	3.376	4.041	4.563	5.457
France	181.013	207.224	215.473	228.778	205.910	230.044	253.928	272.290
Germany	206.279	220.403	231.833	247.742	210.441	226.402	263.150	297.654
Greece	239	449	503	386	448	369	644	593
Hungary	1.394	5.411	5.841	3.437	1.293	4.444	4.861	2.688
Ireland	:	5.187	4.724	14.194	:	7.351	7.261	20.280
Italy	13.024	13.628	16.704	17.915	32.642	35.349	41.770	46.501
Latvia	3.048	3.774	4.738	5.212	2.398	2.589	3.803	4.099
Lituania	8.692	7.973	7.483	8.015	8.523	7.484	7.908	9.188
Luxemburg	6.149	11.400	14.299	15.535	12.822	17.065	21.834	26.828
Malta	20	:	:	:	0	:	:	:
Netherlands	38.611	28.465	26.987	44.604	43.633	38.562	41.129	59.968
Poland	9.296	10.356	16.857	29.092	9.613	12.874	19.684	33.449
Portugal	2.336	5.921	8.607	10.869	2.370	7.658	11.345	13.556
Romania	12	87	1.879	5.491	23	260	2.245	5.153
Slovakia	:	:	:	:	:	:	:	:
Slovenia	1.513	1.557	1.737	1.927	2.310	2.243	2.446	2.659
Spain	16.455	15.764	19.721	16.941	19.950	20.352	24.410	22.452
Sweden	12.034	14.177	19.616	26.847	18.583	24.312	36.876	52.179
United Kingdom	86.963	85.930	86.215	94.654	100.080	98.223	101.706	126.040
EU27 TOTALS	**64.221**	**77.596**	**84.069**	**97.979**	**94.699**	**108.012**	**123.831**	**149.997**

Table 7: European consumption and trade balance of fresh bread (Source: Prodcom)

	European consumption (tons)				Trade balance (1000 Euro)			
	2009	2010	2011	2012	2009	2010	2011	2012
Austria	357.692	369.537	401.556	431.843	704.129	730.075	766.826	798.044
Belgium	441.825	432.460	456.231	460.724	531.590	527.827	560.323	570.638
Bulgaria	357.616	351.229	n.a.	n.a.	147.319	145.108	n.a.	n.a.
Cyprus	n.a.	1.826	2.055	1.834	n.a.	- 3.007	- 3.775	- 3.413
Czech Republic	n.a.	n.a.	n.a.	584.905	n.a.	n.a.	n.a.	522.212
Denmark	275.302	262.245	231.709	258.854	350.170	311.604	282.046	267.430
Estonia	n.a.	n.a.	57.534	n.a.	n.a.	n.a.	71.399	n.a.
Finland	194.658	194.357	192.470	196.752	403.557	393.534	385.546	398.718
France	1.105.382	1.102.960	1.123.372	1.185.602	1.506.165	1.539.046	1.610.319	1.713.728
Germany	4.408.695	4.455.516	4.401.099	4.758.195	8.449.559	8.559.589	9.069.018	9.503.217
Greece	n.a.	70.065	n.a.	n.a.	n.a.	151.458	n.a.	n.a.
Hungary	327.052	n.a.	349.551	356.831	227.733	n.a.	278.840	275.200
Ireland	n.a.	610.058	413.005	369.900	n.a.	610.917	383.321	328.262
Italy	2.290.632	2.188.878	2.119.759	1.719.274	3.809.507	3.653.261	5.033.672	4.276.080
Latvia	96.490	90.183	n.a.	n.a.	85.852	75.611	n.a.	n.a.
Lituania	131.605	131.740	n.a.	120.068	120.996	111.693	n.a.	114.515
Luxemburg	170	- 4.098	n.a.	n.a.	1.215	5.498	n.a.	n.a.
Malta	679	n.a.	n.a.	n.a.	- 1.177	n.a.	n.a.	n.a.
Netherlands	n.a.	790.632	829.707	772.672	987.941	925.498	985.467	950.689
Poland	1.649.052	1.631.467	1.580.579	1.599.177	1.277.086	1.414.619	1.502.937	1.573.397
Portugal	265.687	250.645	262.553	556.586	364.221	345.347	349.884	605.719
Romania	811.641	807.550	n.a.	818.655	450.894	456.523	n.a.	499.968
Slovakia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Slovenia	n.a.	n.a.	n.a.	72.342	n.a.	n.a.	n.a.	110.007
Spain	1.483.085	1.365.313	1.415.771	1.468.381	2.131.449	1.986.225	2.126.663	2.153.403
Sweden	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
United Kingdom	2.602.134	2.895.082	2.646.791	2.866.329	2.862.407	3.113.907	2.995.930	3.512.879
EU27 TOTALS	19.494.899	19.753.728	19.321.691	19.791.484	26.546.087	27.098.317	29.279.017	29.806.291

According to the UK's Federation of Bakers[37] a study for the European Commission in 2010 found that bread consumption patterns differ widely within the EU but most countries have an average consumption of 50 kg of bread per person per year. Bread consumption in Western Europe is stable although it varies greatly between countries. The Germans and Austrians eat the most bread at around 80 kg while the UK and Ireland are at the bottom of the list with annual consumption of less than 50 kg.

[37] Source: http://www.bakersfederation.org.uk/the-bread-industry/industry-facts/european-bread-market.html

3.1.2 Market structure

The market structure of bakeries is mainly dominated by craft bakeries on the one hand and plant bakeries on the other hand.
According to UK's Federation of Bakers[38] craft bakers bake bread and bakery products on their own premises, whereas industrial or plant bakeries produce mainly wrapped bread on a large scale. Most (but not all) plant manufacturers produce bread for sale under retailer labels — including convenience stores and major multiple retailers — as well as their own branded breads.
According to UK's Federation of Bakers, across the whole of the European countries the market share of the industrial bakers vs. the craft bakers was approximately 50:50 but there were great differences in different countries. For example in the UK the industrial sector representing 80% of production, it is 40% in Germany, 35% in France, about 81% in the Netherlands and 19% in Spain. In total there are approximately 1,000 plant bakeries in Europe where the highest market share is in countries such as Bulgaria, Netherlands and the UK followed by Finland. In Turkey and Greece with a long tradition for fresh bread, the market share of plant bakeries is very low at around 1 – 3 %.

Information presented by Bakery Performance[39] even states that in 2012, 66% of all bakery products were produced by industry – a level expected to rise to 69% by 2016. Of these, 32% are pre-packed, long-life products, 19% fresh finished and 15% bake-off. Especially in Eastern Europe, pre-packed bread becomes an important focus segment, largely driven by the rise of supermarkets, which are gradually replacing small grocers and kiosks.

Finally, areas of continuing growth throughout Europe are the increased use of frozen dough and part-baked products which has transformed the market so that co-operatives and industrial baking companies are flourishing, taking market share mostly from artisan products (baked from scratch), but also from fresh industrial bread with a one to two-day shelf life.
More and more supermarkets invest in their own baking facilities, so called In-Store Bakeries (ISB). There are two methods for ISBs: (a) scratch bakery using raw ingredients or (b) bake-off using dough which is part-baked and frozen. Most plant bakers supply ISBs with their own part-baked and frozen products, but many of the larger ISBs now have scratch bakeries making bread fresh from raw ingredients.
In store bakeries continue to be a growing sector. For example, in the UK supermarket in-store bakeries produce around 13% of the bread, with craft bakeries 7% and the remaining 80% produced by industrial bakers.

[38] Source: http://www.bakersfederation.org.uk/the-bread-industry/about-the-bread-industry.html
[39] Source: http://www.bakeryperformance.com/2013/06/03/gira/

3.2 Consumer expenditure

Cosumer prices for fresh bread depend on costs of raw materials, energy and transports. In recent years, these prices have been rising. For example, the costs of raw materials like wheat also strongly depend on the harvest results. Extreme weather events like droughts or floods, but also higher costs for energy lead to increasing prices for bread products.
On the other hand, changes in the market and production structure like trends to industrial bakeries, increased use of frozen dough and part-baked products as well as self-service baker's shops with only few personnel are reasons for low-priced products being offered to the end-consumer.

The average price of fresh bread not only depends on regional differences within European Member States, but also on the different product types available and the type of retailer (e.g. craft bakery, SB-supermarket, or discounter). For example, Handelsdaten[40] provides examples for average consumer prices for different bread types in Germany in 2011.

Table 8: Average consumer prices for different bread types in Germany in 2011 in Euro/kg (Source: Handelsdaten)

Bread types	Total	Craft bakeries	SB-supermarkets	Discounter A	Discounter B
Baguette total	3,58	3,85	3,28	2,76	3,20
Baguette (Others)	3,94	4,13	3,66	2,98	3,56
Baguette (white bread)	3,32	3,63	2,87	2,70	3,16
Ciabatta	3,71	4,22	2,74	3,31	3,24
Spelt bread	3,78	3,84	3,69	3,26	2,30
Pitta bread	2,09	2,56	1,87	1,93	1,61
Mixed bread types	2,96	3,98	3,38	2,97	
Brown bread	2,45	2,69	1,45	2,08	1,10
Wholewheat seedloaf	2,47	3,20	2,16	1,98	1,44
Rye bread	2,31	2,73	1,57	2,00	0,78
Black bread	2,60	2,88	1,42	1,94	1,27
Toast/Sandwich	1,38	2,12	1,44	1,23	1,21
Wholemeal bread	2,25	3,24	2,17	1,56	1,24
White bread	2,44	3,27	1,77	1,78	1,25
Bread total	2,11	2,91	1,69	1,45	1,23

4 Users

4.1 Product choice

In Europe, generally a great variety of bread types exists (see also section 5.1.2). The consumer preferences, however, differ widely between the European Memberstates[41]. For example, in Denmark

[40] Source: http://www.handelsdaten.de/statistik/daten/studie/245341/umfrage/
[41] Source: http://en.wikipedia.org/wiki/Bread_in_Europe

consumption, to a great extent, has switched from rye bread to wheat bread. In France, the standard bread is in the form of baguettes or thicker breads. In Germany, having the largest variety of breads worldwide, the popularity of kinds of bread is as following: mixed bread (wheat and rye) 31.8 %, toast bread 21.6 %, bread with grains and seeds 14.8 %, brown bread 11.5 %. Finland has dark sourdough breads made of rye. Traditional Finnish rye bread is disc-shaped, with a hole in the center for easier storing. These breads have a rougher composition and a stronger taste than wheat bread, and can thus be stored for longer periods of time. Italy specializes in many different kinds of bread, reflecting its great regional variation and widely different breadmaking recipes and traditions. Bread often has a small quantity of olive oil, butter, or rendered lard mixed into the dough to make it softer and more palatable. In Scandinavian and Nordic countries, older grain types such as emmer and spelt are once again being cultivated and new bread types are being developed from these grains. In Sweden, wholegrain bread and wheat bread are the most popular. Many older bread types still exist alongside the newer varieties. The traditional Spanish pan is a long loaf of bread, similar to the French baguette but wider.

According to the UK's Federation of Bakers[37], there continues to be increased demand for greater variety of bread than ever with ethnic breads becoming more popular in the UK and greater varieties of wholemeal breads with oats, bran, seeds etc. On the other hand, there is also a growing trend for increased production of sliced and wrapped bread in many countries across Europe including Germany and France.

The bread market worldwide is witnessing a gradual shift towards healthy bread varieties such as brown bread, whole wheat bread, and multi grain[42].

Health trends will continue with wholegrain, fibre and omega 3 all being important contributors. There will be a continued decrease in bread consumption as alternative foods and bakery type products are increasingly available. Consumers are interested in natural, convenience and indulgence and growing out of home consumption meaning less time spent on home food preparation and consumption[43]. It is anticipated that in the coming years, artisanal bread product sales will decline as packaged bread sales increase. Consumers are looking for convenience, and packaged products have a longer shelf life, which will allow consumers to shop just once a week[44].

4.2 Food waste

For example, in the United Kingdom a study commissioned by WRAP (2008)[45] shows that domestic households threw away 328,000 tonnes per year of bread slices, 86,000 tonnes per year of bread rolls / baguettes, and 75,000 tonnes per year of bread loaves. A significant number of bakery items are thrown away unused or untouched. In numbers of units, 775 million bread rolls and nearly 70 million whole loaves of bread are thrown away each year in the UK. Although not purchased as a single unit, 2.6 billion slices of bread are thrown away each year in the UK.

Figure 1 shows the reasons for throwing away bread are for example: being out of date 29%, looking bad 21%, becoming mouldy 20%, or plate leftover 15% (source: Wrap 2008)[45].

[42] Source: http://www.perishablenews.com/index.php?article=0030213

[43] Source: http://www.bakeryperformance.com/2012/06/25/bake-off-is-a-growth-sector-in-europes-bakery-market/?utm_source=danisco&utm_medium=article-bakery&utm_campaign=industry-article

[44] Source: http://www.gov.mb.ca/agriculture/statistics/agri-food/germany_bakery_products_en.pdf

[45] Source: https://www.ns.is/ns/upload/files/pdf-skrar/matarskyrsla1.pdf

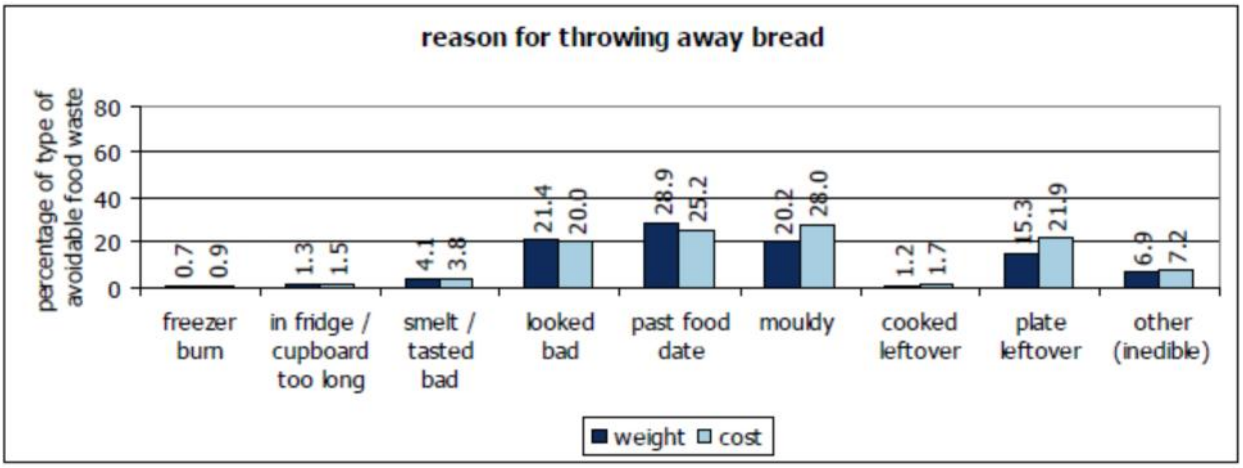


Figure 1: Reasons for throwing away avoidable bread waste in UK (Source: WRAP 2008)

Much of the food thrown away could have been avoided and with better management could have been eaten or used, see Table 9. For example, more than 177,000 tonnes of bread are thrown away every year in the UK households for the reason of being past food date.

Table 9: The proportion and annual tonnage of avoidable bread waste by reason stated (Source: WRAP 2008)

Stated reason for disposal	Weight of avoidable bread waste	Weight (tonnes per year)
Avoidable bread waste	100% (15% of avoidable food waste)	613,500
Past food date	28.9%	177,300
Looked bad	21.4%	131,300
Mouldy	20.2%	123,900
Plate leftover	15.3%	93,900
Other (inedible)	6.9%	42,300
Smelt / tasted bad	4.1%	25,200
In fridge / cupboard too long	1.3%	8,000
Cooked leftover	1.2%	7,400
Freezer burn	0.7%	4,300

Other consumer-related factors influencing the amount of wasted fresh bread, are for example[46]:

> a lack of awareness and knowledge (e.g. recipes to reemploy leftover bread in other, mostly traditional dishes as for example “panzanella” in Italy),

> planning issues (e.g. buying too much due to low cost of food products, promotional sales by retailers as “two-for-one” etc.),

> personal preferences by consumers (e.g. not liking bread crusts or products being bought for the first time), or

> attitudes (e.g. undervaluing of food resources by consumers based on its low market value; preparing more food for a meal than can be eaten as being customary to have leftover food).

[46] Source: http://ec.europa.eu/environment/eussd/pdf/bio_foodwaste_report.pdf

5 Products

5.1 Products

5.1.1 Ingredients of bread

According to the UK Federation of Bakers[47], the basic ingredients are flour, yeast, salt and water. Wheat flour is the key ingredient in most bread. Flour quality is particularly important in bread-making as the quality of the flour will have a significant impact on the finished product. When flour is moistened and stirred, beaten or kneaded, gluten develops to give dough 'stretch'. The elastic framework of gluten holds the gas produced by the fermentation action of yeast.
Yeast requires moisture, food and warmth for growth. Its function in breadmaking is to produce carbon dioxide gas to enable the dough to rise; expand the dough's cellular network to form bread crumb; and give bread its characteristic flavour and aroma.
Salt is an essential ingredient in bread used in very small amounts to give bread its flavour. It also helps to strengthen the gluten and help fermentation to produce bread of good volume and texture.
Water is used to produce the dough. It is important that the correct quantity of water is used when making bread because it affects the dispersal of the other ingredients.
Further ingredients might be combined into so-called 'bread improvers'; these are easily dispensable blends of key minor functional ingredients (such as fat, flour treatment agents, emulsifiers, enzymes, soya) required to enhance ("improve") the flour.

Additional to these basic ingredients, a great variety of wholemeal breads is provided with other types of grain as rye, barley, spelt, oats, millet, corn or rice. Some bread is even made with potato starch flour. Other ingredients are for example bran, seeds, nuts, etc.

5.1.2 Different types of bread

According to Key Note Ltd.[48], the bread sector can be divided into three general segments: white bread; brown and wholemeal bread; and ethnic and speciality bread. The division between white and brown/wholemeal is based on flour type:

- White bread is made from flour, that contains only the endosperm, or central section, of the grain (approximately 75% of the whole grain)
- Brown bread is made from flour representing approximately 85% of the whole grain, containing a crude fibre content derived from wheat of no less than 0.6%, and with an ingredient flour other than wholemeal
- Wholemeal bread is made from the entire wheat grain, with nothing removed.

Further to these general bread types, there are quite a lot of different ethnic and speciality breads from continental Europe and further afield, including the Middle East and Asia made with a variety of different flours and methods, such as for example:

- naan — a white-flour bread, lightly leavened by a natural yeast starter developed from airborne yeasts

[47] Source: http://www.bakersfederation.org.uk/images/pdfs/media-and-resources/how-bread-is-made.pdf
[48] Source: http://www.just-food.com/store/samples/46491.pdf

- pitta — a flat bread from Greece and the Middle East; it is generally made from white flour, but is available in wholemeal variants, is usually oval in shape, and can form a pocket for fillings
- focaccia — a light, soft Italian bread made from white flour with olive oil, and often with added flavourings, such as garlic, herbs, olives or sun-dried tomatoes
- ciabatta — a flat, crusty white Italian bread, made with virgin olive oil and with large holes in the dough
- baguette — a long white crusty baton loaf (also known as a French stick) made with special flour, it has a very short shelf life because it goes stale very quickly
- cholla — a braided Jewish loaf traditionally eaten on the Sabbath and at festival times, enriched with butter and eggs to give a creamy coloured crumb and a very fine texture.

Especially Germany is well-known for its bread variety: About 600 main types of breads and 1,200 different types of pastries and rolls are produced[49]. Germany's most popular breads are:

1. Rye-wheat ("Roggenmischbrot"), >50% but <90% rye flour;
2. Toast bread ("Toastbrot"); ≥90% wheat flour;
3. Whole-grain ("Vollkornbrot"); ≥90% rye and wheat whole grains at any mixing ratio; the added amount of sourness is at least made of two thirds of sourdough;
4. Wheat-rye ("Weizenmischbrot"); >50% but <90% wheat flour;
5. White bread ("Weißbrot"), ≥90% wheat flour;
6. Multigrain, usually wheat-rye-oats with sesame or linseed ("Mehrkornbrot"); one type of grain plus at least another type of grain, together three or more different types of grains; each type of grain has at least 5%
7. Rye ("Roggenbrot"); ≥90% rye flour;
8. Sunflower seeds in dark rye bread ("Sonnenblumenkernbrot")
9. Pumpkin seeds in dark rye bread ("Kürbiskernbrot")
10. Roasted onions in light wheat-rye bread ("Zwiebelbrot")

The specific characteristics of each type of bread are derived from the German guiding principles for bread and small bakery wares[50].

5.2 Production methods

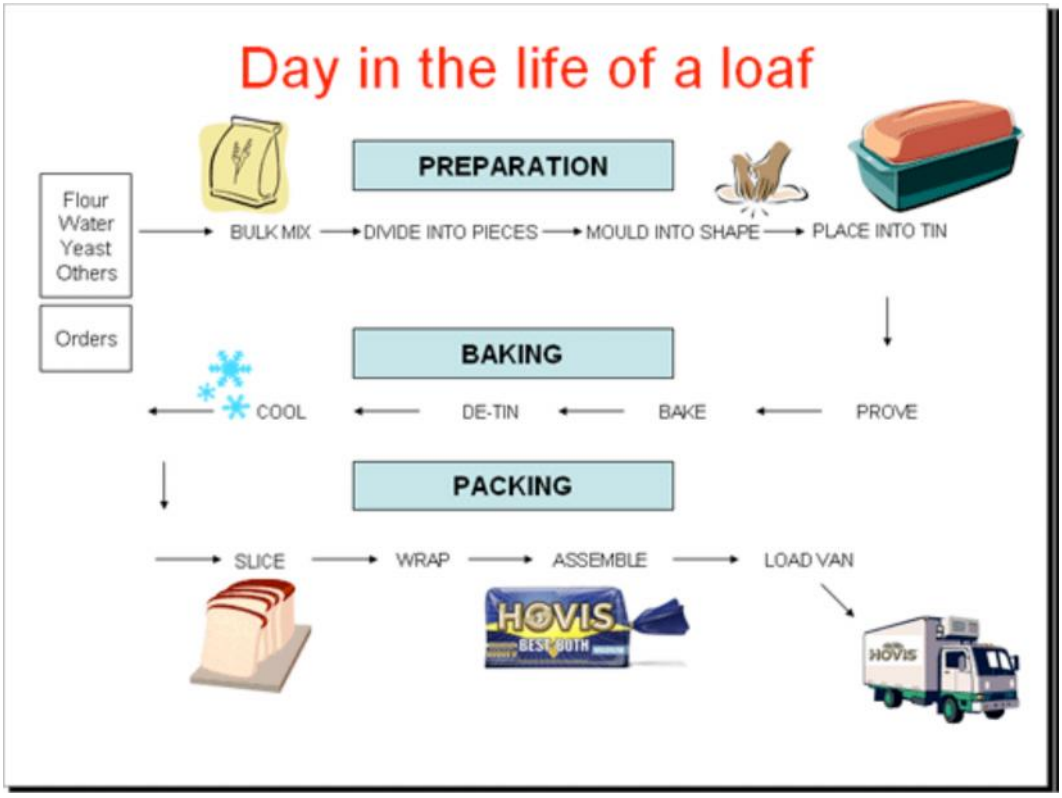
5.2.1 General bread making process

According to the UK's Federation of Bakers[51], all bread making processes generally rely on four key steps (see also Figure 2):

1. Mixing ingredients
2. Proving/Fermenting
3. Baking
4. Cooling

Figure 2: Different steps of an industrial bread making process (source: UK's Federation of Bakers)

[49] Source: http://en.wikipedia.org/wiki/German_cuisine
[50] Source: http://www.bmelv.de/cae/servlet/contentblob/379754/publicationFile/22005/LeitsaetzeBrot.pdf
[51] Source: http://www.bakersfederation.org.uk/images/pdfs/media-and-resources/how-bread-is-made.pdf



Most modern commercial breadmaking processes differ mainly in their dough making stages; dividing, moulding, proving, baking and cooling are similar throughout. Depending on the production process (artisanal or industry) and the end product, some of the final sub-steps like slicing or packaging might not apply.

There are two main methods of making bread[51]:

- Bulk Fermentation Process (BFP): is a traditional method. Ingredients are mixed together to form a dough and left to ferment for up to three hours. During fermentation the dough changes from a short dense mass into an elastic dough. The time taken to reach this state largely depends on the amount of yeast and the dough temperature.
- Chorleywood Bread Process (CBP): The modern commercial process used in large bakeries is known as the Chorleywood Bread Process. CBP uses mechanical energy in the form of high speed mixing to develop the dough for proving and baking. It is essentially a rapid form of kneading helping to develop the gluten (protein) structure within the dough (this means that the lengthy bulk fermentation of traditional processes is not needed). To achieve this, a flour treatment agent (ascorbic acid) and a little fat or emulsifier need to be added; these are usually combined in a bread improver.

Other methods of bread making include:

- Activated Dough Development (ADD): A special improver is added to the other ingredients in order to develop the dough in a shorter time.
- Straight Dough Method: this is a variant of the BFP which consists of only one step; combine all the ingredients together at the same time, immediately knead the dough until the gluten is properly formed, let it rise until doubled, shape it, let it double in size again, then bake it.

- Delayed Salt Method: this is a slight variation of the straight dough method, where all the ingredients are mixed except salt and fat. As salt has a controlling action on the yeast function, the speed of fermentation of a salt-free dough will be faster and a reduction in the fermentation time is affected. The salt is then added at the knock-back stage.
- Sponge and Dough Process (S&D): this is a two-step bread making process; in the first step a sponge is made and allowed to ferment for a period of time, and in the second step the sponge is added to the rest of the ingredients to produce the final dough.
- Ferment Dough Process – this process is a variation of the sponge and dough method and is used mainly for the manufacture of enriched doughs for small baked goods. Rich doughs which contain milk, eggs, substantial amounts of fat and sugar, have a retarding effect on yeast activity and this method allows the yeast to begin actively fermenting before it is mixed into a sugar enriched dough.

5.2.2 Bake-off technology

Bake off technology consists in producing bread from industrial refrigerated or frozen or non frozen bakery goods and retailing them to the bakery shops and supermarkets for the final baking.
This process requires some specifica regarding the raw materials and production steps[52]:

- Frozend dough: Ingredients like flour, yeast and others have to be applicable to the freezing and thawing processes to provide a good quality of the end product. The production process includes another process step: After mixing, the dough is divided, kneaded, rounded, sheeted, rolled and then transported to a freezer. Then the product is transferred from the freezer to the truck and then to the bakery, where the thawing, proving and baking process takes place.
- Partially baked bread: Bread from partially baked is made following the conventional processwith the exception of baking. The partial baking or interrupted baking method consists in baking the bread dough till the structure is fixed. In general, the optimum prebaking time is approximately two thirds of the time required for full baking. The most extended practice is to keep the partially baked bread frozen during the storage period up to its final baking. In the retail bakery the partially baked bread is only finally baked for a very short time.

6 Environmental Impact

This section presents an overview of existing LCA and PCF studies. They were analysed to identify environmental hot spots in the life cycle of bread and potential optimisation strategies for the products and processes which could be a basis for developing ecodesign and labelling requirements for the product category “fresh bread”.
However, in the context of a limited case study, is has to be clarified that a direct comparison of the study results is not possible due to their different goals, scopes (functional unit, system boundaries), methodologies, time related coverage, impact categories etc. Thus, the findings on environmental hot

[52] Source: http://digital.csic.es/bitstream/10261/31053/1/Food%20Reviews%20International-2007-23-303-319.pdf

spots could only be a first orientation. To confirm the results, further in-depth research would be needed.

6.1 Overview of Life Cycle Analysis studies on bread

In a first step, relevant literature regarding the environmental assessment and improvement potential of bread has been identified and analysed regarding their robustness of the results (methodology, data quality, age etc.), see Table 10.

Most of the identified life cycle analysis studies have generally defined “bread” as the scope. Sometimes, that implies “fresh bread” (Wiegmann 2000, Lindenthal et al. / FIBL 2009 and Reinhardt et al. / IFEU 2009), “prepacked bread” (Espinoza-Orias et al. 2011) and in some cases it is not clear which kind of bread content of the study is (Andersson et al. 1999).
Nevertheless, all studies have been analysed as the bread making processes and the potential to optimise are comparable and representative. The represented studies ensure reliability because information on data quality is provided by the study authors or they were even externally critical reviewed. Furthermore they base on a comprehensive LCA methodology as for example PAS 2050 or ISO 14044f.
The total life cycle of the production process of bread implies: agriculture and production of raw materials, milling of the grain, dough production, baking, packaging, distribution, retail, storage and preparation at the consumers’ homes, as well as end of life treatment of the packaging and food waste. These stages of the life cycle are associated with different environmental impacts of more or less importance.
The existing analysis focuses on the production of bread from the agricultural processes up to the bakery with a strong focus on energy consumption and climate change implications.

Table 10: Overview of existing LCA and PCF studies on bread analysed within the case study

Source	Title	Subject of the study	Functional unit	System boundary	Time related coverage	Study type	Reliability / Data quality	Notes	Hotspot
Espinoza-Orias 2011	The carbon footprint of bread	Sliced white and wholemeal bread	One loaf of sliced bread (800g) consumed at home (prepacked bread)	The complete life cycle	Not specified	PCF	Primary data are compliant with PAS 2050; Methodology: ISO 14044 compliant	Wheat from UK, Canada, France, Germany, Spain, USA	Agriculture
Reinhardt et al. /IFEU 2009	Ökologische Optimierung regional erzeugter Lebensmittel: Energie- und Klimagasbilanzen	Ecological valuation of different foods	1kg of wheat bread (fresh bread)	The complete life cycle	2009	LCA	Secondary data	Comparison of conventional and organic wheat production, small bakery vs. industrial bakery (processing, packaging, distribution)	Agriculture and Processing (depends on the bakery)
Lindenthal et al./FIBL 2009	Klimabilanz biologischer und konventioneller Lebensmittel im Vergleich	Wheat bread, baguette, bread rolls	1 kg of bread / baguette packed (fresh bread)	The complete life cycle	Not specified	PCF	Not specified	Comparison of conventional and ecological wheat production, small bakery vs. industrial bakery	Agriculture and Processing (depends on the wheat and the bakery)
LCA Food Database 2003	Bread	Wheat bread, bread rolls, rye bread	Wheat bread 175g, rye bread 500g, bread rolls 60g	The complete life cycle	1999	LCA		Comparison of rolls, wheat bread (fresh and frozen) and rye bread (fresh)	
Wiegmann 2000	Unser täglich Brot unter der Lupe	Comparison of bread production systems	1kg mixed wheat bread (fresh bread)	raw materials, processing, distribution	Not specified	LCA	Secondary data	Comparison of manual production (organic grain) and baking mixture in a bakery and baking at home	
Kingsmill 2013	Kingsmill and the Environment	Carbon Footprint of loaves	Soft white 1kg, Tasty wholemeal 950g, 50:50 1kg	The complete life cycle	Not specified	PCF			Agriculture
Andersson 1999	Life cycle assessment of bread produced on different scales	Comparison of industrial bakeries, local bakery and home baking of white bread	1kg of bread ready for consumtption	The complete life cycle	Not specified	LCA	Primary and secondary data	Comparison of a large and a small industrial bakery, a local bakery and home baking	Agriculture

6.2 Environmental hot spots in the life cycle of bread

With regard to environmental impacts[53] of bread production according to all analysed studies the stages with the most important impacts in the product life cycle are:
> the baking processes (37 - 57%) and
> the agriculture (26 - 49%).

The variations of the results are due to different scopes of the studies, e.g. different production systems and sizes as well as underlying methodologies. For example, Espinoza-Orias et al. 2011 analysed the influence of the assumed methodology and the data sources. It shows a difference in the results of up to 12% between the methodology PAS 2050, based on primary data, and ISO 14044 based on secondary data with higher results in all cases and scenarios for the first one.
In this context it is also important to emphasise that not only the energy and greenhouse gas balances of bread production should be analysed but also other environmental impacts as for example water use to identify the whole ecological effects and to be able to value the life cycle (Reinhardt et al. / IFEU 2009). PAS 2050 requires the inclusion of any land use change that occurred over the last 20 years relative to the base year of the study (Clause 5.5). In the case of bread, this would be referring to the land use change for wheat cultivation that occurred after 1990. However, wit regard to the countries from which European countries are sourcing the wheat, it has been assumed that no land change occurred after this date (Espinoza-Orias et al. 2011).

6.2.1 Agriculture

The comparison between organic and conventional grain farming is the subject of three of the analysed studies: Lindenthal et al. / FIBL 2009, Reinhardt et al. / IFEU 2009 and Andersson et al. 1999. All of these studies emphasize the reduction potential of the greenhouse gas emissions by using raw materials of organic agriculture. Lindenthal et al. / FIBL 2009 demonstrate a reduction potential of 22 to 25 percent. However, besides greenhouse gas emissions, other impact categories such as for example acidification or eutrophation potential have to be analysed to assess the overall environmental impact of and differences between organic and conventional bread quantitatively.
For example, according to Foster et al./Defra 2006, for bread wheat, organic production is associated with much higher eutrophication impacts than conventional production. Lower total emissions of nitrogen oxides and phosphates are more than offset by higher ammonia losses. On the other hand, organic wheat production has significantly lower energy requirements than conventional production. In the case of conventional production, the major primary energy inputs to the system are associated with fertiliser and pesticide production which is significantly lower (fertiliser) or not applicable (pesticides) in the case of organic production. Finally, however, organic wheat production requires more land to produce the same amount of grain compared to conventional grain farming.

The type of grain respectively of the flour has also an impact on the environmental impact. As for white flour the grain has to be grinded more intensively than for wholemeal flour, the energy consumption for wheat milling is for white bread (0.059 kWh / loaf) higher than for wholemeal bread (0.048 kWh / loaf). That implies that the type of flour has a more significant contribution to the carbon footprint than the provenance of wheat: the carbon footprint of wholemeal bread is in the study Espinoza-Orias et al.

[53] here: greenhouse gas potential, but ome studies shows that it is for the other impact categories similar.

2011 about 6.5% lower than that of white bread; by comparison, the source of wheat in the worst case increases the carbon footprint of bread only by 4% (Espinoza-Orias et al. 2011).

6.2.2 Production process

Three of the analyzied studies (Wiegmann 2000, Andersson et al. 1999, Reinhardt et al. / IFEU 2009) compare different production systems and sizes: large industrial bakeries, small industrial bakeries, local/artisanal/individual bakeries. All of the studies conclude that the larger production systems are the most efficient ones and that the baking process of small bakeries is more energy intensive.
This concerns the baking as well as the milling process. It affects not only energy but other inputs such as water. Reinhardt et al. / IFEU 2009, comparing the results of an industrial and a small bakery, conclude that the industrial bakery has 50% less demand than the small bakery.

6.2.3 Distribution and packaging

The contribution of transports and packaging to the overall environmental impacts of bread is small[54].
To reduce the emissions of transportation the distances between the places of the agricultural cultivation, milling, the bakery and the retail should be as short as possible.

6.2.4 Consumer behaviour

The consumer behaviour - purchasing, storage and disposal - has also an influence on the environmental impacts of bread.
Regarding the purchasing the means of transport (by car, bus, or on foot), the amount of goods and the frequency of shopping is decisive (Reinhardt et al. / IFEU 2009).
By reducing the amount of waste bread discarded by consumers – caused for example by an incorrect storage or bad buy; for more details, see also section 4.2 – the product carbon footprint could be reduced by 5 – 10%. Also the size of the bread loaf plays a role, particularly with respect to waste - the larger the bread, the less likely it is that it will be eaten before it is spoiled, thus leading to an estimated 30% wastage. In the study of Espinoza-Orias et al. 2011, a 10% waste of bread has been assumed. If for example a value of 30% would be taken instead, the carbon footprint for all types of bread would increase by 10 – 12%. One solution to avoid this might be to work towards consumers buying smaller bread sizes (Espinoza-Orias et al. 2011).

6.3 Improvement potential of the production process of bread

To improve the environmental impact of the bread production the analysed studies provide some recommendations for different stages of the life cycle.
For example, Wiegmann 2000 suggests the use of gas ovens with climate control. Their energy saving potential amounts up to 35%. The study also advises a reduction of transport distances and the use of organic ingredients.

[54] Exeption: transportation by flight. They are combined with very high environmental impacts (Havers 2008). But in the case of bread (transport of raw materials and delivery of the bread) it is irrelevant.

Reinhardt et al. / IFEU 2009 suggest the replacement of energy intensive with energy efficient equipment. They analysed when using ovens which use the rest heat and exhaust heat, the energy demand could be reduced up to 25%. This should be supported by improving the baking process e.g with the use of the full capacities of the ovens. They further emphasize the use of a narrow distribution network to reduce environmental impacts (Reinhardt et al. / IFEU 2009).

7 Product Design Options

The previous sections provide different starting points for product related design options to improve the environmental impact of fresh bread.

7.1 Organic bread

The general principles of organic food production concern, inter alia, specific production methods, the use of natural resources and stringent restrictions on synthetic chemical inputs. Furthermore, the Regulation 834/2007 of 28 June 2007 on organic production and labelling of organic products lays down specific principles concerning farming, and the processing of organic food. Organic plant production must comply with certain rules concerning:

- ground treatment, which must preserve life and the natural fertility of the ground;
- the prevention of damage, which must be based on natural methods but which can make use of a limited number of plant protection products authorised by the Commission;
- seed and plant propagation material, which must be produced using organic methods.

According to the general rules for organic production, genetically modified organisms (GMOs) are prohibited in all their forms.
The Commission authorises the use of a limited number of products and substances in organic farming, e.g. for plant care. The Commission may also set certain limits and conditions for the application of these products.

Organic processed food, such as fresh bread, must contain organic raw materials and may not be processed using chemical solvents. Processed food must contain mainly ingredients of agricultural origin. Other ingredients are permitted if authorisation has been requested from the Commission. Organic yeast, relevant ingredient of fresh bread, must be produced from organic substrates and other authorised ingredients.

As outlined in section 6.2.1, there is a significant reduction potential of the greenhouse gas emissions of fresh bread when using raw materials of organic agriculture. However, existing LCA studies on bread provide only limited comparable results due to their different scopes, methodologies, geography and time related coverage.

To derive specific improvement options for the production of bread and product related design and policy options, the overall environmental impacts including other impacts such as acidification, eutrophication or land requirements, of fresh bread have to be analysed more in-depth (see also section 8.2.1).

7.2 Prolonged product shelf life

As outlined in sections 4.2 and 6.2.4, the wastage of fresh bread has a large environmental impact. The most relevant reasons were the bread being out of date, looking bad or becoming mouldy. To overcome this effect, the bread baking industry increasingly uses certain enzymes that prolong the freshness of bread for example by up to 15 days.

According to Baking Business[55], the past two decades experienced an increase in enzyme use in all baked foods. Enzymes are naturally occurring components of many bakery ingredients. Adding more enzymes to a batter or dough, however, is seen as beneficial to maximize functionality in a specific application. Today, the primary reason bakers use enzymes is to foster longer shelf life. This is accomplished mainly by using specific amylases that alter the starch, resulting in a form that resists staling. Further, also phospholipases are used to achieve some anti-staling effect; they act on naturally occurring wheat lipids to generate an emulsifier that interacts with starch to slow the staling process. Bacterial xylanases convert water-insoluble wheat fiber into soluble fiber to give a hydrocolloid-like effect in the baked food helping to soften the crumb as well.

Applications are for example industrially produced toast, sandwich, and whole wheat bread. To what extent these design options are also being implemented to fresh bread not being industrially produced, would have to be analysed more in-depth in a context beyond this limited case study.

8 Policy Analysis

8.1 Ecodesign measures

8.1.1 Production process – ovens used in bakeries

According to section 6.2, the baking process of fresh bread has high environmental impacts with regard to the energy use. A preparatory study on Ecodesign requirements for domestic and commercial ovens (DG Energy, Lot 22) has been finished including defining a number of different sub-categories for electric and non-electric commercial ovens used in bakeries, but excluding industrial ovens for food production.
Task 8 on the scenario and policy analysis[56] provides policy recommendations with regard to ovens used in bakeries. This includes Ovens designed exclusively for the cooking of bread, cakes and pastries. It can receive the products to be cooked by an intermediate, fixed or rotating trolley in the cooking chamber, placed on sole plate or on grid shelf or on plates in the different cooking chambers of the oven (in case of sole plate oven).

[55] Source: http://www.bakingbusiness.com/News/News%20Home/Features/2013/3/Enzymes%20help%20bakers%20bake%20faster%20and%20better.aspx?cck=1
[56] See: http://www.eup-network.de/fileadmin/user_upload/Produktgruppen/Lots/Final_Documents/Lot22_Task8_Final.pdf

Generic ecodesign measures for bakery ovens proposed by the preparatory study are:

- Users should be encouraged to use their oven at full-load.
- Users should be warned about the energy consumed to maintain temperature between two baking cycles.
- Recommendations regarding maintenance should be complemented by information on the influence of maintenance on energy efficiency.

Specific ecodesign measures for bakery ovens proposed by the preparatory study are proposals for Minimum Energy Performance Standards (MEPS) for different types of appliances, however stating that to date, no EN standard for measuring the energy consumption of commercial bakery ovens exists, thus the relationship between capacity and energy consumption could not be measured so far. Once, a European standard for measuring the energy efficiency of commercial appliances is available, it would also be possible to make compulsory for manufacturers to inform users about how much energy their product is consuming according to this standard.

The draft regulation under the Ecodesign Directive on these product groups, however, only focussed on domestic ovens; commercial ovens as used in bakeries are not within the scope of the Ecodesign regulation.

8.2 Labelling measures

8.2.1 Labelling of the Product Carbon Footprint (PCF)

The term 'carbon footprint' has become tremendously popular over the last few years. A variety of different CO_2 or climate protection labels partly tailored to certain product groups is meanwhile available at the international level – e.g. Carbon Reduction Label/UK; Carrefour Initiative (France), Stop Climate Change Label/Germany; KRAV Climate Marking Sweden (KRAV Sweden); Climatop-Migros Switzerland, Carbon Label Initiatives or programs in Japan (Japan Environmental Management Association for Industry), Korea (Korea Eco-Products Institute), Thailand (Thailand Greenhouse Gas Management Organization). Interestingly, the main focus lies on foods although individual foods are clearly less relevant to the climate than other product groups, i.e. household appliances or automobiles.

With climate change high up on the political and corporate agenda, carbon footprint calculations are in strong demand. Nevertheless the focus on CO_2-emissions does not only provide possibilities, but also bears some risks that might as well weaken environmental labelling approaches in the future. In a study for ANEC, the European consumer voice in standardisation, Oeko-Institut has recently analysed Requirements on Consumer Information about Product Carbon Footprint[57] with the following results, also being applicable for a possible labelling PCF measure related to fresh bread:

Other environmental effects should not be disregarded

The narrow approach to only focus on greenhouse gas emissions bears the risk to overlook other relevant environmental impacts or even lead to wrong conclusions that increase negative environmental effects in the worse case. Therefore screening analyses of other environmental impacts must be included in a PCF.

[57] See: http://www.anec.eu/attachments/anec-r&t-2010-env-001final.pdf

Drawing up of Product Category Rules for particularly relevant products is essential

The main challenge of PCF meant for communication is to define the whole framework in a way that all products belonging to one product group can be calculated as accurately as possible to assure the same approach even if the studies are performed by different experts. This requires e.g. the same goals, the same system boundaries, the same calculation rules and similar data quality for different studies. It essential for the future that product category rules (PCRs) will be developed that ensure a comparable proceeding within one product group. Such PCRs would have to be defined and adopted at the European level.

It is currently not possible to perform product comparisons of multiple products based on PCFs carried out on behalf of different clients and by different practitioners, or public comparison with competing products in ways that are acceptable under competition law (e.g. through reporting of CO_{2e} values or use of CO_{2e} labels).

Current CO_2 labels neglect consumer comprehensibility, benchmarks and indication of excellence

In order to be useful to consumers a CO_2 label would have to

- be comprehensible, e.g. by a well structured display, aggregation of the information, concentration on the gist. Additionally, have a standardised look thus enabling consumers to quickly comprehend the information, compare different products and include the information on the climate impact in their purchasing decision.
- include a rating scheme, enabling consumers to recognise if the products' Carbon Footprint represents a relatively low greenhouse gas emission for the respective product group or a relatively high emission. It must be possible for consumers to recognise excellent products. Only then an effective reduction of the climate impact due to "the right" purchasing decision can be achieved. Consumers are already well acquainted with the A-G labelling scheme of the EU energy label, so this could be a promising starting point.
- be third party certified. As credibility is of high importance for consumers, it is crucial that a third party review should be requested for the PCF when used in product-related communication.
- be backed-up by easy to access and transparent documentation of the PCF study the label is based on. This includes the motivation for calculating a PCF and assumptions and quantifiers used in the calculations. Any publication of the data must be clear, understandable, conclusive and open to scrutiny. It should be noted to what extent PCF calculations are reliable and/or uncertain and whether other important environmental impacts have been taken into consideration.

Single number CO_2 labels make no sense

A static PCF stand-alone label providing a total CO_2 footprint on products does not make sense and is not very relevant for consumer decision making. Although consumers are increasingly aware of the relevance of climate impacts resulting from their purchasing behaviour and usage of products, the display of a total CO_{2e} footprint figure alone would not be of much help to them. It has to be stressed that a figure of this kind suggests a precision and conclusiveness which cannot be achieved using the current state of methodology. At the current state with only few products being labelled this even bears the risk that the sheer display of such a label makes consumers believe that the product might be better than another one without a label.

8.2.2 Labelling of the Product Environmental Footprint (PEF)

Based on the limitations of Product Carbon Footprint (PCF) labels as outlined above, the labelling of the Product Environmental Footprint (PEF) would be another adequate step.
In its conclusion on the „Sustainable materials management and sustainable production and consumption" (December 2010), the European Council invited the Commission to „develop a common methodology on the quantitative assessment of environmental impacts of products, throughout their life-cycle, in order to support the assessment and labelling of products".[58]

On this basis, DG Environment together with the European Commission's Joint Research Centre (JRC IES) and other Commission services developed the environmental footprint methodology which is recommended to be used by Member States, companies, private organisations and the financial community.
According to DG Environment[59], a three-year testing period (EF European pilot phase) was launched with the following objectives:

- to set up and validate the process of the development of product group-specific rules in case of products (Product Environmental Footprint Category Rules – PEFCRs), including the development of performance benchmarks
- to test different compliance and verification systems, in order to set up and validate proportionate, effective and efficient compliance and verification systems
- to test different business-to-business and business-to-consumer communication vehicles for Product Environmental Footprint information in collaboration with stakeholders (individual companies, industrial associations or any other private, non-governmental or public organisation both from the EU and outside of the EU).

The PEFCRs resulting from the EF pilot phase will become the product rules valid under the PEF, to be used by all stakeholders in the sector in the EU or internationally who decide to measure the performance of their products based on PEF.

A second wave of pilots will be launched in the end of 2013 or early 2014 addressing food/feed/drink products. Reasonably, the outcomes of these pilot studies should be awaited before drafting further specific policy measures on food products such as fresh bread.

[58] Source: http://www.pef-world-forum.org/eu-environmental-footprinting/
[59] Source: http://ec.europa.eu/environment/eussd/smgp/product_footprint.htm

8.2.3 EU Ecolabel for food and feed

Besides the existing EU organic farming label, in 2010 a feasibility study[60] has been published with the following targets:

> To assess the feasibility of establishing reliable EU Ecolabel criteria covering the environmental performance of food, feed and drinks products throughout their whole lifecycle.
  - To assess the impact and the added value of establishing these EU Ecolabel criteria and implementing the scheme in the various sectors, and the impact this could have on organically certified products (including the risk of consumer confusion).
  - To evaluate the option of limiting the scope of the EU Ecolabel for food, feed and drinks products to organically certified products only.

The findings of the study, reduced to those being applicable also for bread, can be reflected as follows:

- Finding 1: The 'extraction of resources' or the primary production stage (e.g. agriculture) is responsible for most of the significant environmental impacts of food products over their lifecycle, although this can vary between product categories. However, impacts that are not easily measured (e.g. biodiversity loss, landscape pollution, soil fertility) cannot easily be included in a ranking of environmental impacts. The same is true for ethical or social issues (e.g. labour standards, fair producer prices).
- Finding 2: The extent of the environmental impact of food products in the "extraction of resources" stage of their lifecycle results from an interaction between the practice employed and the place where the practice takes place because of the use of physical elements (land, water etc). For a particular product, on a specific site employing specific production technologies the actual environmental impacts may differ significantly.
- Finding 3: The consultants of the study found a gap in the labelling landscape which may present an opportunity for an EU Ecolabel. Even though environmental impacts may vary between product categories and lifecycle stages, most labels currently only concentrate on the environmental impacts of primary production and not, or only to a limited extent, the processing lifecycle stage. Therefore a focus on highly processed products would play to the strength of the EU Ecolabel (its lifecycle approach) by covering the environmental impacts of processing, transport and consumption, while the environmental impacts of primary production could be dealt with by cooperating with existing sufficiently strict agri labelling schemes. However the risk of a switch from existing labels to an EU Ecolabel cannot be discounted and this may lead to no net environmental improvement if the criteria used are not significantly different.

[60] See: http://ec.europa.eu/environment/ecolabel/documents/Ecolabel_for_food_final_report.pdf

- Finding 4: Existing environmental food labels mainly employ input- or practice-based criteria, i.e. prescribing or banning certain defined practices in the production process. The disadvantages of such criteria are that they can lead to a shift of environmental burdens when practices or ingredients are substituted as well as hampering innovation. Output-based criteria can be more economically efficient and provide a transparent link with environmentally positive results. A number of initiatives are underway at the European level to develop environmental footprinting tools and multi-criteria methodologies and these may, in the future, provide the basis for developing more output based criteria for food products. They will not be without challenges, in terms of the cost of assessment and the need for co-operation and openness between market actors throughout the supply chain.
- Finding 5: A key finding from the consumer survey and workshop with stakeholders was that an environmental label for food products is expected to cover, not only environmental issues but also social and ethical issues such as fair remuneration for producers.
- Finding 6: In terms of implementing an EU Ecolabel for food, the complexity of developing criteria and then verifying compliance should not be underestimated, based on the experience of existing organic (EU) and non-organic food certification schemes (SMK). This would also require a level of expertise that is not currently present in the national competent bodies charged with the administration of the EU Ecolabel scheme. Furthermore the process of multicriteria assessment and verification is likely to be resource intensive. The costs involved could not be met from the current licence fees as these are limited by the EU Ecolabel Regulation. It is also important to recognise the costs of application, which may be particularly burdensome for SMEs.
- Finding 7: The consumer survey revealed that labels are seen as valuable tools in making purchasing decisions and the majority of respondents, when presented with a choice, indicated a preference for a product that was both EU Ecolabelled and organically labelled. However, many respondents reported that they felt confused. This is exacerbated by the fact that the term “eco” (including similar derivatives) is used in connection with organically produced foods in many jurisdictions and associated with other meanings (e.g. resource efficiency) in others. When consumers were asked which environmental impacts a possible EU Ecolabel should cover, many issues were raised that were already covered by organically certified produce (e.g. no use of chemical pesticides, no artificial fertilizers, no GMO, low number of additives). Unsurprisingly, many consumers expected a product with an EU Ecolabel to be organically produced. In addition the use of the word “eco” is legally protected in the EU and therefore there may be some difficulty in using it within the logo ‘EU Ecolabel’ when it is placed on food products which are not organically produced. It should be noted that consumer confusion was lessened once respondents were provided with more information about the EU Ecolabel. This would suggest a significantly resourced communications campaign would need to accompany any extension of the EU Ecolabel to the food sector.

- Finding 8: Half of the stakeholders surveyed for this study supported an EU Ecolabel for food products in one way or another, whereas the other half was against the use of such an Ecolabel at all. Moreover, the study consultants found that there was no scenario for which there was strong support. However a significant share of processors and retailers expected a positive effect and would thus form the target stakeholder group of a potential EU Ecolabel for food products. More importantly, there were a number of stakeholder groups who were clearly opposed to any scenario that included the introduction of the EU Ecolabel. These groups were food umbrella organisations, farmers' groups, the organic sector and environmental and consumer NGOs and administrations. Their reasons varied but mainly concerned the expected consumer confusion of an EU Ecolabel with organic labels and resulting adverse effects on the credibility of the organic label and its market share.

The study authors see the opportunity to extend the EU Ecolabel to food products, especially bread as candidate product category, depending on the possibility to resolve the following issues:

> Development of a credible multi-criteria overall outcome based assessment system for primary production – this does not currently exist.
> Clarifying the legality of using the current Ecolabel and the term "eco" in respect of food products.
> If extended to non-organic products: finding solutions to avoid consumer confusion (e.g. a distinct label) – this may involve an extensive consumer communication campaign.
> An economic assessment of the full public and private costs of implementing the EU Ecolabel scheme (the costs for a consumer awareness/education campaign and costs for operators etc).

8.2.4 Further consumer information

According to Foodmanufacture[61], a WRAP report proposed the following measures to reduce the waste of fresh bread:
> Clearer date labels
> Storage advice / freezing guidance

In general, on-pack information could advise consumers on how best to store and handle bread in order to maintain its quality in the home. However, for fresh bread, being unpacked, other ways than information directly on the packaging would have to be found.

8.2.4.1 Clearer date labels

According to a Foodwaste Report commissioned by DG Environment[62], misinterpretation or confusion over date labels is widely recognised for its contribution to household food waste. In many Member States, there is a lack of consistency in the terms employed ("best before", "use by", "sell by", "display until"), with a tendency among consumers to treat all terms equally, and in some cases to leave a safety margin before the stamped date. A lack of clarity and consistency in date labels thus results in a greater proportion of discarded food that was in fact still edible.

[61] Source: http://www.foodmanufacture.co.uk/Sectors/Bakery/Food-labelling-shelf-life-are-top-waste-priorities
[62] Source: http://ec.europa.eu/environment/eussd/pdf/bio_foodwaste_report.pdf

According to the European Food Information Council (EUFIC)[63], the European Parliament has suggested dual-date labelling to include both 'sell by' (which can help retailers avoid selling products reaching their end-of-life) and 'use by' dates, but consumer understanding of terminology is needed first. Currently legislation on the provision of food information to consumers reserves the 'use by' date for highly perishable foods. After this date they are deemed unsafe (safety indicator). The 'best before' date refers to minimum durability, beyond this date it is unlikely to cause any harm but a warning from the manufacturer that the sensory qualities (taste, texture etc.) may not be as good as intended (quality indicator).

8.2.4.2 Storage advice / freezing guidance

Inappropriate storage conditions leads to food waste not only throughout the supply chain, but also in the households. Lack of consistency in food storage labels can contribute to premature food spoilage, as can the absence of storage guidance and lack of consumer attention to labels where provided. Storage conditions will also vary based on climate and household temperature. Optimal storage conditions, by contrast, can significantly extend the edible life of products, often beyond expiry dates. The other way round, advice on food labels regarding freezing instructions should be harmonised so that consumers can confidently and safely freeze food[63].

8.2.4.3 Labelling of life cycle costs

One further measure the Foodwaste Report commissioned by DG Environment[62] proposed to overcome in the long term a consumer's attitude to percept food as rapidly disposable due to its low cost is the information about the total life cycle costing of food products with the aim of reflecting their real economic and environmental price.

9 Conclusions: Feasibility of implementing ecodesign and labeling measures

The main environmental hot spots that have been identified in the course of this study are

- agricultural production (energy use, global warming, eutrophication, acidification, biodiversity, land use etc.)
- energy use in the production process
- food waste.

In order to determine which role Ecodesign and Labeling Directives may play in regulating these aspects, it has to be asked

- to what degree the respective aspect can, or should, be politically regulated at all:
- whether effective policies are already in place, and
- if not, which tools are most appropriate to fill existing gaps.

[63] Source: http://www.eufic.org/article/en/artid/How-to-minimise-food-waste/

In the agricultural production, political minimum standards are necessary in order to prevent the most important hazards to health and the environment, while labelling policies and other incentives should be used to "pull" the market towards more beneficial practices.
The "push" role is currently fulfilled by the Common Agricultural Policy. It defines, for example, the conditions and amount of financial support to farmers, sets quality and hygiene standards for food, and provides certification systems. This policy is surrounded by much controversy and it is often argued by environmental NGOs that it provides insufficient protection of the environment. But as many of the environmental impacts in the agricultural production phase are practice-based and cannot be verified on the product itself, an improvement of the practice-related agricultural policies would be more appropriate than introducing additional product policies (for example, the coupling of subsidies to environmentally beneficial practices; rules for fertilizer and pesticide use, GMOs etc.).
The "pull" role is currently fulfilled by the EU organic label and its national adaptations. Already today, the label is mandatory for packaged food produced in the EU.
All additional labelling will have to take the existing organic labelling into account. One option would be to extend the mandatory nature of the organic label to imported food and non-packaged food. For fresh bread, the latter could be for example realized by applying the label to shelves. However, as the overall environmental advantage of organically produced bread is inconclusive from a life cycle perspective, additional labelling could be envisaged along the lines of the feasibility study of an Ecolabel for food and feed products, covering the missing life cycle stages and environmental aspects. However, the precondition would be to resolve the mentioned issues:
>Development of a credible multi-criteria overall outcome based assessment system for primary production
> Clarifying the legality of using the current Ecolabel and the term "eco" in respect of food products;
> If extended to non-organic products: finding solutions to avoid consumer confusion; and
> An economic assessment of the full public and private costs.

In the production process, there is space for policy to improve energy efficiency without compromising goals such as consumer choice, fair competition, or low life cycle costs. Both generic and specific Ecodesign requirements, as they have already been suggested in the preparatory study on Lot 22, could be envisaged for baking ovens. On the other hand, energy labelling seems less suitable because in B2B communication, different means of communication are used.

Food waste is a complex phenomenon with multiple causes. Policies can only be of an enabling, incentivizing, and informative nature. Labeling and consumer information requirements (as generic Ecodesign measures) may be part of the package, but a suitable response will have to involve a range of complementary policies with more general consumer-oriented awareness and informational strategies.
Currently, the EU Commission is analyzing in close cooperation with stakeholders, experts and Member States how to reduce food waste, discussing good practices, obstacles and options for EU actions which includes for example donation of surplus food, date labelling, short food supply chains, bio-energy etc. [64] The outcomes of this process should be awaited before taking further steps in this direction.

[64] See: http://ec.europa.eu/food/food/sustainability/eu_actions_en.htm

10 Analysed LCA Literature

Andersson et al. 1999	Andersson, K.; Ohlsson, T. Life Cycle Assessment of Bread Produced on Different Scales. Göteborg 1999.
Espinoza-Orias et al. 2011	Espinoza-Orias, N.; Stichnothe, h.; Azapagic, A. The carbon footprint of bread. Manchester / Braunschweig 2011.
Foster et al. /Defra 2006	Foster, C.; Green, K.; Bleda, M.; Dewick, P.; Evans, B.; Flynn A.; Mylan, J. Environmental Impacts of Food Production and Consumptions: A report to the Department for Environment, Food and Rural Affairs. Manchester Business School. Defra, London 2006.
Havers 2008	Havers, K. Die Rolle der Luftfracht bei Lebensmitteltransporten. Aktuelle Entwicklungen und deren ökologische Folgen. Magisterarbeit. Humboldt-Universität zu Berlin. 2008.
Lindenthal et al./FIBL 2009	Lindenthal, T.; Markut, T. Klimabilanz biologischer und konventioneller Lebensmittel im Vergleich. Wien 2009
Reinhardt et al. /IFEU 2009	Reinhard, G.; Gärtner, S.; Münch, J.; Häfele, S. / IFEU (Hrsg.) Ökologische Optimierung regional erzeugter Lebensmittel: Energie- und Klimagasbilanzen. Heidelberg 2009
Wiegmann 2000	Wiegmann, K. Unser täglich Brot unter der Lupe. Darmstadt 2000.

ECOFYS

sustainable energy for everyone

ECOFYS Netherlands B.V.

Kanaalweg 15G
3526 KL Utrecht

T: +31 (0) 30 662-3300
F: +31 (0) 30 662-3301

E: info@ecofys.com
I: www.ecofys.com

ECOFYS

sustainable energy for everyone

Case Study: Paints and Varnishes

Evaluation of the Energy Labelling Directive

and specific aspects of the Ecodesign Directive – Task 3 -

ENER/C3/2012-523

Case Study: Paints and Varnishes

Evaluation of the Energy Labelling Directive

and specific aspects of the Ecodesign Directive – Task 3 -

ENER/C3/2012-523

- Confidential –

By: Mark-Oliver Diesner (Oeko-Institut)
With the support of: Corinna Fischer (Oeko-Institut)

Date: 28-05-2014

Project number: BUINL13345

Table of contents

1 Introduction

This case study shall examine the feasibility of developing ecodesign and labelling requirements for the product category “paints and varnishes” within the context of the Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive. This product category has been selected as representative of the broader product group “Materials for the maintenance and repair of the dwelling”.

“Materials for the maintenance and repair of the dwelling” was among the highest ranking product groups within a ranking exercise that considered sold Volume, environmental impact, the availability of LCA relevant information, the suitability for Ecodesign and Labelling instruments, and an assessment of the possible costs / risks and benefits of both Ecodesign and Labelling.

Two of the highest ranking groups, namely “Materials for the maintenance and repair of the dwelling” and “Other appliances, articles and products for personal care” are representative of industrially produced products, while the others cover food and drink items and vehicles. In order to cover a variety of different product types, at least one industrial product had to be chosen. “Paints and varnishes” is the product with the highest market share within its group. Also, existing expertise within the consortium favoured the choice of “Paints and Varnishes” over a product representing the group of personal care products.

2 Scope

2.1 Brief definition of the product group

Paints and varnishes are coatings that are applied to surfaces with the aim of changing the outer appearance and/or to imbue the treated surface with protective properties. In line with the EU Ecolabel and member state specific guidances, the following products are included, inter alia:

- Liquid, pastelike, or powdered decorative paints and varnishes for wood, masonry and metals;
- Pre-mixed or on-demand mixed products coating for professional and private use;
- Primers;
- Undercoats.

Not included are products that

- imbue anti-corrosive properties to metals (finishes or primers);
- imbue anti-fouling properties (biocidal);
- wood preservation products;
- coatings for particular industrial and professional uses, including heavy duty coatings.

The product group includes both indoor and outdoor paints. The definitions of paint, varnish, and decorative paints and varnishes are identical with the definitions given in the EU Ecolabel criteria for indoor and outdoor paints and varnishes (EUCOM, 2008a, 2008b). While additional exclusions exist in other labels (see chapter 2b), an overarching view is appropriate here.

The following table illustrates the Prodcom codes that are considered for this report.

Prodcom code[1]	Definition
20.30.11.50	Paints and varnishes, based on acrylic or vinyl polymers dispersed or dissolved in an aqueous medium (including enamels and lacquers)
20.30.11.70	other paints, varnishes dispersed or dissolved in an aqueous medium
20.30.12.25	Paints and varnishes, based on polyesters dispersed/dissolved in a non-aqueous medium, weight of the solvent > 50 % of the weight of the solution including enamels and lacquers
20.30.12.29	Paints and varnishes, based on polyesters dispersed/dissolved in a non-aqueous medium including enamels and lacquers excluding weight of the solvent > 50 % of the weight of the solution
20.30.12.30	Paints and varnishes, based on acrylic or vinyl polymers dispersed/ dissolved in non-aqueous medium, weight of the solvent > 50 % of the solutionweight including enamels and lacquers
20.30.12.50	Other paints and varnishes based on acrylic or vinyl polymers
20.30.12.70	Paints and varnishes: solutions n.e.c.
20.30.12.90	Other paints and varnishes based on synthetic polymers n.e.c.
20.30.22.13	Oil paints and varnishes, for finishing leather (including enamels, lacquers and distempers)
20.30.22.15	Prepared water pigments for finishing leather; paints and varnishes (including enamels, lacquers and distempers) (excluding of oil)
20.30.22.55	Painters' fillings
20.30.22.60	Non-refractory surfacing preparations for façades, indoor walls, floors, ceilings or the like
20.30.22.73	Organic composite solvents and thinners used in conjunction with coatings and inks; based on butyl acetate
20.30.22.79	Organic composite solvents and thinners used in conjunction with coatings and inks (excluding those based on butyl acetate)
20.30.23.50	Artists', students', or signboard painters' colours, amusement colours and modifying tints in sets of tablets, tubes, jars, bottles or pans
20.30.23.70	Artists', students' or signboard painters' colours, amusement colours and modifying tints in tablets, tubes, jars, bottles or pans (excluding in sets)

2.2 Standards and Legislation

a) Inventory of existing measures in the EU (including possible regulatory failures)

EU directives and regulations affect the life cycle of paints and varnishes at different stages. During manufacturing, REACH[2] (1907/2006) (EC, 2006) is highly relevant.
The distribution phase is impacted by the CLP regulation[3] (1272/2008) (EC, 2008) and the directive on the limitation of emissions of volatile organic compounds due to the use of organic solvents (2004/42/EC) (CE, 2004).

[1] EuroStat. (2013). RAMON - PRODCOM - Classification Detail List. European Commission - European Statistics. Accessed: 28. 11. 2013, Retrieved from: http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL_LINEAR&StrNom=PRD_2013&StrLanguageCode=EN

[2] Regulation concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
[3] Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC)

The use phase is targeted by the Regulation on a revised community eco-label award scheme (1980/200/EC) (EC, 1980); Here, differentiated ecolabels have emerged (EUCOM, 2008a, 2008b), and several member state labels have focused on this product group as well.
In the end-of-life phase, the landfill directive 99/31/EC (EC, 1999), the Waste Framework Directive (2008/98/EC), the regulation on persistent organic pollutants (850/2004) (EC, 2004a), and the packaging and packaging waste directive (1272/2008) (EC, 2004b) impact on the fate of paints and varnishes.

As such, the product group is regulated in detail by the regulations and directives mentiones above. The handling of the raw materials and the manufacturing process is covered within REACH. Potential environmental impacts arising from these stages in the life cycle are limited considering the extensive ingredient and workplace regulations. They are however amplified by the size of the market which is large enough to make small oversights considerable in their effects (see chapter 0).
Similarly, the distribution phase is attributed with low potential impacts on the environment.
The use phase is the phase in which the majority of exposure is expected also due to the fact that the users range from professionals to amateurs. Potential impacts on human health and the environment are large in this phase.
The end-of-life phase is relevant as residual paints and varnishes as well as products coated with such need to be disposed of according to their characteristics. The technical capacities of the disposal facilities are different in the individual memberstates as well as compliance, monitoring and enforcement. Potential hazards to the environment and human health likely vary with the geographical region. (see also CSES Study, 2012)

b) Analysis of legislation in EU Member States

The labelling initiatives launched by several member states are significant contributors to the proliferation of the criteria and goals of the EU Ecolabel in the member state regions.

Specific efforts in the sector of paints and varnishes have been undertaken by Germany (Blauer Engel, 2010, 2011), the Nordic Ecolabel (2008), and Austria (Das Österreichische Umweltzeichen, 2010a, 2010b). The Ecolabel ‘Blauer Engel’ has distinct criteria for indoor and outdoor applications analoguous to the EU ecolabel criteria but has a few additional exclusion criteria such as for example the exclusion of mixtures that contain hazardous substances as these are regulated separately in Germany. The Austrian Ecolabel does not explicitely include outdoor paints and varnishes but distinguishes between indoor paints and water based varnishes in general. Two component systems are excluded in both cases.

3 Markets

3.1 Market data

a) EU Market information

On the basis of Eurostat Prodcom statistics[4], the following tables present the recent production, import and export data and the resulting EU consumption for the selected Prodcom codes for paints and varnishes. The overall export has been stable for the last years. The import has been declining since 2009. It also becomes clear that EU consumption, being between 17.000 tons and 3,5 mio. tons annually, depending on the product group, but usully several 100.000 tons, by far exceeds the recommended 200.000 pieces threshold, even if package sizes vary greatly.

[4] Source: http://epp.eurostat.ec.europa.eu/portal/page/portal/prodcom/data/database

Table 1: Prodcom Sold data for the relevant product groups (quantities in t)

		2009				2010				2011				2012			
		Prod	Exp	Imp	EU Cons	Prod	Exp	Imp	EU Cons	Prod	Exp	Imp	EU Cons	Prod	Exp	Imp	EU Cons
20301150	Paints and varnishes, based on acrylic or vinyl polymers dispersed or dissolved in an aqueous medium (including enamels and lacquers)	3.582.000	144.008	21.675	3.459.666	3.780.500	164.831	23.581	3.639.249	3.887.010	176.818	25.453	3.735.646	3.763.970	196.287	26.824	3.594.507
20301170	Other paints, varnishes dispersed or dissolved in an aqueous medium	640.073	112.410	15.583	543.246	686.000	137.908	18.453	566.545	723.125	145.579	16.876	594.422	756.000	148.967	14.666	621.699
20301225	Paints and varnishes, based on polyesters dispersed/dissolved in a non-aqueous medium, weight of the solvent >50% of the weight of the solution including enamels and lacquers	157.195	12.777	2.005	146.424	164.890	14.333	2.371	152.928	160.164	15.327	1.780	146.617	122.381	16.024	1.827	108.184
20301229	Paints and varnishes, based on polyesters dispersed/dissolved in a non-aqueous medium including enamels and lacquers excluding weight of the solvent >50% of the weight of the solution	620.238	95.092	12.498	537.644	612.296	113.983	14.377	512.690	580.000	122.919	12.539	469.620	527.580	130.591	11.513	408.502
20301230	Paints and varnishes, based on acrylic or vinyl polymers dispersed/dissolved in non-aqueous medium, weight of the solvent >50% of the solutionweight including enamels and lacquers	120.564	20.353	5.563	105.774	132.095	35.100	7.069	104.064	139.147	39.131	6.425	106.442	114.435	41.731	6.885	79.590
20301250	Other paints and varnishes based on acrylic or vinyl polymers	322.167	71.838	12.461	262.789	323.984	107.308	13.141	229.817	333.891	108.668	15.899	241.121	298.400	116.536	14.149	196.014
20301270	Paints and varnishes: solutions n.e.c.	278.088	41.171	4.092	241.008	300.736	51.603	6.550	255.683	272.329	53.953	4.971	223.347	266.671	59.159	5.140	212.652
20301290	Other paints and varnishes based on synthetic polymers n.e.c.	1.170.016	191.465	17.885	996.437	1.171.200	224.821	18.941	965.320	1.140.772	230.430	17.796	928.137	1.167.371	239.522	18.711	946.560
20302213	Oil paints and varnishes, for finishing leather (including enamels, lacquers and distempers)	19.066	4.312	2.735	17.489	19.119	4.863	1.886	16.142	23.250	5.335	2.172	20.087	24.600	5.337	1.958	21.221

		2009				2010				2011				2012			
		Prod	Exp	Imp	EU Cons	Prod	Exp	Imp	EU Cons	Prod	Exp	Imp	EU Cons	Prod	Exp	Imp	EU Cons
20302215	Prepared water pigments for finishing leather; paints and varnishes (including enamels, lacquers and distempers) (excluding of oil)	200.846	20.986	6.054	185.915	209.808	21.860	7.759	195.707	400.000	22.109	6.783	384.674	480.000	22.640	4.459	461.819
20302255	Painters' fillings	784.073	203.290	12.641	593.424	775.000	213.424	15.400	576.977	800.000	209.807	17.064	607.257	702.465	172.704	15.528	545.289
20302260	Non-refractory surfacing preparations for façades, indoor walls, floors, ceilings or the like	4.639.810	607.250	143.685	4.176.245	4.400.525	612.600	82.593	3.870.518	4.441.055	569.636	76.755	3.948.174	2.448.528	631.561	74.077	1.891.044
20302273	Organic composite solvents and thinners used in conjunction with coatings and inks; based on butyl acetate	74.010	9.279	218	64.949	72.146	17.482	229	54.893	61.787	13.845	369	48.311	68.009	15.451	455	53.013
20302279	Organic composite solvents and thinners used in conjunction with coatings and inks (excluding those based on butyl acetate)	702.000	113.623	47.639	636.015	802.000	136.314	46.706	712.392	820.000	138.174	48.690	730.516	734.000	154.601	40.538	619.937
20302350	Artists', students', or signboard painters' colours, amusement colours and modifying tints in sets of tablets, tubes, jars, bottles or pans	23.785	1.742	8.806	30.850	29.102	2.470	10.187	36.820	26.345	2.271	10.190	34.264	30.247	2.121	9.307	37.433
20302370	Artists', students' or signboard painters' colours, amusement colours and modifying tints in tablets, tubes, jars, bottles or pans (excluding in sets)	15.287	6.355	5.039	13.970	16.509	8.461	5.488	13.536	15.465	7.021	5.819	14.262	12.822	7.263	5.488	11.046
Total EU 27	1.655.951	13.349.218	1.655.949	318.577	12.011.847	13.495.910	1.867.361	274.731	11.903.280	13.824.339	1.861.022	269.581	12.232.898	11.517.479	1.960.495	251.525	9.808.510

Table 2: Prodcom Sold data for the relevant product groups (value in EUR)

		2009				2010				2011				2012			
		Prod	Exp	Imp	EU Balance	Prod	Exp	Imp	EU Balance	Prod	Exp	Imp	EU Balance	Prod	Exp	Imp	EU Balance
20301150	Paints and varnishes, based on acrylic or vinyl polymers dispersed or dissolved in an aqueous medium (including enamels and lacquers)	5.723.250	273.001	45.771	5.950.480	6.441.120	332.607	58.082	6.715.645	6.940.200	374.720	59.058	7.255.863	7.110.600	438.289	60.295	7.488.593
20301170	Other paints, varnishes dispersed or dissolved in an aqueous medium	1.496.361	292.090	58.576	1.729.875	1.600.000	372.656	69.167	1.903.489	2.100.000	396.292	66.711	2.429.580	2.004.000	435.846	69.496	2.370.350
20301225	Paints and varnishes, based on polyesters dispersed/dissolved in a non-aqueous medium, weight of the solvent >50% of the weight of the solution including enamels and lacquers	543.082	47.698	7.023	583.756	613.541	52.617	10.398	655.761	623.354	56.304	7.386	672.272	491.672	61.911	9.336	544.247
20301229	Paints and varnishes, based on polyesters dispersed/dissolved in a non-aqueous medium including enamels and lacquers excluding weight of the solvent >50% of the weight of the solution	1.956.584	324.744	45.454	2.235.875	2.052.793	378.944	57.720	2.374.016	2.050.000	425.558	52.774	2.422.784	1.951.983	482.647	50.854	2.383.776
20301230	Paints and varnishes, based on acrylic or vinyl polymers dispersed/dissolved in non-aqueous medium, weight of the solvent >50% of the solutionweight including enamels and lacquers	447.219	105.014	20.466	531.767	492.151	145.135	30.115	607.171	522.134	149.260	30.587	640.807	478.380	166.647	36.468	608.560
20301250	Other paints and varnishes based on acrylic or vinyl polymers	1.115.009	324.412	51.066	1.388.355	1.195.999	448.639	56.571	1.588.067	1.293.171	507.752	65.654	1.735.269	1.280.000	540.152	71.595	1.748.558
20301270	Paints and varnishes: solutions n.e.c.	792.000	179.098	33.040	938.058	885.356	217.588	45.148	1.057.796	940.861	228.801	42.803	1.126.859	932.034	253.378	47.094	1.138.318
20301290	Other paints and varnishes based on synthetic polymers n.e.c.	3.805.383	680.503	92.768	4.393.118	4.014.400	802.819	100.493	4.716.726	4.184.728	852.962	101.885	4.935.804	4.445.288	911.825	110.983	5.246.131
20302213	Oilpaints and varnishes, for finishing leather (including enamels, lacquers and distempers)	108.984	20.145	12.329	116.800	108.087	25.882	11.917	122.052	122.841	30.622	11.756	141.708	128.454	30.867	12.561	146.760

		2009				2010				2011				2012			
		Prod	Exp	Imp	EU Balance	Prod	Exp	Imp	EU Balance	Prod	Exp	Imp	EU Balance	Prod	Exp	Imp	EU Balance
20302215	Prepared water pigments for finishing leather; paints and varnishes (including enamels, lacquers and distempers) (excluding of oil)	500.000	64.954	25.612	539.342	602.332	70.803	32.876	640.258	674.228	73.740	31.487	716.482	641.348	83.297	25.395	699.251
20302255	Painters' fillings	498.034	109.111	20.050	587.095	525.911	120.296	23.369	622.838	564.861	128.540	23.744	669.657	574.396	119.821	23.782	670.435
20302260	Non-refractory surfacing preparations for façades, indoor walls, floors, ceilings or the like	1.365.166	299.308	47.922	1.616.551	1.356.483	336.658	44.793	1.648.348	1.507.549	343.562	84.114	1.766.997	1.419.724	373.311	68.382	1.724.653
20302273	Organic composite solvents and thinners used in conjunction with coatings and inks; based on butyl acetate	130.474	17.559	797	147.236	141.104	23.558	937	163.725	137.802	20.985	1.260	157.527	148.356	24.238	1.622	170.972
20302279	Organic composite solvents and thinners used in conjunction with coatings and inks (excluding those based on butyl acetate)	850.650	159.128	45.041	964.736	987.000	194.295	46.920	1.134.375	1.098.000	199.722	55.430	1.242.292	1.079.121	235.429	52.524	1.262.025
20302350	Artists', students', or signboard painters' colours, amusement colours and modifying tints in sets of tablets, tubes, jars, bottles or pans	123.943	10.307	26.414	107.836	149.971	15.599	32.425	133.146	133.989	16.038	31.656	118.372	167.613	17.472	33.610	151.475
20302370	Artists',students' o rsignboard painters' colours, amusement colours and modifying tints in tablets, tubes, jars, bottles or pans (excluding in sets)	121.084	50.298	17.471	153.911	123.471	63.381	22.961	163.891	120.000	55.245	21.891	153.354	99.751	63.065	23.652	139.164
Total EU 27	1.655.951	19.577.223	2.957.368	549.799	21.984.791	21.289.720	3.601.476	643.891	24.247.305	23.013.718	3.860.105	688.195	26.185.628	22.952.721	4.238.194	697.647	26.493.269

3.2 Market Structure

The paint and coatings industries in Western Europe, Japan and the United states are mature but generally closely correlated with the development of the housing and construction market. Therefore, the health of the general economy is a significant impact factor for these markets. 44 % of the total sales of Tikkurila in 2012 were located in the department of decorative paints.[5]. In 2010, ca. 25 % of the sales in this department went to professional users.[6] As a rough approximation, the data from Tikkurila can serve to illustrate the share of professional vs private users.

Worldwide growth makets are Brazil, Russia, India and China. Within the EU, the construction and manufacturing sectors are not growing significantly.

The major players are situated in Europe, the USA, and Japan. The market is highly concentrated. In 2013,[7] estimations concerning the top ten coating producers world wide listed the following companies, measured by annual sales in US $:

1. AkzoNobel (The Netherlands)
2. PPG (USA)
3. Henkel (Germany)
4. Sherwin-Williams (USA)
5. Axalta (USA)
6. Valspar (USA)
7. BASF (Germany)
8. Kansai (Japan)
9. Sika (Switzerland)
10. RPM (USA)

In 2012, ca. 102.732 billion dollar worth of coating products were sold by the top ranking companies world wide. The top ten companies listet above make up 62 % of those sales. 27 % of the sales are attributed to companies situated within the EU27.
Small and medium sized enterprises focus mainly on speciality paints. Many SMEs are active in the ecopaint market. They specialize in organic paints, natural ingredients based paints, and VOC free paints.[8] In 2009, ca. 1000 SMEs were situated in the coatings business in Europe. The supply chain for paint materials is composed of a mixture of large enterprises and SMEs. The main problems for SMEs are the rising cost of raw materials and the lack of access to credit due to the recession across Europe.

[5] Tikkurila, 2012
[6] Tikkuralia, 2010
[7] Coatings World, 2013
[8] Coatings World, 2009

3.3 Consumer expenditure

Consumer prices depend heavily on the price of raw materials, which have been rising in the past years. Due to the diversity of this product group, no approximation concerning consumer prices is attempted here.

4 Users

Extrapolating from the market data given in chapter 3, the major part of paints and varnishes are sold to professional users (see also chapter 6.2). Nonetheless the private user "do-it-yourself" market is substantial, especially related to water based paints.
The variety of products is constantly increasing with a strong focus on the segment water based paints.[9]
In the private user segment, the various ecolabels are heavily used, thus aiding non-professional users in their choice of products with easy to handle characteristics.[10]

Table 3: National Ecolabel licences for paints and varnishes

Label	No. of labelled products / licences
EU Ecolabel	
Indoor paints and varnishes 2009/544/EC	2469[11]
Outdoor paints and varnishes 2009/543/EC	n.a.
Blauer Engel[12]	
Ral-UZ 102 (wall paints)	861
RAL-UZ 12a (varnishes)	449
Nordic Ecolabel	
Indoor paints and varnishes	n.a.
Austrian Ecolabel	
EL 01: Paints, varnishes and wood sealant lacquers	4
EL 17: Wall paints	72

Users influence the environmental impacts of paints and varnishes with their handling and disposal behaviour, with non-professional users especially at risk for incorrect practices. During use, incorrect handling and insufficient ventilation can lead to the exposure of the user to hazardous chemicals, both by the inhalation of volatile substances released to the air and by skin contact with the product. Paints and varnishes may be disposed of in various ways: Product remains may be wiped away with paper or tissue which are then disposed of as solid waste; or containers with rests of products may be discharged as solid waste.

[9] Koncept Analytics, 2013
[10] Volatile organic content (VOC); drying time; spreading characteristics; etc.
[11] (EU Ecolabel, 2013)
[12] (Der Blaue Engel, 2013)

Depending on the type of waste treatment in place, this may cause air pollution in the case of incineration, or a risk to water and soil in the case of landfills. Also products may be released in the drain, causing water pollution and toxicity.

A variety of member-state specific systems is in place for the collection and correct treatment of paints and varnishes at the end of life, and also, compliance monitoring is country specific. Therefore, no general estimate on the impact of user behaviour can be given. On a Community level, the EU CLP regulation[13] ensures the provision of information to consumers in form of precautionary statements and hazard pictograms.

5 Products

Apart from pigment powders, the majority of mixtures found on the paint market can be roughly grouped into oil and water based paints. Both encompass a wide range of uses. The specific composition determines their properties. Paints generally consist of four different components:

1. Pigments/extender –defining colour, opacity and some of its physical properties. Common pigments, the choice of which is also relevant for life-cycle and toxicological assessments, include TiO_2, iron oxide, and carbon black among many others.
2. Resin/polymer – determines the physicochemical properties of the drying and dried coating. These include hardness, resistance to water, flexibility, but in some cases also more exotic properties such as conductivity. Types of resin used among many others are:
    a. Alkyd
    b. Vinyl
    c. Bitumen
    d. Polyurethane.
3. Solvents/thinners – water and organic solvents influence the spreading characteristics of the pigments and the resins significantly and prevent curing of the paint.
4. Further additives – enhance the functionality of the coatings and convey new properties e.g. mold resistance, improved spread rates, prevent foaming, etc.

In the following life cycle considerations, a major distinction in the environmental burden appears between water and solvent based coatings. Although solvent based coatings fulfill important roles, research efforts are increasingly focused on water based coatings as they minimize life-cycle costs and reduce risks during the application and use phase as well as environmental impacts.

6 Environmental Impact

This section presents an overview of existing LCA and PCF studies. They were analysed to identify environmental hot spots in the life cycle of paints and varnishes and potential optimisation strategies for the products and processes which could be a basis for developing ecodesign and labelling requirements for the product category “paints and varnishes”.

[13] EC, 2008

However, in the context of a limited case study, is has to be clarified that a direct comparison of the study results is not possible due to their different goals, scopes (functional unit, system boundaries), methodologies, time related coverage, impact categories etc. Thus, the findings on environmental hot spots could only be a first orientation. To confirm the results, further in-depth research would be needed.

6.1 Overview of Life Cycle Analysis studies on paints and varnishes

In a first step, relevant literature regarding the environmental assessment and improvement potential of paints and varnishes has been identified and analysed regarding their robustness of the results (methodology, data quality, age etc.), see Table 4. The existing LCAs focus on the carbon footprint and add to varying degrees global warming, acidification, eutrophication, heavy metals, carcinogens, photo oxidant formation, pesticides, cumulative energy demand, water use, and solid waste.

All studies make the distinction between water and solvent based coatings as the solvent is consistently responsible for the major part of the environmental burdens attributed to coatings in general. Nayak & Kumar and James &Vandestadt focus on products from specific companies whereas Kougoulis et al. and Häkkinen et al. use standardized and representative ingredient lists. Kougalis et al. use the representative ingredients to formulate two model paints and hinge their calculations on those. Häkkinen et al. use the ingredient lists as basis for the 15 analysed coating variations. This study also elaborates on the environmental burdens associated with all of the individual components of the mixtures. Additionally, it finds that a concentration of >10 % TiO_2 contributes significantly to the environmental burden of the coating in question irrespective of the solvent system.

Beyond these general findings, few comparisons can be made as the reference systems are vastly different, focussing on either the coating itself, a surface application, or the lifetime of a product coated with the paint including the ensuing repainting needs. Additionally, the products differ in their mixture and area of application, which makes comparisons between the individual LCAs problematic.

Table 4: Overview of existing LCA studies on paints and varnishes within the last 15 years

Source	Title	Subject of the study	Functional unit	System boundary	Time related coverage	Study type	Reliability / Data quality	Notes	Hotspot
(Kougoulis et al., 2012)	Revision of EU European Ecolabel and Development of EU Green Public Procurement Criteria for Indoor and Outdoor Paints and Varnishes - Preliminary Background Report	Solvent and water based paints	1 kg	cradle to gate;	not specified	LCA; impact assessment	not specified	two model paints; carbon footprinting; environmental benchmarks; human health	paint performance/ durability; choice of solvent; choice of binder; method of TiO_2 production
(Nayak & Kumar, 2008)	Jotun Paints – Product Life Cycle Assessment	Solvent and water based paints of Jotun Paints	1 litre	The complete life cycle	2007	LCA	Product specific sensitivity analysis performed	Five paints from this producer are assessed. Carbon Footprinting	solvent based paints having three times the environmental impact compared to waterbased paints; disposal of water based paints makes up ca. 38 % of the LCC
(James & Vandestadt, 2005)	The Orica Consumer Products Story of Using Life Cycle Assessment and The Natural Step	Solvent vs water based paint from Orica	100 m^2 coverage	The complete lifecycle of the painted surface including one repainting	40 years	LCA	Not specified	global warming, acidification, eutrophication, heavy metals, carcinogens, photo oxidant formation, pesticides, cumulative energy demand, water use, solid waste	Emission of VOC during application of the solvent based paint
(Häkkinen et al., 1999)	Environmental Impact of Coated Exterior Wooden Cladding	coated, wooden cladding	1 m^2	The complete life cycle with coating renewals	100 years	LCA	Not specified; manufacturing costs averaged with 10 % of the total environmental burden	Environmental profiling with a focus on the individual components of the paint mixtures.	environmental cost of the organic solvent, VOC emission in solvent based paints, the service life of the paints has significant impact on the results

6.2 Environmental hot spots in the life cycle of paints and varnishes

The life cycle of the products in this category encompasses the production phase in which the raw materials and the resources used, as well as the transport and the formulation and manufacture have to be taken into account. The use phase is characterised by the ease of use of the products as well as their efficiency and toxicological considerations. The end of life phase contains the waste management of packaging material and the fate of the unused paint. Furthermore the use and end of life phases are bridged by degradation and wash-off of coatings from the surfaces they were applied to. The latter is of import where the release of nanomaterials is concerned but is a long term process that is currently being studied (Al-Kattan et al., 2013; Kiser et al., 2009).

The production phase (cradle to gate) is represented with three LCAs of paints and varnishes in the Ecoinvent database. The studies are outdated (1990s) which impacts mainly on the paint formulas. These have been modified by many factors including human health and environmental considerations, usability, resource consumption etc. Beyond the framework that can be provided by such datasets, irrespective of their age, the amount of different formulas is problematic for any generalized findings. There are several thousand pigments, more additives and fillers and even more different resin/polymer formulations.
Chemicals with significant environmental impact are:

- Alkylphenolethoxylates
- Perfluorinated alkyl sulfonates
- Fromaldehyde
- Halogenated organic solvents
- Phthalates
- Heavy metals
- Volatile aromatic hydrocabons
- Volatile organic solvents
- Isothiazolinone compounds.

The greatest impact by far is attributed to the distinction between solvent and water based coatings. During production, the organic solvent accounts for the majority of the environmental burden and during the use phase it is associated with the majority of the human health hazards – the inhalation of vapours of organic solvents. Due to the very different frames of reference, no quantitative estimation is given here. Suffice to say that all four LCAs cited in chapter 6.1 quantify the environmental burdens of solvent vs water based coatings as roughly three times as high. Beyond the choice of solvent, the amount of ingredients such as TiO_2 plays a major role concerning the environmental burden. As Häkkinen et al. (1999) show, TiO_2 contributes significantly to the bottom line if the content in a coating is higher than 10 %. The recipe of the coating is relevant to the extent discussed above.

Another important factor that spans the use phase and impacts on the end-of-life phase is the durability of the coatings. Häkkinen et al. (1999) show significant impacts in connection with the performance of the coating. This can be quantified via the amount needed to coat a certain surface and the number of necessary applications over the lifetime of a product.

This also impacts on the disposal of paint remains that are not immediately used, as the time span to the next coating is usually too long for storage and even for professional users the amount of different products and customer demands is likely too diverse to store individual products efficiently. This is highlighted by a study from 2011[14]. It focusses on the UK and elaborates the waste of paint that goes unused (~25 %) especially in the private use market. In the professional sector, wastage is estimated as low as 1,5 %. When these numbers are scaled to the European market, roughly 900.000 t per year are wasted every year, amounting to a higher than 10 % contribution of this unused paint to the environmental burden of the entire product.[15]
The disposal of the unused paint and the containers it is stored in is problematic as a separation of both is difficult to achieve efficiently. In the majority of cases, the pots with the residual paint are burned in kilns to regain some of the energy stored in the products additionally to disposing of the paint. The latter is classified as hazardous waste in most cases. Akzo Nobel are currently experimenting with collection facilities in which water based paints can be collected and reused in new emulsions.[16]

For a future LCA it is recommended to look towards the Prodcom codes listed in chapter 3.1. The categories with the highest market volume are:

1. 20301150: Paints and varnishes, based on acrylic or vinyl polymers dispersed or dissolved in an aqueous medium (including enamels and lacquers)
2. 20301170: Other paints, varnishes dispersed or dissolved in an aqueous medium

Model paints from these categories have been suscepted to LCA (cradle to gate + extrapolation from there) and impact assessment studies by Ipts and Oakdene and Hollins.[17] The results are available online as a preliminary report. These should be used as a basis for new LCA studies and should be expanded. The spectrum of products covered by even only these two categories is very large.

7 Design Options

The strongest impacts lie with the use of solvents, the performance of the coatings i.e. their durability, followed by the problem of waste of unused paint.
Therefore, one major step is the shift from solvent to water based coatings. The annual report 2012 from Tikkurila as well as the desk based research associated with this project, indicate that there is a major trend in research and consumption towards water based coatings.

Developing recycling measures such as Akzo Nobel is attempting to do in Great Britain is another important step in reducing the environmental burden associated with paints and varnishes.
The choice of binders and the amount of titanium dioxide used should be monitored carefully as they can also contribute significantly to the environmental burden.

[14] WRAP, 2011
[15] Kougoulis et al. (2012)
[16] The Guardian, 2013
[17] Kougoulis et al. (2012)

8 Policy analysis

According to the environmental hot spots and design options identified above (chapters 6.2 and 7), the principal aspects that might be regulated, are

- the formula of the mixture, including the use of solvent, the choice of binders and the amount of titanium dioxide;
- the end-of life phase (correct disposal by the users; environmentally appropriate collection, waste treatment and recycling).

In order to determine which role Ecodesign and Labeling Directives may play in regulating these aspects, it has to be asked

- to what degree the respective aspect can, or should, be politically regulated at all:
- whether effective policies are already in place, and
- if not, which tools are most appropriate to fill existing gaps.

The formula of the mixture should only be regulated to a limited degree. Relevant hazards to human health and the environment should be avoided, but apart from that, the availability of a variety of mixtures is desirable in order to accommodate different needs and serve various purposes. Market-based instruments may be used to pull the market into a more environmentally friendly direction.
Effective policies are already in place today for both of these purposes. The REACH regulation is the appropriate instrument to deal with hazardous substances in paints and varnishes and limit their placing on the market. We do not recommend additional Ecodesign minimum requirements which might cause a problematic overlap of scope and complicate the regulatory landscape.
The various Ecolabels, which are heavily used, serve as a pull instrument in the private user market but also for public procurement which effectively works towards a higher market share of water based paints. These labels are fairly very well received. However, there are gaps in certain product groups. For example, there are only few EU Ecolabel licences for outdoor paints. Therefore, mandatory labelling could contribute to filling these gaps and help pull the market more consistently. The mandatory labelling could be based on a few key indicators such as use of solvent, amount of titanium dioxide and other hazardous substances.

The end-of-life treatment should be improved both on the consumer side by giving proper advice, incentives, and provide supporting infrastructure for correct disposal, and on the infrastructure side by ensuring environmentally adequate collection, recycling and treatment of the waste. The consumer information aspect is dealt with by the CLP regulation, so that consumer information requirements under Ecodesign would rather cause a regulatory overlap than bring added value. For the provision of adequate facilities and incentives for waste collection, recycling and treatment, on the other hand, the Ecodesign and Labeling Directives do not provide adequate instruments. These are the tasks of the national waste management systems which are in turn regulated under the Waste Framework Directive (Dir 2008 / 98 /EC).

9 Conclusions

9.1 Issues found in the application of the methodology

The market data is readily available through the Prodcom databases and individual company reports. Problems arise when studies and market data are linked. This is also the case when market data is being linked to company reports. It is often difficult to allocate the data found outside of the prodcom database to the multitude of prodcom codes related to the field of paints and varnishes. The extrapolations found in market descriptions of various studies and the impact analysis' concerning upscaled effects f.ex. in the environment are most liekely severely affected by the individual scopes of the studies and the lack of differentiation in company reports. Further research into the product portfolios of the latter would be necessary to estimate which prodcom codes could be applicable to the numbers in the company reports.

9.2 Feasibility of implementing ecodesign and labeling measures

While additional Ecodesign requirements do not seem necessary in the presence of the REACH regulation, mandatory labelling could provide some added value given the fact that the current voluntary Ecolabels do not consistently cover all product types. The mandatory labelling could be based on a few key characteristics of the formula, such as use of solvent, amount of titanium dioxide and other hazardous substances, that are known to heavily influence the environmental performance. As the formula is known to the producer, such a labelling requirement would pose little additional burden. Also, the properties can be tested on the product, which would make market surveillance in principle possible.

10 Bibliography

Al-Kattan, A., Wichser, A., Vonbank, R., Brunner, S., Ulrich, A., Zuin, S. & Nowack, B. (2013). Release of TiO2 from paints containing pigment-TiO2 or nano-TiO2 by weathering. Environmental science. Processes & impacts. doi:10.1039/c3em00331k

Der Blaue Engel. (2013). Übersicht über alle Vergabegrundlagen. Der Blaue Engel. Retrieved from: http://www.blauer-engel.de/de/produkte_marken/uebersicht_vergabegrundlagen.php

Blauer Engel. (2010). Der Blaue Engel | Farben (RAL-UZ 102). Retrieved from: http://www.blauer-engel.de/de/produkte_marken/produktsuche/produkttyp.php?id=224

Blauer Engel. (2011). Der Blaue Engel | Lacke (RAL-UZ 12a). Retrieved from: http://www.blauer-engel.de/de/produkte_marken/produktsuche/produkttyp.php?id=569

CE. (2004). Directive 2004/42/CE of the European Parliament and of the Council of 21 April 2004 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amendi. The European Parliament and the Council of the European Union. Retrieved from: http://new.eur-lex.europa.eu/legal-content/EN/TXT/?qid=1385359412099&uri=CELEX:32004L0042

Coatings World. (2009). SMEs are fighting to hold on. Date accessed: 02. 12. 2013, Retrieved from: http://www.coatingsworld.com/contents/view_europe-reports/2009-02-02/smes-are-fighting-to-hold-on/

Coatings World. (2013). Top Companies Report. Date accessed: 03. 12. 2013, Retrieved from: http://www.coatingsworld.com/heaps/view/544

CSES Study. (2012). Appendix - List of non-energy related products considered for case studies, 227–349.

EC. (1980). Regulation (EC) No 1980/2000 of the European Parliament and of the Council of 17 July 2000 on a revised Community eco-label award scheme. The European Parliament and the Council of the European Union. Retrieved from: http://new.eur-lex.europa.eu/legal-content/EN/TXT/?qid=1385543189425&uri=CELEX:32000R1980

EC. (1999). Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste. The European Parliament and the Council of the European Union. Retrieved from: http://new.eur-lex.europa.eu/legal-content/EN/TXT/?qid=1385369548153&uri=CELEX:31999L0031

EC. (2004a). Regulation (EC) No 850/2004 of the European Parliament and of the Council of 29 April 2004 on persistent organic pollutants and amending Directive 79/117/EEC. The European Parliament and the Council of the European Union. Retrieved from: http://new.eur-lex.europa.eu/legal-content/EN/TXT/?qid=1385545485757&uri=CELEX:32004R0850

EC. (2004b). Directive 2004/12/EC of the European Parliament and of the Council of 11 February 2004 amending Directive 94/62/EC on packaging and packaging waste. The European Parliament and the Council of the European Union. Retrieved from: http://new.eur-lex.europa.eu/legal-content/EN/TXT/?qid=1385371216385&uri=CELEX:32004L0012

EC. (2006). Regulation concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). European Union. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2006R1907:20121009:EN:PDF

EC. (2008). Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC). The

European Parliament and the Council of the European Union. Retrieved from: http://new.eur-lex.europa.eu/legal-content/EN/TXT/?qid=1385466168183&uri=CELEX:32008R1272

EEC. (1991). Council Directive 91/689/EEC of 12 December 1991 on hazardous waste. Retrieved from: http://new.eur-lex.europa.eu/legal-content/EN/TXT/?qid=1385371666120&uri=CELEX:31991L0689

EU Ecolabel. (2013). Facts and Figures. Retrieved from: http://ec.europa.eu/environment/ecolabel/facts-and-figures.html

EUCOM. (2008a). Commission Decision of 13 August 2008 establishing the ecological criteria for the award of the Community eco-label to indoor paints and varnishes (notified under document number C(2008) 4453). European Commission. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009D0544:EN:NOT

EUCOM. (2008b). Commission Decision of 13 August 2008 establishing the ecological criteria for the award of the Community eco-label to outdoor paints and varnishes (notified under document number C(2008) 4452). Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009D0543:EN:NOT

Häkkinen, T., Ahola, P., Vanhatalo, L. & Merra, A. (1999). Environmental Impact of Coated Exterior Wooden Cladding (pp. 1–84). Retrieved from: http://virtual.vtt.fi/virtual/proj6/environ/env_woodclad.pdf

James, K. & Vandestadt, S. (2005). The Orica Consumer Products Story of Using Life Cycle Assessment and The Natural Step (pp. 1–11). Retrieved from: http://www.conference.alcas.asn.au/2005/Papers/James_et_al.pdf

Kiser, M. A., Westerhoff, P., Benn, T., Wang, Y., Pérez-Rivera, J. & Hristovski, K. (2009). Titanium Nanomaterial Removal and Release from Wastewater Treatment Plants. Environmental Science & Technology, 43(17), 6757–6763. American Chemical Society. Retrieved from: http://dx.doi.org/10.1021/es901102n

Koncept Analytics. (2013). Paint and Coating Industry: Market Research Reports, Statistics and Analysis. Retrieved from: http://www.reportlinker.com/ci02362/Paint-and-Coating.html

Kougoulis, J. S., Kaps, R., Wolf, O., Bojczuk, K. & Crichton, T. (2012). Revision of EU European Ecolabel and Development of EU Green Public Procurement Criteria for Indoor and Outdoor Paints and Varnishes - Preliminary Background Report. Retrieved from: http://susproc.jrc.ec.europa.eu/paints/docs/Preliminary report.pdf

Nayak, G. & Kumar, V. (2008). Jotun Paints – Product Life Cycle Assessment. Retrieved from: http://www.thefuturebuild.com/product-life-cycle-assessment-981475/file-files/DC8_JotunPaints_ProductCarbonFootprint_FINAL_for Masdar.pdf

Nordic Ecolabel. (2008). Indoor paints and varnishes, Version 2.3. Retrieved from: http://www.nordic-ecolabel.org/Templates/Pages/CriteriaPages/CriteriaGetFile.aspx?fileID=158887001

Das Österreichische Umweltzeichen. (2010a). Richtlinie UZ 01 Lacke , Lasuren und Holzversiegelungslacke. Retrieved from: http://www.umweltzeichen.at/richtlinien/uz01_r7a_lacke_2010.pdf

Das Österreichische Umweltzeichen. (2010b). Richtlinie UZ 17 Wandfarben. Retrieved from: www.umweltzeichen.at/richtlinien/Uz17_R7a_Wandfarben_2010.pdf

The Guardian. (2013). Recycling and reuse: a fresh approach to paint waste | Guardian Sustainable Business | Guardian Professional. Retrieved from: http://www.theguardian.com/sustainable-business/recycling-reuse-fresh-approach-paint-waste

Tikkuralia. (2010). Annual Report. Retrieved from: http://www.tikkurilagroup.com/files/944/Tikkurila_Annual_Report_2010.pdf

Tikkurila. (2012). Annual report. Retrieved from: http://hugin.info/142852/R/1682708/550523.pdf
WRAP. (2011). Paint and woodcare products - distribution and delivery. WRAP - Material Change for a better environment. Retrieved from: http://www.wrap.org.uk/sites/files/wrap/FINAL_Bulk_Paint_Report.pdf

ECOFYS

sustainable energy for everyone

ECOFYS Netherlands B.V.

Kanaalweg 15G
3526 KL Utrecht

T: +31 (0) 30 662-3300
F: +31 (0) 30 662-3301

E: info@ecofys.com
I: www.ecofys.com

ECOFYS

sustainable energy for everyone

Case Study: Trucks

Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive

ENER/C3/2012-523

Case Study: Trucks

Evaluation of the Energy Labelling Directive

and specific aspects of the Ecodesign Directive

ENER/C3/2012-523

- Confidential –

By:
João Fong (ISR-University of Coimbra)
Leandro Silva (ISR-University of Coimbra)

Date: 28-05-2014

Project number: BUINL13345

Table of contents

1 Introduction

This case study shall examine the feasibility of developing ecodesign and labelling requirements for the product category “trucks” within the context of the Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive. This product category has been selected as representative of the broader product group “Transportation”.

Road clearly plays a predominant role in EU-27 transport, be it that of passengers or of goods. In 2006, transport accounted for 31,5 % of EU-27 energy consumption in 2006. Industry, services and households accounted in large part for the remaining shares.

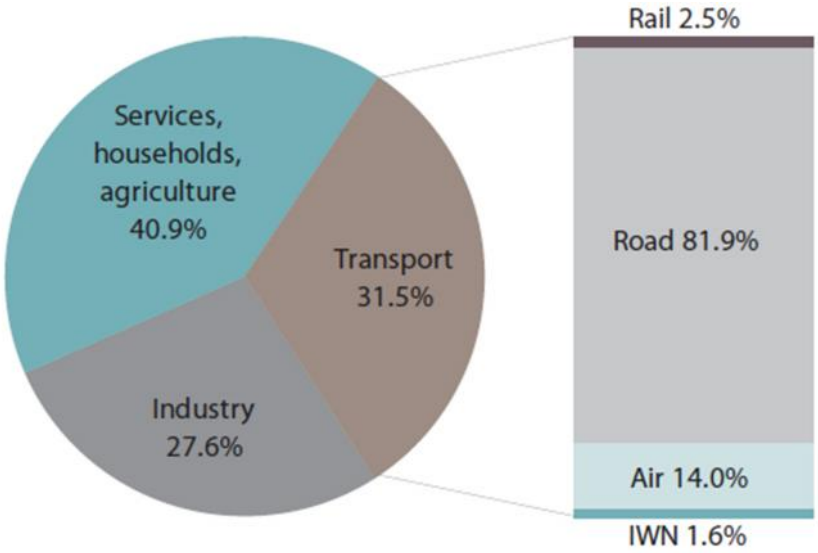


Figure 1 Share of transport in final energy consumption, EU-27, 2006 (% TOE) (Source: Eurostat)

Cars are responsible for the largest part of the energy consumption of road vehicles (48%) followed by freight transport (trucks and light-duty vehicles) which are responsible for 30% of total energy consumption of transport. The remaning part is attributable to buses and motorcycles.

This means that freight transport by road is responsible for roughly 10% of the total final energy consumption in the EU-27.

Road transportation of goods represented 46% of the total goods transportation performance.

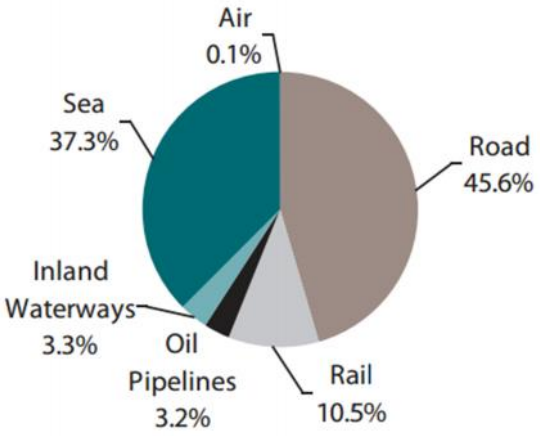


Figure 2 Modal distribution of goods transport performance, EU-27, 2006 (% tkm) (source: DG Energy and Transport)

Demand factors such as the increasing importance of door-todoor and just-in-time services have contributed to Road's growing modal share in goods transport performance over the 1995-to-2006 period.

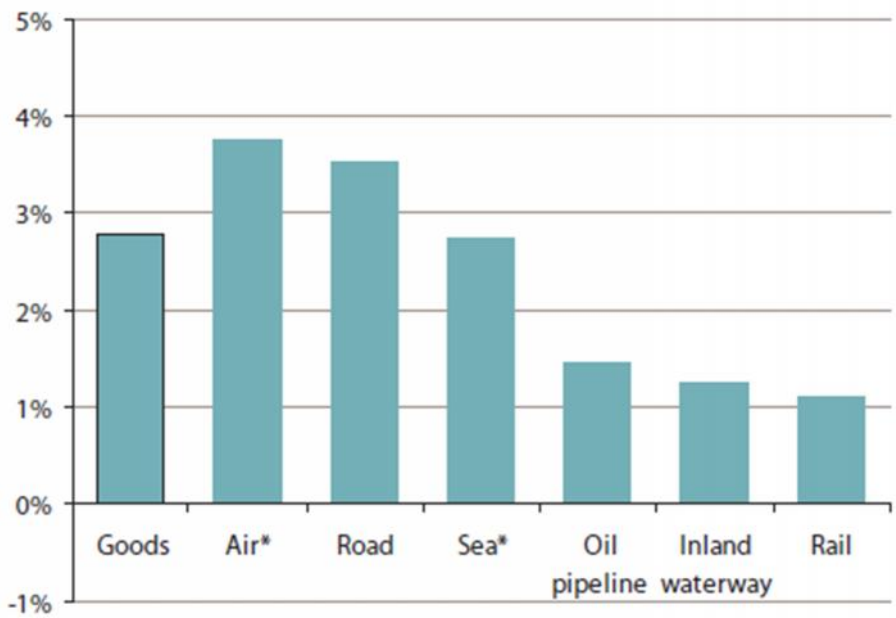


Figure 3 Average annual growth rates, goods transport, EU-27, 1995 to 2006 (%) (source: Eurostat)

2 Scope

2.1 Brief Definition of the Product Scope

For the purpose of this study, a truck is defined as a vehicle designed and constructed for the carriage of goods, and having a maximum weight higher than 3.5 tonnes. Note that, it can be a national road freight transport, where the loading and unloading places are both inside of the country, or an international road freight transport, where the loading and unloading places are in different countries independent of the country in which the vehicle is registered.
According with Directive 2007/46/EC[1], Annex II - section A.2, there are two categories of heavy commercial vehicles:

- Category N2: Vehicles designed and constructed for carriage of goods and having a maximum mass exceeding 3,5 tonnes but not exceeding 12 tonnes.
- Category N3: Vehicles designed and constructed for the carriage of goods and having a maximum mass exceeding 12 tonnes.

Category N1 corresponds to light commercial vehicles having a maximum mass not exceeding 3,5 tonnes and are out of the scope of this case-study.

These types of vehicles are used in different applications such as:

- Service / delivery: Urban operation including frequent stop start.
- Regional Delivery / Collection: Regional delivery of consumer goods from a central warehouse includes periods of constant high speed and urban operation.
- Long Haul: Long periods of constant high speed travel with very few periods of urban operation.
- Urban Delivery / Collection: Distribution in cities or suburban areas including frequent stop/start driving.
- Municipal Utility: Typical duty cycle is low speed urban operation with frequent stop starts, typical vehicle is a refuse truck.
- Construction: Vehicles operating on and off-site both light and heavy duty.

2.2 Standards and legislation

The following section briefly describes the existing legislation and standards related to different stages of the life cycle of trucks (manufacture, use, and end-of-life). Table 1 summarizes such legislation applied to medium and heavy duty road transport vehicles.

[1] Directive 2007/47/EC - Establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles

Table 1 Legislation regarding road freight transport vehicles.

Life cycle stage	Product	Legislation
Manufacture	Plant processes	- IPPC Directive 2010/75/EC: on industrial emissions (integrated pollution prevention and control).
		- Directive 2007/46/EC: Establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles;
		- Directive 2004/42/EC: on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC.
		- Environmental Technologies Action Plan (COM (2004) 38);
Use	Fuel quality	- Directive relating to the quality of petrol and diesel fuels (2009/30/EC);
	Emissions	- Regulation 595/2009 on type-approval of motor vehicles and engines with respect to emissions from heavy duty vehicles (Euro VI)
	Labelling of tires	- Regulation on the labelling of tyres (Regulation 2009/1222)
	Noise	- Directive relating to the permissible sound level and the exhaust system of motor vehicles (Directive 70/157/EEC) amended by Directive 2007/34/EC
End-of-life	Road transport	- Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators

Emissions

European emission regulations for new heavy-duty diesel engines are commonly referred to as Euro I to VI.

The emission standards apply to all motor vehicles with a “technically permissible maximum laden mass” over 3,500 kg, equipped with compression ignition engines or positive ignition natural gas (NG) or Liquefied petroleum gas (LPG) engines.

The most important rulemaking steps in the heavy-duty engine regulations, were:

- Euro I standards were introduced in 1992, followed by the introduction of Euro II regulations in 1996. These standards applied to both truck engines and urban buses, the urban bus standards, however, were voluntary.

- In 1999, the EU adopted Directive 1999/96/EC, which introduced Euro III standards (2000), as well as Euro IV/V standards (2005/2008). This rule also set voluntary, stricter emission limits for extra low emission vehicles, known as “enhanced environmentally friendly vehicles” or EEVs.
- In 2001, the European Commission adopted Directive 2001/27/EC which prohibits the use of emission “defeat devices” and “irrational” emission control strategies, which would be reducing the efficiency of emission control systems when vehicles operate under normal driving conditions to levels below those determined during the emission testing procedure.
- Directive 2005/55/EC adopted in 2005 introduced durability and on-board diagnostic (OBD) requirements, as well as re-stated the emission limits for Euro IV and Euro V which were originally published in 1999/96/EC. In a “split-level” regulatory approach, the technical requirements pertaining to durability and OBD—including provisions for emission systems that use consumable reagents—have been described by the Commission in Directive 2005/78/EC.
- Euro VI emission standards were introduced by Regulation 595/2009, with technical details specified in the ‘comitology’ Regulation 582/2011. The new emission limits, comparable in stringency to the US 2010 standards, become effective from 2013/2014. The Euro VI standards also introduced particle number (PN) emission limits, stricter OBD requirements and a number of new testing requirements—including off-cycle and in-use testing.

The following tables contain a summary of the emission standards and their implementation dates. There are two sets of emission standards, with different type of testing requirements:

- Steady-State Testing: Table 1 lists emission standards applicable to diesel (compression ignition, CI) engines only, with steady-state emission testing requirements.
- Transient Testing: Table 2 list standards applicable to both diesel and gas (positive ignition, PI) engines, with transient testing requirements.

Table 1 EU Emission Standards for Heavy-Duty Diesel Engines: Steady-State Testing

Stage	Date	Test	CO	HC	NOx	PM	PN	Smoke
			g/kWh				1/kWh	1/m
Euro I	1992, ≤ 85 kW	ECE R-49	4.5	1.1	8.0	0.612		
	1992, > 85 kW		4.5	1.1	8.0	0.36		
Euro II	1996.10		4.0	1.1	7.0	0.25		
	1998.10		4.0	1.1	7.0	0.15		
Euro III	1999.10 EEV only	ESC & ELR	1.5	0.25	2.0	0.02		0.15
	2000.10		2.1	0.66	5.0	0.10[a]		0.8
Euro IV	2005.10		1.5	0.46	3.5	0.02		0.5
Euro V	2008.10		1.5	0.46	2.0	0.02		0.5
Euro VI	2013.01	WHSC	1.5	0.13	0.40	0.01	8.0×10^{11}	
a - PM = 0.13 g/kWh for engines < 0.75 dm^3 swept volume per cylinder and a rated power speed > 3000 min^{-1}								

Table 2 EU Emission Standards for Heavy-Duty Diesel Engines: Transient Testing

Stage	Date	Test	CO	NMHC	CH_4[a]	NOx	PM[b]	PN[e]
			g/kWh					1/kWh
Euro III	1999.10 EEV only	ETC	3.0	0.40	0.65	2.0	0.02	
	2000.10		5.45	0.78	1.6	5.0	0.16c	
Euro IV	2005.10		4.0	0.55	1.1	3.5	0.03	
Euro V	2008.10		4.0	0.55	1.1	2.0	0.03	
Euro VI	2013.01	WHTC	4.0	0.16[d]	0.5	0.46	0.01	6.0×10^{11}

a - for gas engines only (Euro III-V: NG only; Euro VI: NG + LPG)
b - not applicable for gas fueled engines at the Euro III-IV stages
c - PM = 0.21 g/kWh for engines < 0.75 dm3 swept volume per cylinder and a rated power speed > 3000 min-1
d - THC for diesel engines
e - for diesel engines; PN limit for positive ignition engines TBD

Additional provisions of the Euro VI regulation include:

- An ammonia (NH3) concentration limit of 10 ppm applies to diesel (WHSC + WHTC) and gas (WHTC) engines.
- A maximum limit for the NO2 component of NOx emissions may be defined at a later stage.

The regulatory emission test cycles have been changed several times, as indicated in Table 1 and Table 2. Since the Euro III stage (2000), the earlier steady-state engine test ECE R-49 has been replaced by two cycles: the European Stationary Cycle (ESC) and the European Transient Cycle (ETC). Smoke opacity was measured over the European Load Response (ELR) test. The following testing requirements applied:

Euro III: (1) ESC/ELR test for conventional diesel engines, (2) ESC/ELR + ETC testing for diesel engines with “advanced aftertreatment” (NOx aftertreatment or DPFs) and for EEVs, and (3) ETC test for positive ignition (NG, LPG) engines.

Euro IV-V: (1) ESC/ELR + ETC testing for diesel engines, and (2) ETC test for positive ignition engines.

Since the Euro VI stage, diesel engines are tested over the World Harmonized Stationary Cycle (WHSC) + World Harmonized Trasient Cycle (WHTC) tests, while positive ignition engines are tested over the WHTC only.

Off-Cycle Testing. Euro VI regulation introduced off-cycle emissions (OCE) testing requirements. OCE measurements, performed during the type approval testing, follow the NTE (not-to-exceed) limit approach. A control area is defined on the engine map (there are two definitions, one for engines with a rated speed < 3000 rpm, and another for engines with a rated speed ≥ 3000 rpm). The control area is divided into a grid. The testing involves random selection of three grid cells and emission measurement at 5 points per cell.

In-Service Conformity Testing. Euro VI regulation also introduced in-use testing requirements that involve field measurements using Portable Emission Measurement Systems (PEMS). The testing is conducted over a mix of urban (0-50 km/h), rural (50-75 km/h) and motorway (> 75 km/h) conditions, with exact percentages of these conditions depending on vehicle category. First in-use test should be conducted at the time of type approval testing.

Emission Durability. Effective 2005.10/2006.10, manufacturers should demonstrate that engines comply with the emission limit values for useful life periods which depend on the vehicle category.

These Euro standards only regulate emissions that affect air quality, not CO_2 or other GHGs (although CO_2 emissions have been measured since Euro V). In practice, many of the engine modifications required to limit the regulated emissions have also decreased the fuel efficiency of the engines and therefore led to an increase in CO_2 emissions.

Other Legislation

Directive 2009/33 on the promotion of clean and energy-efficient road transport vehicles, which requires contracting authorities, contracting entities as well as certain operators to take into account lifetime energy and environmental impacts, including energy consumption and emissions of CO_2 and of certain pollutants, when purchasing road transport vehicles with the objectives of promoting and stimulating the market for clean and energy- efficient vehicles and improving the contribution of the transport sector to the environment, climate and energy policies of the Community.

Directive 2003/59/EC on the initial qualification and periodic training of drivers of certain road vehicles for the carriage of goods or passengers, which requires professional bus, coach and lorry drivers need to hold a Driver Certificate of Professional Competence (CPC) in addition to a vocational driving licence. It has been introduced across Europe with the aim of improving road safety and helping to maintain high standards of driving. The course may contain parts on fuel efficient driving techniques.

Directive 2007/46/EC : Establishes a harmonised framework containing the administrative provisions and general technical requirements for approval of all new vehicles/components/units within its scope. It shall be applied to the type-approval of vehicles designed and constructed in one or more stages for use on the road, and of systems, components and separate technical units designed and constructed for such vehicles. Note that some sections of the directive were amended.

Regulation 661/2009: Sets requirements for the general safety of motor vehicles, as a complement to the directive 2007/46/EC.

Regulation 2009/1222: establishes a framework for the provision of harmonised information on tyre parameters through labelling, allowing end-users to make an informed choice when purchasing tyres.

Directive 2009/30/EC: Describes requirements regarding fuel characteristics (diesel, petrol, and gas-oil) in respect to road vehicles.

Directive 2006/66/EC: Specifies rules for collection, treatment, recycling and disposal of waste batteries and accumulators. Also, it sets rules for the placement of batteries and accumulators on the market.

Directive 2007/34/EC: Related to the permissible sound levels and the exhaust system of motor vehicles. Such permissible sound levels can be found in Annex I of the Directive.

2.3 Standards and legislation outside the EU

USA

The USA, through the Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) standards, have implemented fuel efficiency and CO_2 emission limits for heavy-duty vehicles, in 2011. EPA is adopting GHG emissions standards under the Clean Air Act, and NHTSA is adopting fuel efficiency standards under EISA. The standards will phase in to the 2017 models.

Heavy-duty vehicles include both work trucks and commercial medium and heavy-duty on highway vehicles as defined by the Energy Independence and Security Act (EISA). Heavy-duty engines affected by the final standards are generally those that are installed in commercial medium- and heavy-duty trucks and buses. The agencies' scopes are the same except that EPA is including recreational on-highway vehicles (RV's, or motor homes) within its rulemaking, while NHTSA is not including these vehicles.

Trailers are not covered under these rules, due to the first-ever nature of this program and the agencies' limited experience working in a compliance context with the trailer manufacturing industry. However, because trailers do impact the fuel consumption and CO2 emissions from combination tractors, and because of the opportunities for reductions, trailers are intended to be included in a future rulemaking.

The majority of these vehicles carry payloads of goods or equipment, in addition to passengers. To account for this in the regulatory program, two types of standard metrics have been adopted:

- payload-dependent gram per mile (and gallon per 100-mile) standards for pickups and vans;
- and gram per ton-mile (and gallon per 1,000 ton-mile) standards for vocational vehicles and combination tractors.

These metrics account for the fact that the work to move heavier loads burns more fuel, and emits more CO2 than in moving lighter loads.

These standards are expected to achieve from nine to 23 percent reduction in emissions and fuel consumption from affected tractors over the 2010 baselines.

The USA also has standards limiting other emissions to air (NOx, PM, NMHC) which apply to new diesel engines used in heavy-duty highway vehicles.

In addition to these standards the EPA has implemented, in 2004, a program for improving fuel efficiency and reducing greenhouse gases and air pollution from the transportation supply chain industry, SmartWay.

SmartWay Transport Partnership is a strong government/industry collaboration between freight shippers, carriers, logistics companies and other stakeholders, to voluntarily achieve improved fuel efficiency and reduce environmental impacts from freight transport. Participating companies use performance based quantification and reporting tools that benchmark and inform industry and the marketplace on freight operations, energy and environmental efficiency.

SmartWay partners demonstrate to customers, clients, and investors that they are taking responsibility for the emissions associated with goods movement, are committed to corporate social responsibility and sustainable business practices, and are reducing their carbon footprint. To date, the partnership includes nearly 2,900 companies and associations committed to improving fuel efficiency. SmartWay Tractors and Trailers meet voluntary equipment specifications that can reduce fuel consumption by 10 to 20 percent for 2007 long-haul tractors and trailers. Each qualified tractor/trailer combination can save between 2,000 to 4,000 gallons of diesel per year. Models that meet these equipment specifications save operators money and reduce greenhouse-gas emissions and air pollutants. EPA Technology Verification for SmartWay Designation is a testing and verification program designed to quantify emissions reductions and fuel savings from various available technologies, such as tractor and trailer aerodynamics, auxiliary power units, and wide-based tires. As a result, companies can compare the fuel efficiency and environmental performance of various technologies and make more informed purchases (EPA, 2013).

Japan

The first vehicle fuel efficiency standards, were adopted in 1979, under the “Law Concerning the Rational Use of Energy” and were applicable to new gasoline cars from 1985.

Two important sets of fuel efficiency targets are the 2010 targets and the 2015 targets (the latter also known as new fuel efficiency targets). These requirements were adopted through a number of amendments to the “Law Concerning the Rational Use of Energy”, based on the gross vehicle weight (GVW) category, as follows:

- 1999—Adoption of 2010 fuel efficiency targets for gasoline passenger cars and light commercial vehicles (effective 2005 for diesel vehicles).
- 2003—Fuel efficiency standards for LPG cars (2010 targets).
- 2006—New fuel efficiency standards for heavy vehicles above 3.5 t (2015 targets).
- 2007—Adoption of 2015 fuel efficiency targets for light vehicles, including revisions to passenger car and light commercial vehicles standards, and new standards for small buses.

Manufacturers must ensure that in each financial year the average fuel economy of their vehicles in each weight category meets the standard (with small penalties for exceeding the limit).

Financial incentives—such as progressive taxes levied on the vehicle weight and engine displacement— are in place that promote the purchase of more efficient vehicles. Vehicles that exceed the fuel economy standards and emission standards may be also eligible for additional reductions in vehicle tax. A label is in place that allows customers to identify vehicles that exceed standards.

The new fuel efficiency standard for medium and heavy duty vehicles (GVW>3,5 t) powered by diesel engines will be enforced from 1015.

When the targets are fully met, the fleet average fuel economy is estimated at:

- 7.09 km/L (369.6 g CO2/km), a 12.2% increase over 2002 performance of 6.32 km/L (414.6 g CO2/km)

A computer simulation procedure has been developed that allows to calculate fuel efficiency (in km/L) of heavy-duty trucks and buses based on engine dynamometer testing. The engine testing is performed over the urban JE05 test and over an interurban transient test (speed: 80 km/h, load factor: 50%). A number of vehicle factors, such as vehicle mass, payload, tire size, gear ratios and efficiency, and others are accounted for in the calculation.

Japan also has regulations in place regarding other emissions, which is similar to the European scheme (see Figure 4).

It is important to notice that the heavy-duty fleet in Japan ihas a very different composition than the European one, with almost non-existant long-haul vehicles.

China

With a few exceptions, emission standards for new heavy-duty truck and bus engines are based on the European standards.

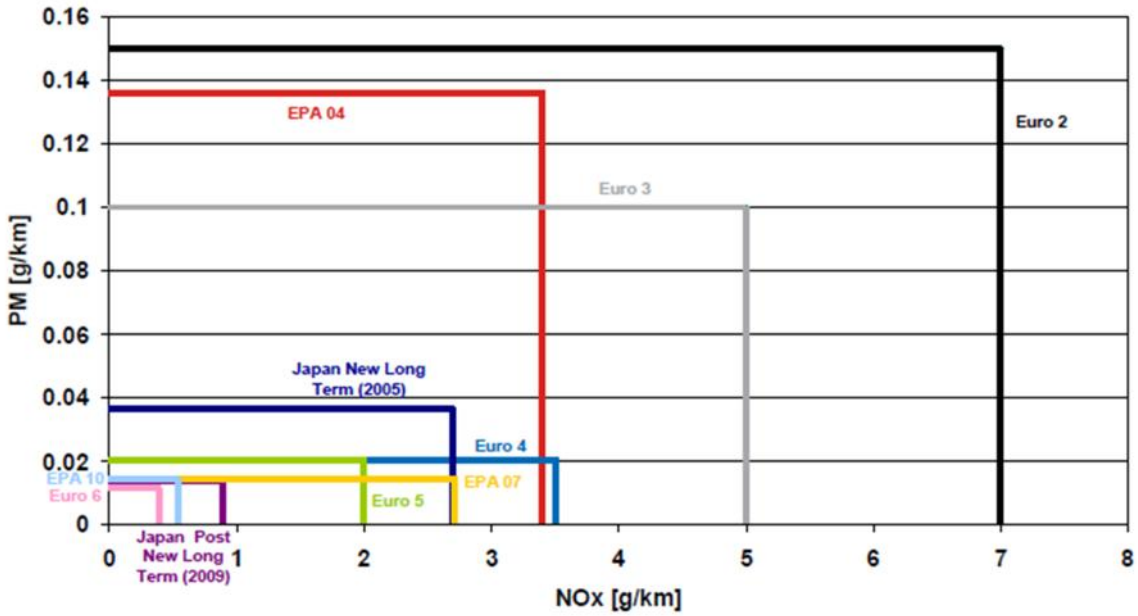


Figure 4 Heavy Duty Diesel Emissions Legislation (AEA - Ricardo, 2011)

3 Market

3.1 Road freight transport by vehicle characteristics

The stock of goods vehicles decreased about 21.5 % since 2006 until 2011 in Europe. From tabela 4, it is possible to observe that the number of road transport vehicles achieved a maximum of 5 164 931 units in 2007 and a minimum of 3 778 726 units in 2008.

Table 3 Total number of goods vehicles in Europe, 2006-2011, in thousands (Eurostat, 2013)

	2006	2007	2008	2009	2010	2011	Change 2006-2011
EU-27	4 984	5 165	3 779	4 105	3 922	3 911	21.6%

The large variation between 2007 and 2008 is due to a change in accounting method for the UK. If this change is disregarded, the increasing trend would have continued until 2009 where a slight decrease in the total number of goods vehicles can be observed probably caused by the economic crisis.

Road transport by maximum permissible laden weight

In 2011 about 84% of EU-27 road transport was done by vehicles with a maximum permissible laden weight over 30 tonnes, and only 1% under 10 tonnes (Table 4).

Table 4 Road transport by maximum permissible laden weight of vehicle, 2011 (Eurostat, 2013)

Maximum permissible laden weight of vehicle (tonnes)	2011 Million tonnes-kilometre	2011 % of total
0 - 6	1 223	0.1
6.1 – 10.0	9 860	0.6
10.1 – 20.0	158 615	9.1
20.1 – 30.0	107 328	6.2
30.1 – 40.0	835 181	48.1
> 40.0	624 331	36.0
Total	1 736 623	100.0

Between 2006 and 2011, vehicles with MPLW less than 30 tonnes had decreased 27% (Figure 5). Note that, 76.5% of all inland freight transport in EU is done by medium and heavy duty vehicles (BIOIS, 2010).

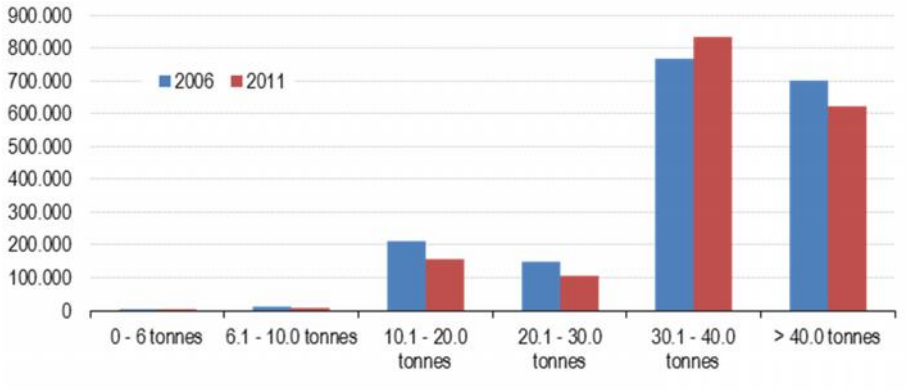


Figure 5 EU-27 road transport by maximum permissible laden weight of vehicle, 2006 and 2011 (million tonne-kilometres) (Eurostat, 2013)

Road transport by load capacity

During 2011, the statistics retrieved from (Eurostat, 2013) shows that 79,6 % of EU-27 road transport was done by trucks with a load capacity higher than 20,6 tonnes (Table 5). Although, only 19,4 % of it was carried out by a range of vehicles with a load capacity bellow 20,6 tonnes. Note that, heavy duty vehicles dominate the road transport in Europe.

Table 5 Road transport by load capacity, 2011 (Eurostat, 2013)

Load capacity (tonnes)	2011 Million tonnes-kilometre	2011 % of total
0 – 3.5	6 802	0.4
3.6 – 9.5	49 630	2.9
9.6 – 15.5	196 446	11.3
15.6 – 20.5	101 690	5.9
20.6 – 25.5	493 921	28.4
25.6 – 30.5	612 424	35.3
> 30.5	275 660	15.9
Total	1 736 623	100.0

Comparing to 2006, in 2011 there was an increase of nearly 40% on vehicles with a load capacity over 30.5 tonnes, while for all the other categories there was a decrease ranging from 1% to 25%. The overall EU-27 load capacity decreased by 6% during the same period (Error! Reference source not found.). (Eurostat, 2013)

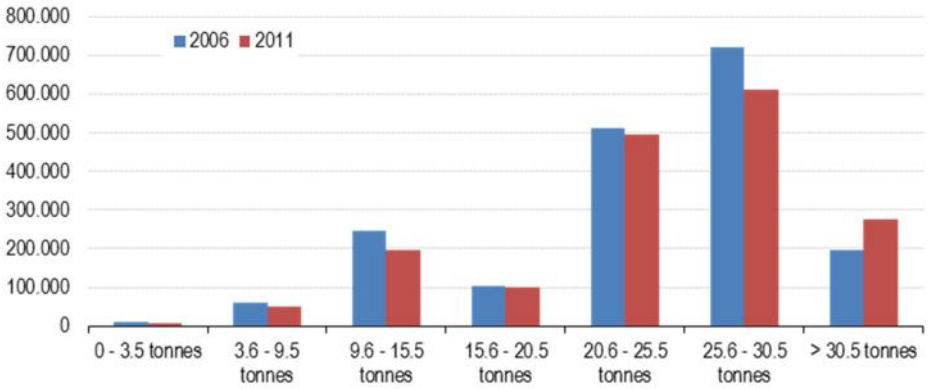


Figure 6 Evolution of EU-27 road transport by load capacity, 2006 and 2011 (million tonne-kilometres) (Eurostat, 2013)

Age of vehicles

Three years old vehicles dominated the EU-27 truck market in 2011 with an estimation of 255 242 billion tonne-kilometres covered. Vehicles with 5 or less years old had contributed for 60 % of the total tonne-kilometres, and only 13% of the total tonne-kilometres were covered by vehicles with an age above 10 years old.

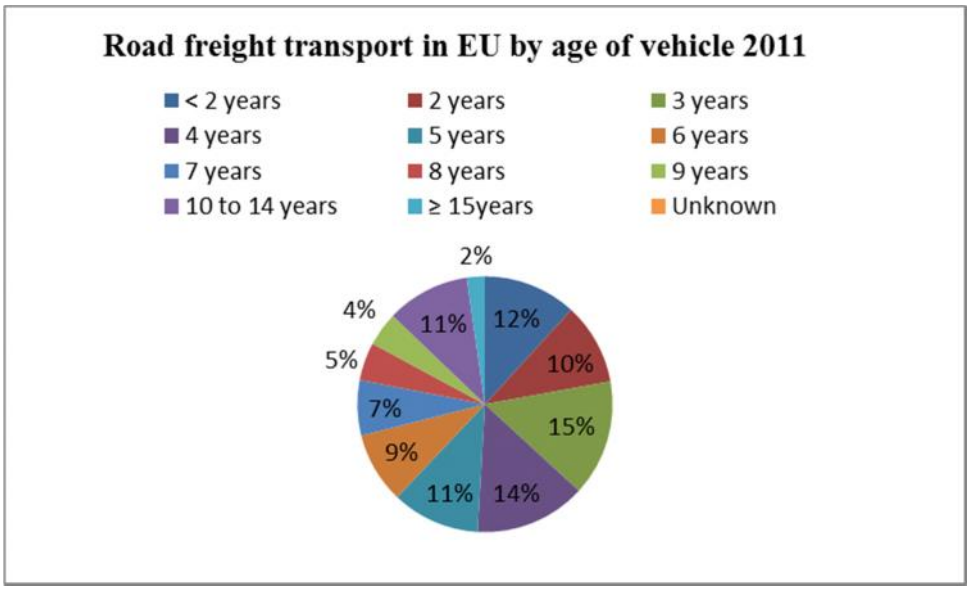


Figure 7 Road freight transport in the EU-27 by age of vehicle, 2006-2011 (% of the total million tonne-kilometres) (Eurostat, 2013).

Road freight transport by axle configuration

Regarding the road freight transport by axle configuration, road tractor ad semi-trailer had done more that 78% of the total EU-27 tonne-kilometres. Error! Reference source not found. shows different axle configuration of commercial vehicles and their tonne-kilometres carried out. Note that, commercial vehicles can have different axle configuration: lorry, lorry and trailer, and road tractor and semi-trailer.

Table 6 Road freight transport by axle configuration, 2011 (Eurostat, 2013).

	Lorry	Lorry and trailer	Road tractor and semi-trailer	Total
EU-27 (million tonne-kilometres)	156 991	172 588	1 155 881	1 485 857

Road freight transport by journey characteristics

The total, national, and international EU-27 road freight transport from 2006 to 2011 can be observed in Error! Reference source not found.. The national EU-27 road freight transport had dominated with 67.35 % of the total tonne-kilometres in 2011. Although, the international EU-27 road freight transport covered 32.65 % of the total tonne-kilometres. Note that the EU-27 average vehicle loads were 13.6 tonnes in 2011, with national loads of 12.7 tonnes and international loads of 16.1 tonnes. Regarding the average distance of journeys in the EU-27, it was estimated 116 kilometres in 2011. This average distance was 84 kilometres in national transport and 596 kilometres in international transport. The average distance obtained for individual Member States depends on the size of the country and on its involvement in international transport where longer distances are travelled. (Eurostat, 2013)

Table 7 Total road freight transport, 2006-2011 (million tonne-kilometres);

EU-27	2006	2007	2008	2009	2010	2011	Change 2010-2011
Total	1.847.322	1.914.206	1.879.834	1.690.081	1.746.281	1.730.986	-1%
National	1.246.475	1.292.450	1.269.137	1.153.366	1.172.144	1.165.867	-1%
International	600.849	621.752	610.696	536.717	574.136	565.120	-2%

Road freight transport by economic activity

Figure 8 shows the road transport by economic activity in 2011 for 20 countries. Such economic activity was divided in 5 groups: manufacturing, construction, wholesale and retail trade / repair of motor vehicles and motorcycles, transportation and storage, and others.

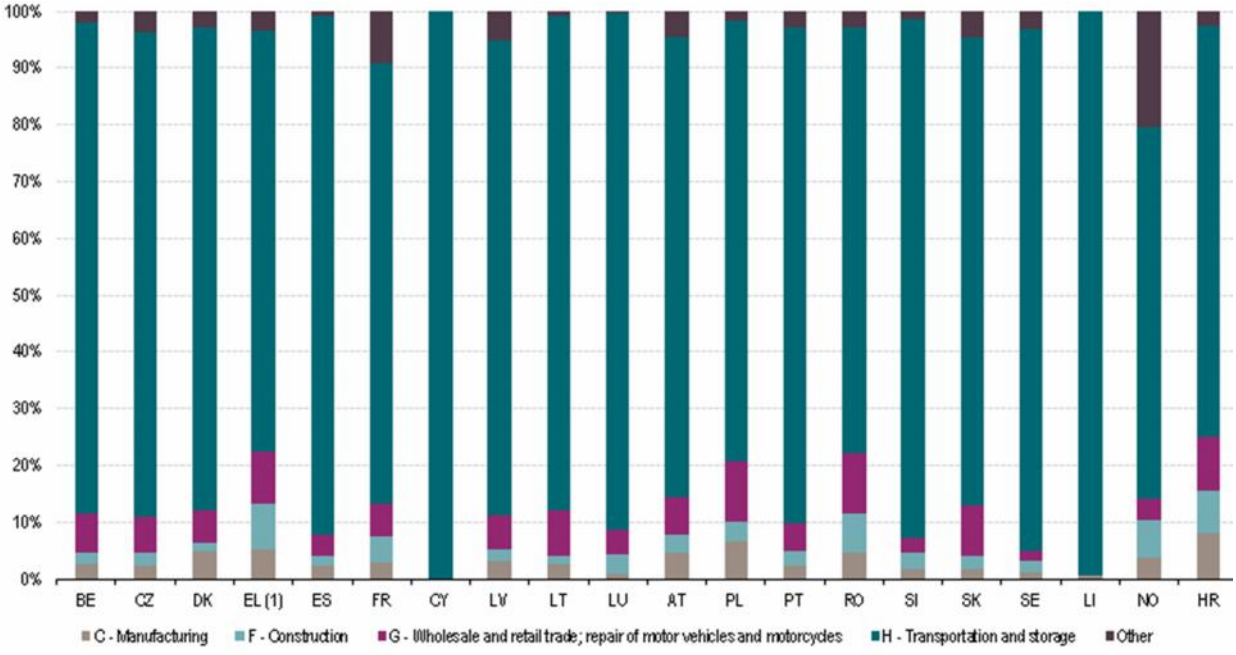


Figure 8 Road freight transport by economic activity in 2011 (million tonne-kilometres) (Eurostat, 2013)

4 Users

Consumer behaviour can – in part – be influenced by product-design but overall it is a very relevant input for the assessment of the environmental impact and the Life Cycle Costs of a product. This section identifies relevant user-parameters that influence the environmental impact during product-life.

Driving Behaviour

The fuel consumption of a vehicle is mainly dependent on its user/driver. Training drivers, with formation on a variety of fuel efficient driving techniques, are able to reduce the fuel consumption by at least 5% (AECOM, 2008). Such training techniques are based mainly on the following key elements:

- Use of cruise control where safe and appropriate;
- Use of exhaust brake;
- Forward planning and keeping the vehicle moving;
- Using the of exhaust brake momentum of the vehicle;
- Keeping the engine speed within the 'green band' and using the highest possible gear;
- Keeping the height of the trailer or load to a minimum;
- Positioning loads as close as possible to the body on flat trailers;
- Changing gears as few times as possible;
- The need to avoid speeding;
- Planning routes effectively to reduce lost running;
- Using constant speeds as far as possible;
- Checking the condition of tires;
- Ensuring familiarity with the vehicle's technology.

Such training techniques can offer several benefits for drivers, transport operators, and for organizations. The stress levels of a driver with training may be lower than a driver without training. Transport operators can have the advantage of: reduced running costs (maintenance and tires), reduced fuel consumption, more productivity and vehicle utilization, improved resale value of fleet, and potential reductions in insurance premiums. Regarding organizations, there is higher possibility to develop the health and safety culture of the organization, effective risk management, and reduced vehicle and personal injury accidents/incidents. Also, the greenhouse emissions, CO2 and other, from fuels will be decreased.

Vehicle choice

Environmental impacts can be decreased significantly by choosing an appropriated vehicle for a certain task. This can lead to improvements on fuel consumption and operational efficiency, cost savings, increased profitability and reduced environmental impacts. It is the responsibility of the buyer to check if the vehicle specification matches with the requirements.

Table 8 Vehicle and journey characteristics

TRANSPORT EFFICIENCY IS ALSO: PICKING THE MOST APPROPRIATE VEHICLE FOR THE JOB — SOURCE: VOLVO

GCW/GVW* tonne	Load Capacity tonne	Distance km	Fuel Consumption l/100km	tonnekm	l/1000tonnekm at 100% utilisation	normal utilisation	l/1000tonnekm considering normal utilisation
LONG DISTANCE							
26	17	100	25	1700	14.7	70%	21.0
40	25	100	32	2500	12.8	70%	18.3
60	40	100	43	4000	10.8	70%	15.4
URBAN DISTRIBUTION							
3.5	1.5	100	12	150	80.0	45%	177.8
7.5	4	100	15	400	37.5	45%	83.3
12	7.2	100	19	720	26.4	45%	58.6
18	11	100	22	1100	20.0	45%	44.4

*Gross Combination Weight (Long Distance) / Gross Vehicle Weight (Urban Distribution)

Maintenance (Nylund, 2006)

Preventative maintenance can be thought of as a proactive management strategy, rather than a set of individual actions. It is a strategy that involves making sure that vehicles are always kept in good order to help minimize the chance of major defects occurring, whilst finding ways to improve vehicle efficiency above merely ensuring that basic roadworthiness is attained.

This strategy can include daily vehicle checks, as well as systematic, thoroughly documented safety inspections at programmed intervals, whilst ensuring that proper procedures are in place for dealing effectively with any vehicle faults. Records of these activities are the foundation of a preventative maintenance trainings, and the system should be supported by capable and responsible staff and adequate maintenance facilities.

Other proactive preventative maintenance measures also include tire management and laser wheel alignment. These measures are relatively cheap actions for an operator to carry out and have real fuel efficiency benefits. In terms of the EC's, it could be possible to extend the scope of labelling passenger car tires to also include HDV tires.

5 Technologies and Product Design Options

This section describes the new and current technology of medium and heavy duty vehicles and its impact/benefit on the environment, with particular attention given to fuel consumption and greenhouse emissions in Europe which is where the main technological developments have occurred due to its economic implications. Developments in emissions controls have been driven by the increasingly strigent emissions regulations.

(AEA - Ricardo, 2011) conducted a benchmark of the models of the leading OEMs in the EU, USA and Japan to identify the state-of-the-art technology in the market at the time of the study. Current state of the art technology is defined as that which is offered by a number of OEMs within a specific market across more than one model. The technologies identified in the European market are shown in the next two tables for medium and heavy duty vehicles.

Table 9 Current State of the Art Technology for Medium Duty Trucks (AEA - Ricardo, 2011)

Engine	• Euro V Emissions level; • Inline 4 cylinder circa 4L or inline 6 cylinder circa 6L; • SCR or EGR + POC; • Common Rail or Unit Injectors; • FGT or 2 stage Turbocharging;
Drivetrain	• 5,6 or 9 speed manual; • 6 speed AMT – Optional; • 5 speed automatic – Optional;
Vehicle	• Front bumper with air dam; • Cab side edge turning vanes; • Rounded cab corners; • Cab deflector – Optional; • Cab collars – Optional;
Incompatible Timesharing System / Information and communication technology (ITS/ICT)	• Driver display, including fuel consumption; • Tire pressure indication – Optional;

Table 10 Current State of the Art Technology for Heavy Duty Trucks (AEA - Ricardo, 2011)

Engine	• Euro V emissions legislation; • 10, 11, 12, 13 or 16L inline 6, 12L V6 or 16 or 18L V8; • Unit injectors or common rail; • SCR or EGR + DPF; • FGT, VGT or 2 stage turbocharger; • 100% biodiesel compatible (Daimler);
Drivetrain	• 12 or 16 speed AMT; • 16 speed manual – Optional;
Vehicle	• Integrated air dam; • Cab side edge turning vanes; • Tire pressure monitoring – Optional; • Roof and side air deflector (Articulated) – Optional (Rigid);
Incompatible Timesharing System / Information and communication technology (ITS/ICT)	• Adaptive cruise control – Optional; • Navigation system – Optional; • Fleetboard Telematics system – Optional; • Forward collision warning – Optional;

A number of technologies for improving the environmental performance of medium and heavy duty vehicles are either available on the market, or under development. Some of these technological options are described below and its improvement potential is based on the analysis carried out in (AEA - Ricardo, 2011) and (Tiax, 2011) . The variation present in the improvement potentials is due to several factors, including the category of use of the vehicle (e.g. the impact of aerodynamic improvements is greater in heavy duty vehicles than in medium duty vehicles due to the different journey characteriscs of both vehicles).

Aerodynamics

Improving the aerodynamics of a vehicle can greatly improve its fuel efficiency and therefore GHG emissions. The power needed to overcome aerodynamic drag (D) equals D·V. As the drag itself increases with the square of the travelling speed (V), the power needed is proportional to the cube of the speed. Hence, at road speeds the power needed to overcome drag can represent over 40% of the power needed to move the vehicle.

A number of technological options are available to improve vehicles aerodynamic performance, such as:

Spray Reduction Mud Flaps - The mud flap separates the water from the air through a series of vertical passages created by vanes which makes the spray change direction a number of times eliminating the water.

Chassis Aerodynamic Features - Additional add-ons to vehicle chassis that help reduce aerodynamics drag and improve fuel consumption; Technologies include tractor and chassis/trailer side panels.

Cab Aerodynamic Fairings - Additional add-ons to cabs that help reduce aerodynamics drag and improve fuel consumption; Technologies include cab deflectors and cab collars and can be added as aftermarket additions.

Body Aerodynamic Features - Vehicle body designs aimed at reducing aerodynamic drag; Technologies include gap seals, body roof tapering and container / trailer front fairings.

Trailer Aerodynamic Tail Extensions - Extension of trailer beyond load length to improve aerodynamic performance of the trailer;

Active Aero - Active aerodynamics to reduce vehicle drag where air is blown from trailer trailing edge and over trailer roof to reduce drag caused by low pressure region behind trailer.

Lightweighting

Apply aluminum alloys intensively in tractor chassis and body, trailer and powertrain; Use of aluminum alloy may achieve a total combined unit weight savings of up to 2,000kg. The use of lightweight materials can help reduce fuel consumption through increased payload and fewer vehicle journeys or by lighter vehicles.

Tires and Wheels

Low Rolling Resistance Tires - Tires designed to minimize rolling resistance whilst still maintaining the required levels of grip.

Single Wide Tires - Replacement of dual tires on an axle with a lower aspect ratio single wide tire.

Automatic Tire Pressure Adjustment - Automatic tire pressure monitoring automatically monitors and adjust tire pressures. Automatic Tire Pressure systems use the air compressor on the vehicle to automatically monitor and adjust tire pressures to optimum levels for load and terrain conditions.

Transmission and Driveline

Automated Transmission - Replacement of manual transmissions with automated transmission based on a manual (AMT) which has similar mechanical efficiency to a manual transmission but automated gear shifts to optimize engine speed.

Engine

Variable flow / Electric Water Pump: Mechanical variable flow and electric water pumps vary speed, hence coolant water flow according to the engine demand (speed / load condition).
Variable speed oil Pump: Oil flow amount adjusted to engine speed and requirement to optimize oil flow and oil pump power consumption.
Controllable air Compressor: Air compressor with electric / air actuated clutch to de-connect compressor in idle status or when compressor not required. Current truck airbrake systems simply dump excess pressure to ambient when the air tanks are full, the compressor keeps running. For long-haul truck work, the airbrake system may not be used for up to 90% of the time.
Electric engine accessories: Electrification of Power Steering, A/C Compressor, Air Compressor, Engine Cooling Fan, Fuel Pump, etc.
Mechanical Turbocompound: Exhaust gas energy recovery with additional exhaust turbine, which is linked to a gear drive and transfers the energy on to the crankshaft providing extra torque.
Electrical Turbocompound: Exhaust turbine in combination with an electric generator / motor to recover exhaust energy: Recovered energy can be stored or used by other electrical devices; Motor during transients to accelerate.
Bottoming Cycles: Exhaust gas energy recovery with heat exchangers. Sometimes called “bottoming cycles”, this concept uses exhaust gas heat in an exchanger to drive an additional power turbine to generate energy.

Hybridization

Stop/Start Hybrid - System uses a high-voltage e-motor mounted to the crankshaft to operate stop / start, i.e. stopping the engine running whenever the vehicle is stationary, along with regenerative braking.
Hydraulic Hybrid - Convert the waste kinetic energy from braking into hydraulic energy by using an accumulator to store hydraulic fluid. This is then released and used to aid vehicle acceleration.
Flywheel Hybrid - An additional flywheel that stores and releases energy from/to the vehicle driveline. The flywheel stores energy, while braking for example, releasing it to supplement or temporarily replace the engine output.
Pneumatic Booster System - Compressed air from vehicle braking system is injected rapidly into the air path and allows a faster vehicle acceleration, which allows an earlier gear shift (short shifting), resulting in the engine operating more in an efficient engine speed / load range.

Management

Predictive Cruise Control - Development of systems that use electronic horizon data to improve the fuel efficiency of vehicles; Combining GPS with Cruise Control to better understand the road ahead for optimal speed control.
Vehicle Platooning - Vehicle driving in close proximity to each other to create a train; Vehicles are able to follow each other closely and safely to reduce aerodynamic drag and fuel consumption and increase safety.
Green Zone Indicator - Green zone indicates real-time fuel economy to encourage better driving.

Emission control

DPF (Diesel Particulate Filter) - A porous filter which removes particulate matter (PM) from exhaust gas

EGR (Exhaust Gas Recirculation) - Recirculation of exhaust gases into combustion chamber to reduce formation of NOx emissions

POC (Particle Oxidation Catalyst) - A flow through metallic filter with a reactive wash coat used to reduce particulate matter from the exhaust gas

SCR (Selective Catalytic Reduction) - Provides continuous NOx reduction using ammonia generated from injected urea. Urea consumption depends engine-out NOx level and catalyst temperature

6 Environmental impact

Previous studies have shown that the direct impacts of the vehicle cycle - producing the truck itself - were determined to contribute only modestly to the totals, in contrast to results of similar studies with automobiles. The main reasons are the long distances traveled by trucks at low fuel economy.

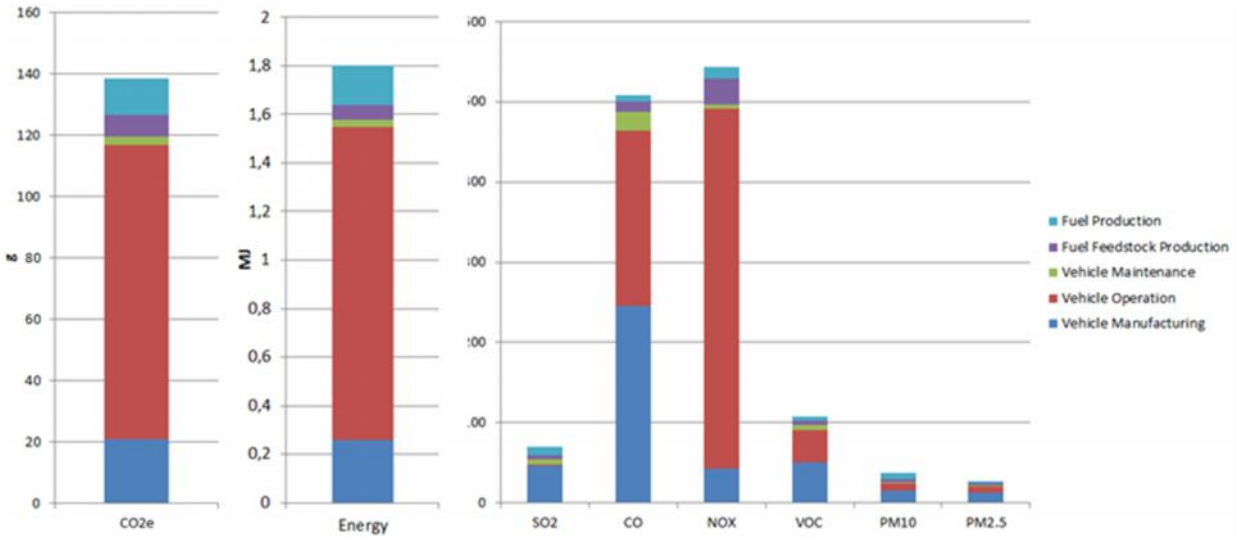


Figure 9 Emission Factors for Heavy-Duty Truck (Diesel) (source: Taptich 2013)

The transport sector is the fastest growing consumer of energy and producer of greenhouse gases in the European Union, despite advances in transport technology and fuel formulation that have resulted in marked decreases in emissions of certain pollutants.
From 1990 to 2006, the final energy consumption of Road transport grew at an annual rate of 1.6 %, to reach 303.3 million toe in 2006, which amounted to 25.8 % of total final energy consumption, and to 81.9 % of consumption in transport.

Road transportation is also responsible for the most emissions contributing with 93.1 % of the total greenhouse gas emissions of the transport sector in 2006. The figures exclude all international air and maritime transport.

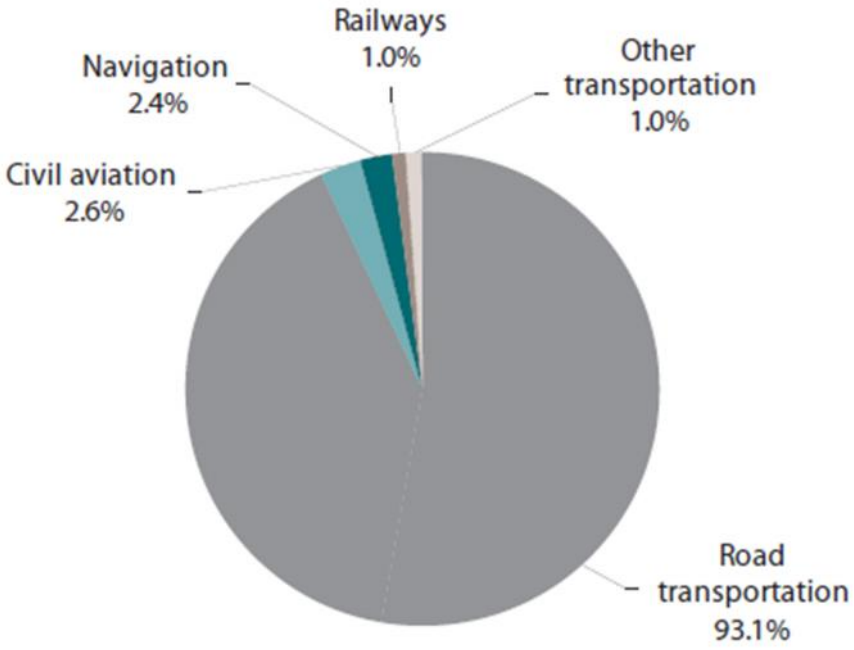


Figure 10 Greenhouse gas emissions, by transport mode (% CO2 eq) (Source: Eurostat)

Private cars represent the dominant transport mean in road transport, accounting for 55.9% of total energy consumed in road transport in 2005. Energy used by trucks accounted for 39.4% of total energy consumed in road transport in 2005, up from 34.5% in 1990. In the period 2000-2005 transport by trucks grew very fast, as a result of the increasing freight transport in the enlarged EU. This growing trend is expected to continue, with a faster growth rate in trucks than in any other mode of road transportation, at or above the rate of economic growth.
Road freight transport is responsible for roughly 10% of the total final energy consumption in the EU-27.

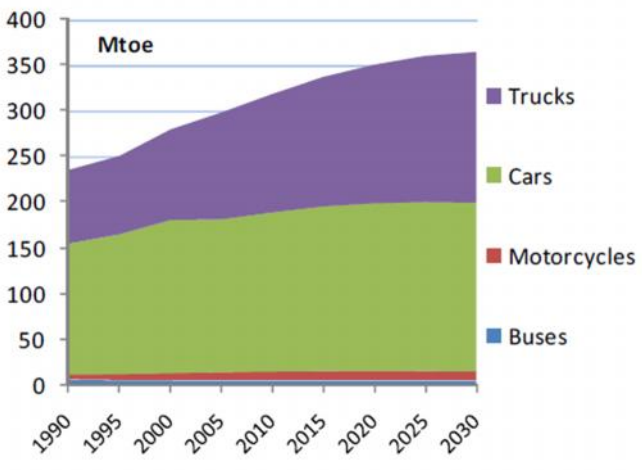


Figure 11 Energy consumption in road transportation (source: DG Energy and Transport)

Considerable improvements in the environmental performance can be achieved by the application of the technology options described in the section 5.

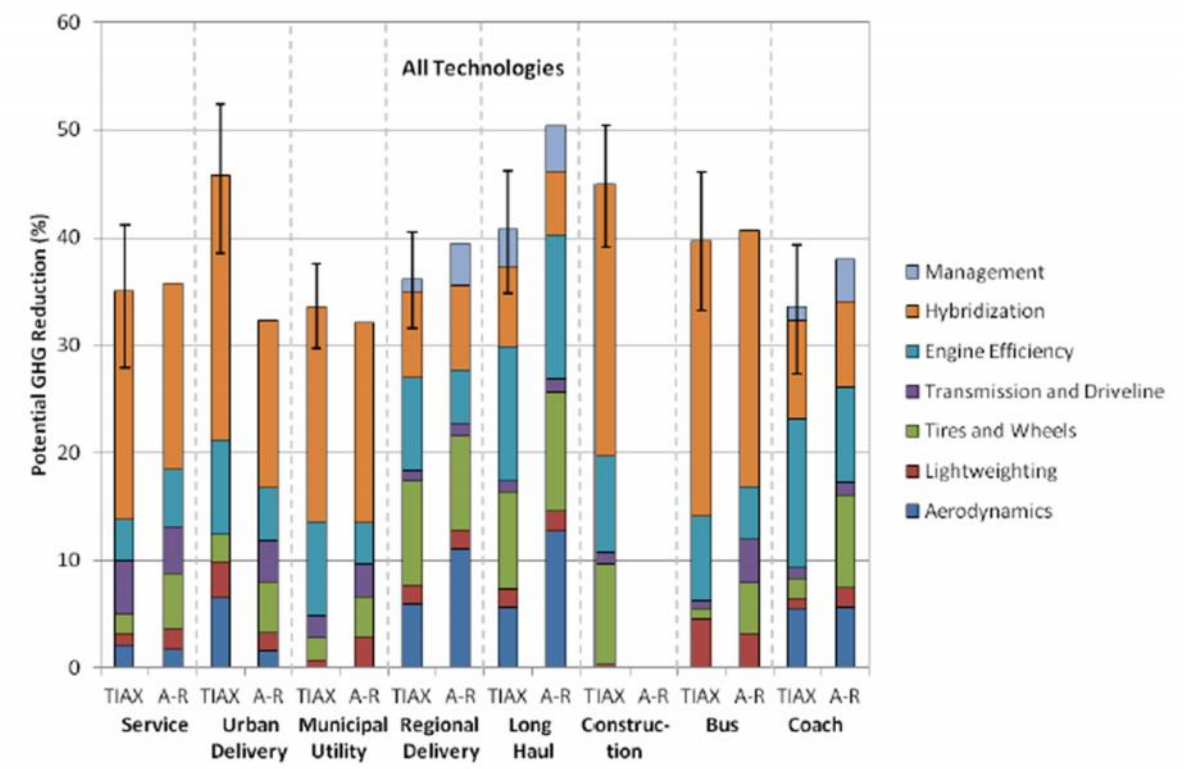


Figure 12 Potential New EU Vehicle GHG Reductions from All Technologies (Tiax, 2011)

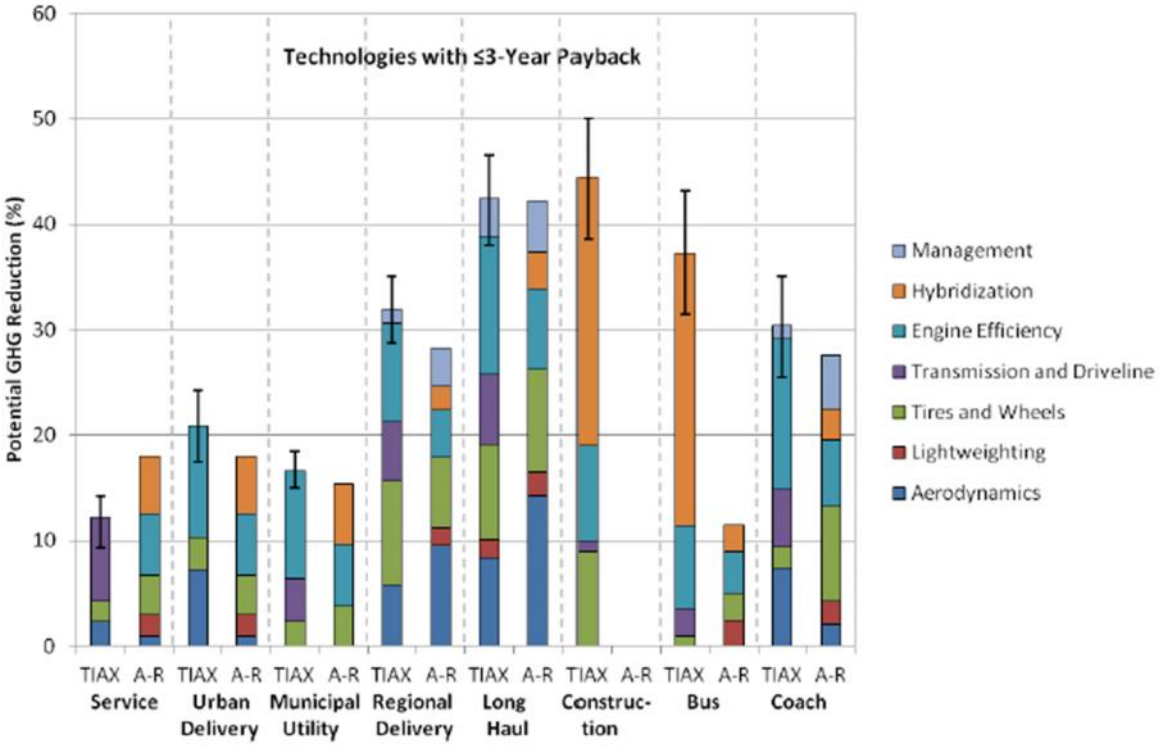


Figure 13 Potential New EU Vehicle GHG Reductions from Technologies with Payback within Three Years (Tiax, 2011)

(Tiax, 2011) analysed the impact of introducing the above described technology options in the service, regional delivery, and long haul categories and its conclusions are presented below:

Service Category

It was observed that the benefit of all technologies applied in the service category is around 30 to 43 percent. Such benefits are offered mainly by hybridization due to the stop/start, and also some contributions come from engine improvements and vehicle aerodynamics.

The results are quite similar in both studies, AEA – Ricardo and TIAX, where hybridization presents the highest impact on fuel consumption. According to such studies, for technologies with payback periods of three years or fewer, it is possible to have benefits of 9 to 14 percent achieved mainly from: transmission and driveline, tires and wheels, and aerodynamics.

Regional Delivery Category

For vehicle within the regional delivery category there is the possibility to reduce the fuel consumption of 36 to 45 percent. Meanwhile, it was not observed a large difference between the benefits of such technologies observed on the TIAX study. From table 6.4, the benefits are roughly divided among engine efficiency, tires and wheels, and aerodynamics. Small contributions came from management, transmission and driveline, and leightweighting.

According to the AEA – Ricardo study, higher benefits came from aerodynamics, and smaller ones from hybridization. Note that, the duty cycle has a high impact on fuel consumption. For instance, highway driving takes more advantage from aerodynamics, but in city driving hybridization is able to reduce a high percentage of fuel consumption rather than aerodynamics.

For payback periods of three years or fewer, TIAX study shows that there is the possibility to have benefits of 29 to 35% from technologies such as: management, engine efficiency, transmission and driveline, tires and wheels, and aerodynamics. For AEA – Ricardo study, similar benefits are offered mainly from management, hybridization, tires and wheels, engine efficiency, lightweighting, and aerodynamics.

Long Haul Category

In this category, regarding vehicles in the long haul category, there is a possibility to reduce the fuel consumption by 41 to 52% with all technology options available. These benefits are roughly equally divided among hybridization, engine efficiency, tires and wheels, and aerodynamics, with small contributions from management, transmission and driveline, and lightweighting

Comparing both studies, the AEA – Ricardo study shows that aerodynamics offer higher benefits than the TIAX study.

Note that, it is possible to decrease the GHG emissions by 38 to 47 percent for payback periods of three years according to (Tiax, 2011). For this period, benefits may come from management, engine efficiency, transmission and driveline, tires and wheels, lightweighting, and aerodynamics.

It is also important to notice that many of the engine modifications required to limit the regulated emissions (PM, NOx, SOx, etc.) have also decreased the fuel efficiency of the engines and therefore led to an increase in CO_2 emissions.

7 Policy Analysis

As shown in the previous sections, trucks have a relevant environmental impact and potential for improvement. Several policy instruments present themselves as options to reduce this environmental impact. Performance standards for emissions to air have been set at the European level for heavy duty vehicles, so this environmental impact is considered as already tackled. The following analisys will, therefore focus on GHG emissions and fuel-efficiency.

7.1 Education and behavioural change programme

Experience with the UK freight best practices programme has shown that this type of programme can have a significant impact. The companies that participate in such a programme have reported fuel and carbon savings of approximately 4.8% per fleet which would be a considerable improvement if adopted at EU level.

The Freight Best Practice programme is funded by the Department for Transport and offers a range of free publications to help freight operators improve their efficiency. Guides, case studies, software and seminars are available on topics such as saving fuel, developing skills, equipment and systems, operational efficiency and performance management.

A voluntary government/private initiative similar to the USA's Smartway could also be a possibility.

7.2 Changes in the weights and dimensions legislation

There are two aspects associated with potential changes to the weights and dimensions legislation to be considered:

- Changes to the weight and/or dimensions of the vehicle itself to enable increased carrying capacity; and
- Exemptions to the legislation in order to allow alterations to the existing standard lengths of vehicles, e.g. to improve their aerodynamics, without increasing the load capacity.

7.3 Energy Efficiency Labelling

An Energy Efficiency Labelling scheme would increase transparency and competition, and drive the industry towards further emission reductions.

There are three possibilities for labelling:

- Engine only
- Entire vehicles
- Vehicle components

Setting engine only labeling schemes would be simpler since due to the large variety of vehicle configurations (Euro VI legislation already covers measurement of engine CO2 emissions). Typically, heavy duty vehicles are maid to order according to the buyers specifications.

Labelling entire vehicles would require the development of a simulation model that would take into account different optional characteristics of the vehicle (including aerodynamic features, weight reductions, tire rolling resistance, the presence of idle-reducing technology, vehicle speed limiters, and other factors).

7.4 Minimum Energy Performance Requirements

Performance standards for air (i.e. non greenhouse gases) pollutants have been set at the European level for HDV engines and CO_2 performance standards are in place for cars, which shows that developing such standards at the European level is possible (AEA - Ricardo, 2011).

Setting engine-only limits would be quite straightforward and practical since Euro VI legislation already covers measurement of engine CO_2 emissions. This approach has been taken by the USA see Section 2.3.

As for labelling, setting requirements for the entire vehicle would require the developmet of a simulation model.

Possible requirements need to take into account different vehicle categories and uses.

7.5 Include Trucks in the scope of Directive 2000/53/EC on end-of-life vehicles

This Directive aims to decrease the quantity of waste arising from vehicles. Among other requirements, it encourages vehicle manufacturers and importers of vehicles into the European Union to:

- limit the use of hazardous substances in their new vehicles;
- design and produce vehicles which facilitate re-use and recycling;
- develop the integration of recycled materials.

Aditionally, it aims to increase the rate of re-use and recovery. The rate of re-use and recovery (in average weight per vehicle and year) should reach:

- 85 % no later than 1 January 2006;
- 95 % no later than 1 January 2015.

7.6 Include Trucks in Emissions Trading Scheme (ETS)

This option involves including HDV CO2 emissions in the existing EU ETS. The most likely outcome would be that HDV operators would purchase allowances for their emissions rather than invest in upgraded vehicles and it could therefore have limited effectiveness in curbing HDV CO2 emissions.

7.7 European Commission - IP/14/576 - Strategy to curb CO2 emissions from trucks, buses and coaches

The European Commission has set out a strategy to curb CO2 emissions from trucks, buses and coaches. Under the new strategy, adopted on 21 May, heavy-duty vehicles (HDVs) will emit lower amounts of carbon dioxide and use less fuel. In Europe, heavy-duty vehicles are responsible for around 25% of CO2 from road transport. Without action, HDV emissions in 2030-2050 are projected to remain close to current levels.

The Commission has developed a computer simulation tool, VECTO, to measure CO2 emissions from new vehicles. With the support of this tool the Commission intends to bring forward proposals for legislation next year which would require CO2 emissions from new HDVs to be certified, reported and monitored. This will contribute to a more transparent and competitive market and the adoption of the most energy-efficient technologies.

When this legislation is in force the Commission may consider further measures to curb CO2 emissions from HDVs. The most apparent option is to set mandatory limits on average CO2 emissions from newly-registered HDVs, as is already done for cars and vans.

Other options could include the development of modern infrastructure supporting alternative fuels for HDVs, smarter pricing on infrastructure usage, effective and coherent use of vehicle taxation by Member States and other market-based mechanisms. An impact assessment will be done to identify the most cost-effective option or options.

Studies carried out while preparing the strategy suggest that state-of-the art technologies can achieve cost-effective reductions in CO2 emissions from new HDVs of at least 30%.

8 Conclusions

There is an identified large potential for improvement of the environmental performance of trucks, with reasonable payback times.

Both labelling and minimum performance requirements have been identified as possible policy options to improve the environmental performace of these vehicles. They have been implemented in other economies (e.g. Japan, USA). Because these are energy using products, the implementation of such policies could be done through the Energy Labelling Directive and the Ecodesign Directive or, alternatively, through another policy instrument as has been done with passenger cars.
The European Commission has set out a strategy to curb CO2 emissions from trucks, buses and coaches. With the support of this tool the Commission intends to bring forward proposals for legislation next year which would require CO2 emissions from new HDVs to be certified, reported and monitored. This will contribute to a more transparent and competitive market and the adoption of the most energy-efficient technologies. However, curbing emissions from HDVs is more challenging than from light-duty vehicles due to the considerable variety of models and sizes of trucks available, which are customized to market needs and produced in much smaller quantities than cars and vans.

For the inclusion of Trucks in the Ecodesign Directive some changes would have to be made to the MEErP Methodology to take into account the existing differences between trucks and the products already covered, particularly in the EcoReport tool.

9 References

AEA - Ricardo. (2011). Reduction and Testing of Greenhouse Gas (GHG) Emissions from Heavy Duty Vehicles – Lot 1: Strategy. AEA.

AECOM. (2008). Reducing Greenhouse Gas Emissions from Heavy-Duty Vehicles.

BIOIS. (2010). Technical support to identify product categories with significant environmental impact and with potential for improvement by making use of ecodesign measures.

EPA. (February 2013). SmartWay Transport Overview. U.S. Environmental Protection Agency.

Eurostat. (6. June 2013). Road freight transport by journey characteristics. (European Commission) Abgerufen am 22. November 2013 von Eurostat: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Road_freight_transport_by_journey_characteristics

Eurostat. (6. June 2013). Road freight transport by vehicle characteristics. (European Commission) Abgerufen am 19. November 2013 von Eurostat: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Road_freight_transport_by_vehicle_characteristics

Nylund, N.-O. (2006). Fuel Savings for Heavy-Duty Vehicles. Summary report 2003 – 2005. VTT.

Tiax. (2011). European Union Greenhouse Gas Reduction Potential for Reduction Potential for.

ECOFYS

sustainable energy for everyone

ECOFYS Netherlands B.V.

Kanaalweg 15G
3526 KL Utrecht

T: +31 (0) 30 662-3300
F: +31 (0) 30 662-3301

E: info@ecofys.com
I: www.ecofys.com

ECOFYS

sustainable energy for everyone

Case Study: T-shirts

Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive

ENER/C3/2012-523

Case Study: T-shirts

Evaluation of the Energy Labelling Directive

and specific aspects of the Ecodesign Directive

ENER/C3/2012-523

- Confidential –

By:
João Fong (ISR-University of Coimbra)
Leandro Silva (ISR-University of Coimbra)

Date: 28-05-2014

Project number: BUINL13345

Table of contents

1 Introduction

This case study shall examine the feasibility of developing ecodesign and labelling requirements for the product category “T-shirts” within the context of the Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive. This product category has been selected as representative of the broader product group “Garments”.

2 Scope

2.1 Product definition and scope

T-shirts can be defined as a textile clothing product made of at least 80% in weight of textile fibres. T-shirts are typically made of cotton fibers (sometimes others), knitted together in a jersey stitch that gives a T-shirt its distinctive soft texture. The majority of modern T-shirts have a body that is made from a continuously woven tube, so the torso has no side seams. This is accomplished with special weaving machines called circular looms, which produce seamless fabric for tube tops, stockings, and the like. Conventional stitching is used for the waist band, neck band, sleeves and to close the shoulders.

The Life-cycle of textile products covers different stages that go from raw material production - for instance cotton growing – to its end-of-life (disposal, recycling or reuse). The processes that the products undergo can have a very wide variation of practices which can lead to uncertainties in environmental impact.

2.2 Standards and Legislation

The following table presents a summary of the relevant legislation regarding the production phase, use phase, and end-of-life of t-shirts (textile product). It should be noted that this list is not exhaustive.

Table 1 Summary of legislation applicable to textiles

Life cycle stage	Product	Legislation / Standard
Production phase	Raw Materials	- Directive 2000/60/EC of 23 October 2000 establishing a framework for Community action in the field of water policy;
		- IPPC Directive 2010/75/EC: on industrial emissions (integrated pollution prevention and control).
		- Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91;
	Plant processes	- Regulation COM(2009)267 concerning the placing on the market and use of biocidal products;
		- Environmental Technologies Action Plan (COM (2004) 38);
	Distribution	- Directive 2004/12/EC of 11 February 2004 amending Directive 94/62/EC on packaging and packaging waste;
Use phase	Washing and drying equipment	- Regulation 1015/2010 setting ecodesign requirements for washing

Life cycle stage	Product	Legislation / Standard
		mashines; - Regulation 932/2012 setting ecodesign requirements for tumbledryers
	Detergents	- Regulation 2004/648 of 31 March 2004 on detergents;
	Packaging	- Directive 2004/12/EC of 11 February 2004 amending Directive 94/62/EC on packaging and packaging waste;

REACH (Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals)

IPCC - Integrated Pollution Prevention and Control: his Directive aims at minimising pollution from various industrial sources throughout the European Union.

Directive 2000/60/EC: This directive establishes a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. It aims at preventing and reducing pollution, promoting sustainable water use, protecting the aquatic environment, improving the status of aquatic ecosystems and mitigating the effects of floods and droughts. Note that, the textile production industry is one of the biggest wastewater generating sectors.

Regulation (EC) 834/2007: This Regulation provides the basis for the sustainable development of organic production while ensuring the effective functioning of the internal market, guaranteeing fair competition, ensuring consumer confidence and protecting consumer interests.

Regulation COM(2009)267: establishes a harmonised regulatory framework for the authorisation and the placing on the market of biocidal products, the mutual recognition of these authorisations within the Community and the establishment at Community level of a positive list of active substances that may be used in biocidal products. It restricts the use of biocidal additives in the treatment process of textiles.

Directive 2008/121/EC: requiring the labelling of the fibre composition of textile products.

Directive 73/44/EEC and Directive 96/73/EC harmonised the methods for sampling and analysis to be used in Member States for the purpose of determining the fibre composition of binary and ternary textile fibre mixtures. Both Directives have been introduced in order to facilitate the implementation of the provisions on the harmonisation of textiles names (now regulated through Directive 1007/2011, but firstly introduced as early as 1971). In this sense, (a) they identified methods for the quantitative analysis of binary and ternary fibre mixtures, (b) they set up rules in case no uniform method exists and (c) they specified proceedings which take into consideration recent technical progress. As a result of the implementation of these Directives, manufacturers, importers, traders and retailers must carry out fibre tests in accordance to the uniform test methods set out in the Directives.

Regulation 2004/648: establishes rules designed to achieve the free movement of detergents and surfactants for detergents in the internal market while, at the same time, ensuring a high degree of protection of the environment and human health.

Regulation 1015/2010 setting ecodesign requirements for washing mashines;

Regulation 932/2012 setting ecodesign requirements for tumbledryers

Directive 94/62/EC amended by Directive 2005/20/EC: Covers all packaging placed on the market in the community and all packaging waste, whether it is used or released at industrial, commercial, office, shop, service, household, or any other level, regardless of the material used. Member States should take measures to prevent the formation of packaging waste, and to develop packaging reuse systems reducing their impact on the environment.

The European Ecolabel for Textiles

The EU Ecolabel for Textiles promotes the production and consumption of products with a reduced environmental impact along the life cycle and is awarded only to the best environmental performing products in the market.

The main aim of the label is to promote the reduction of water pollution related to the key processes throughout the textile manufacturing chain, including fibre production, spinning, weaving, knitting, bleaching, dyeing and finishing.

The EU Ecolabel criteria are divided into three main categories concerning textile fibres, processes and chemicals, and fitness for use.

- Fibre-specific criteria are set for acrylic, cotton and other natural cellulosic seed fibres, elastane, flax and other bast fibres, greasy wool and other keratin fibres, man-made cellulose fibres, polyamide, polyester and polypropylene. Criteria promote the use of sustainable fibres, including organic cotton and recycled fibres.
- The criteria for processing of textiles aim mainly to reduce the use of toxic dyes and agents and to promote adequate waste water treatment.
- Fitness for use criteria address the dimensional changes during washing and drying, colour fastness to washing, perspiration, wet and dry rubbing and light.

3 Market

3.1 Generic economic data

3.1.1 Market data

According to Eurostat statistics (Eurostat, 2013) there were 129.4 thousand enterprises classified to the wearing apparel manufacturing sector in the EU-27 in 2010. Together they employed 1.06 million persons, equivalent to 0.8 % of all persons employed in the non-financial business economy and 3.5 % of the manufacturing workforce. They generated EUR 19.2 billion of value added which was 0.3 % of the non-financial business economy total and 1.2 % of the manufacturing total.

Nearly 9 in every 10 enterprises (88.1 %) within the EU-27's wearing apparel manufacturing sector in 2010 were classified to the manufacture of wearing apparel, except fur apparel, with most of the remainder classified to the manufacture of knitted and crocheted apparel (such as socks, tights, pullovers, cardigans and similar articles).

Table 2 Key indicators for wearing apparel manufacturing sector, EU-27, 2010.

	Value
Main indicators	
Number of enterprises (thousands)	129.4
Number of persons employed (thousands)	1 060
Turnover (EUR million)	73 000
Purchases of goods and services (EUR million)	54 100
Personnel costs (EUR million)	13 800
Value added (EUR million)	19 400
Gross operating surplus (EUR million)	5 580
Share in non-financial business economy total (%)	
Number of enterprises	0.6
Number of persons employed	0.8
Value added	0.3
Derived indicators	
Apparent labour productivity (EUR thousand per head)	18.3
Average personnel costs (EUR thousand per head)	14.6
Wage-adjusted labour productivity (%)	125.0
Gross operating rate (%)	7.7

Source: Eurostat (online data code: sbs_na_ind_r2)

The next table shows the leading producing countris of cotton, in 2011. Greece, which is the leading producer in the EU (80% of European cotton) area ranks 11th in wheight of cotton produced. European cotton production represents only 1% of world cotton production.

Table 3 Cotton production by country, 2011 (source: FAO)

Rank	Area	Production (MT)	Flag
1	China, mainland	6588959	
2	India	5984000	
3	United States of America	3412550	
4	Pakistan	2312000	
5	Brazil	1673337	*
6	Uzbekistan	983400	*
7	Turkey	954600	
8	Australia	843572	
9	Turkmenistan	330000	F
10	Argentina	295000	*
11	Greece	280000	*
12	Mexico	274000	*
13	Myanmar	177600	F
14	Burkina Faso	175000	F
15	Syrian Arab Republic	151320	*
16	Mali	148000	F
17	Egypt	137000	F
18	Kazakhstan	118000	F
19	Tajikistan	103400	
20	Nigeria	100000	F

* : Unofficial figure

[ ]: Official data

F : FAO estimate

The following tables show the EU Trade statistics for the years 2008 to 2012.

Table 4 Top 10 suppliers in clothing (million Euro)

	2008	2009	2010	2011	2012	Share
EXTRA-EUR	57 313	55 728	60 586	65 994	62 795	100,0
China	25 095	25 398	28 089	29 574	26 786	42,7
Bangladesh	4 718	5 136	5 843	7 581	8 236	13,1
Turkey	7 857	7 009	7 850	8 291	8 197	13,1
India	3 852	4 075	4 174	4 584	3 912	6,2
Tunisia	2 434	2 144	2 197	2 227	1 935	3,1
Morocco	2 195	1 930	2 028	2 041	1 909	3,0
Vietnam	1 166	1 129	1 263	1 574	1 609	2,6
Pakistan	880	892	988	1 260	1 242	2,0
Cambodia	557	546	592	920	1 217	1,9
Indonesia	1 068	1 044	1 008	1 185	1 139	1,8

Source : Eurostat, codes NC61+NC62

Table 5 Top 10 markets in clothing (million Euro)

	2008	2009	2010	2011	2012	Share
EXTRA-EUR	16 723	14 045	14 910	17 873	19 590	100,0
Switzerland	2 879	2 688	2 833	3 236	3 232	16,5
Russia	3 072	2 168	2 203	2 682	3 002	15,3
USA	1 769	1 296	1 502	1 789	2 182	11,1
Hong Kong	1 050	932	977	1 095	1 286	6,6
Japan	772	615	842	1 146	1 220	6,2
Turkey	236	278	360	562	744	3,8
Norway	547	640	613	755	721	3,7
China	695	610	624	674	715	3,7
Ukraine	563	365	393	448	499	2,5
U,A,Emirates	478	392	339	427	498	2,5

Source : Eurostat, codes NC61+NC62

From the above the following can be observed:

- In 2012 the countries of the European Union imported clothes worth a total of €62.795 million. Ten countries control 90% of the volume of imports. China is the major source of imports to the EU (42.7%).
- Clothing imports into the EU countries increased by 10% over the past four years as a result of the decline in European clothes production. This decline is expected to continue over the coming years because of significant rises in wages in all EU countries, including the Eastern European countries which joined the Union recently and which used to manufacture a significant portion of the European Union's clothing market's needs.

Because of the lower added value in a t-shirt it is expected that most are imported from other economies.

4 Users

Consumer behaviour and usage patterns can – in part – be influenced by product-design but overall it is a very relevant input for the assessment of the environmental impact and the Life Cycle Costs of a product. This section identifies relevant user-parameters that influence the environmental impact during product-life.

Consumer choices have the greatest effect in the use-phase impact of t-shirts. Factors that influence the use-phase impacts of clothes in general are:

- Washing frequency
- Washing temperature
- Drying methods

Ultimately, even the care taken with the clothes and its usage has an effect on its life-time. Because of the great variation in the user behavior that can exist most existing LCA studies use average scenarios.

The preparatory studies for the introduction of ecodesign measures for Washing Machines (Lot 14) (ref) and for laundry dryers (Lot 16) (ref) give a thorough explanation of how user behavior can influence the environmental impact of this type of equipment. The main conclusions are summarized below.

In (ref Lot 14) the following issues were identified:

- the average nominal washing temperature is 45,8 °C and the most frequently used programme is at 40 °C (including all programmes for wool, silk, synthetics, etc),
- nevertheless the cotton 60 °C programme is still the most frequently used programme and consumes more energy than a cotton 40 °C programme,
- the average wash frequency is 4,9 cycles per week,
- most consumers normally use the full loading capacity of their washing machine, but it is agreed that this does not mean that the rated capacity is really used,
- delay start options are only used in approximately 8 % of the cycles with a shift of the washing starting time by an average of 3 hours (no reason could be identified for this delay),
- at programme end the machine may stay in this mode in about 50 % of the cases for an average of 3 hours. Afterwards in about 90 % of the cases the machine is switched off.

For laundry dryers (ref lot 16) consumer behaviour has been identified as being the main source of influence on the actual energy consumption and environmental impacts. The following results were obtained:

- The average drying frequency in summer is 2.3 cycles per week and household, and 3.6 in winter,
- The laundry dryer is located in a heated room in 37% of the cases and in an unheated room in 52% of the cases. Depending on the type of dryer technology (air vented or condenser) and the season (summer and winter), the energy consumption will depend, among others, on the use of a heating system (in summer) or a cooling system (in winter),

- Most consumers usually consider that they use the full loading capacity of their laundry dryer, but it is agreed that this does not mean that the rated capacity is really used, 76% of the laundry dryers are time-controlled (not automatic),
- The average spin speed of the washing machine (used before the drying process in the laundry care chain) was found to be 1217 rpm to be put in relation with the average spin speeds taken into account for the Lot 14 (on domestic washing machines) base-cases of 1129 rpm,
- Delay start options are used in less than 20% of the cycles with a delay of 2.5 hours on average,
- In 70% of the cases the dryer is switched off immediately or within 30 minutes after the program has finished. The average time during which the dryer may stay with the “on button” engaged is of 24,6 minutes.

5 Technologies

This section describes the new and current technology involved in each of the lifecycle stages of a t-shirt as well as its impact/benefit on the environment. Because of the many processes involved, only a summary of the most important ones is made here.

Raw materials

Most t-shirts are made of cotton or a cotton/polyester combination. Cotton is an arable crop used mainly for its fibre. The fibers are processed into fabrics or other cotton goods, and any undamaged seeds may be used to grow more cotton or to produce cottonseed oil and oilseed cake for animal feed. There are four main stages to cotton fabric production:

- fibre production and processing
- yarn formation
- fabric formation
- finishing.

After harvesting the fibres are separated from the seeds and other impurities by gining. Before it's spun, cotton is carded -- a process that combs the fibers, removing the shortest ones and aligning the longer ones. Combing further cleans the cotton fiber as well. The long carded fibers are formed into a loose rope called a sliver. Slivers are fed into commercial spinning machines that spin them into weave-ready fibers. The fibers can then be weaved into fabric. Once woven, it undergoes finishing. Finishing usually involves bleaching, dying, printing and/or coating with a special finish.

The term "polyester" as a specific material most commonly refers to polyethylene terephthalate (PET). Polyester is made from crude oil or distillation products in the oil. Fibers are produced by melting PET for extrusion through the spinneret and then directly solidified by cooling. These two materials have very different technical, physical and chemical properties and their annual production volumes are so high that it is not possible to compensate one with another.

Several technologies exist that can improve the environmental impact of cotton farming and include:

- Reduced use of pesticides, and the subsequent reduced risk to human health and the environment, namely by using non-chemical means of controlsuch as encouraging bird and bat species that act as predators to cotton pest populations or the use of pheromones.
- Use of a wider range of control techniques and reduced reliance on a single method of pest control, leading to a more resilient approach to crop protection.
- Water management practices are adopted that optimise water use.
- Minimizing the use of fertilizers.

Substitution of hazardous substances used in dying, printing and finishing, such as replacing chemicals with enzymes, can also help reduce the toxicity impact of textile production.

Manufacturing

To turn a piece of fabric into a t-shirt several operations take place: pattern making, grading, nesting and marking, cutting, sewing, quality inspection, pressing and packaging. All these operations can be carried out with several degrees of automation. However, sewing is still a complex task for a robot and is mainly done by humans.

Improvements in the manufacturing stage can be achieved through increasing process efficiency, be it energy efficiency or throughput.

Waste reduction can have an important impact also in raw material production by minimizing the amount of material used. One example is using computorized cutting tools.
Minimising waste in all processes, not only waste of primary materials but also of auxiliary chemicals, energy etc. can often improve the environmental profile of the product and establish a basis for a more profitable production (ref EDIPTEX).

Distribution

As discussed above, the clothing industry is a global industry with large distribution networks. For example cotton can be farmed in Turkey, spinned and woven in China and be made into a t-shirt in Europe to be sold in the USA.

Use-Phase

(See section 4)

End-of-life

After the consumer use phase, textiles can be reused or recycled or they are disposed of by landfilling or incineration (with and without energy recovery).

For recycling, the cotton waste is first sorted by type and color and then processed through stripping machines that first breaks the yarns and fabric into smaller pieces before pulling them apart into fiber. The mix is carded several times in order to clean and mix the fibers before they are spun into new yarns. The resulting staple fiber is of shorter length compared to the original fiber length, meaning it is more difficult to spin. Recycled cotton is therefore often blended with virgin cotton fibers to improve yarn strengths. Commonly, not more than 30% recycled cotton content is used in the finished yarn or fabric. Alternatively, recycled cotton fabrics can be mixed with polyester fibers from recycled bottles. Because of the lower quality of the separated fibres they are normally converted into a lower chain product such as stuffing for upholstery products, insulation and roofing felt, carpet components, lower quality blankets, paper

6 Environmental impact

EDIPTEX analalysed the environmental impact of a 100% cotton t-shirt making the following assumptions:

- For the cotton cultivation, conventional farming and harvesting was considered, which included the use of pesticides and defoliating agents.
- The use of hydrogen peroxide was considered in the bleaching process while reactive dyes are assumed to be used in the dyeing process which avoid the emission of heavy metals and arylamine. Regarding finishing, a non-problematic softener is considered.
- The life time of the T-shirt was set to 50 washes and drying is assumed to be carried out in a tumble dryer.
- Water consumption was not assessed, but it was noted that cotton irrigation may have a significant impact on water resources. It can take more than 20,000 litres of water to produce 1kg of cotton; equivalent to a single T-shirt and pair of jeans. 73% of global cotton harvest comes from irrigated land (ref WWF report The Impact of Cotton on Freshwater Resources and Ecosystems)

The contribution of each life-cycle phase to toxicity can be seen in Figure 1.

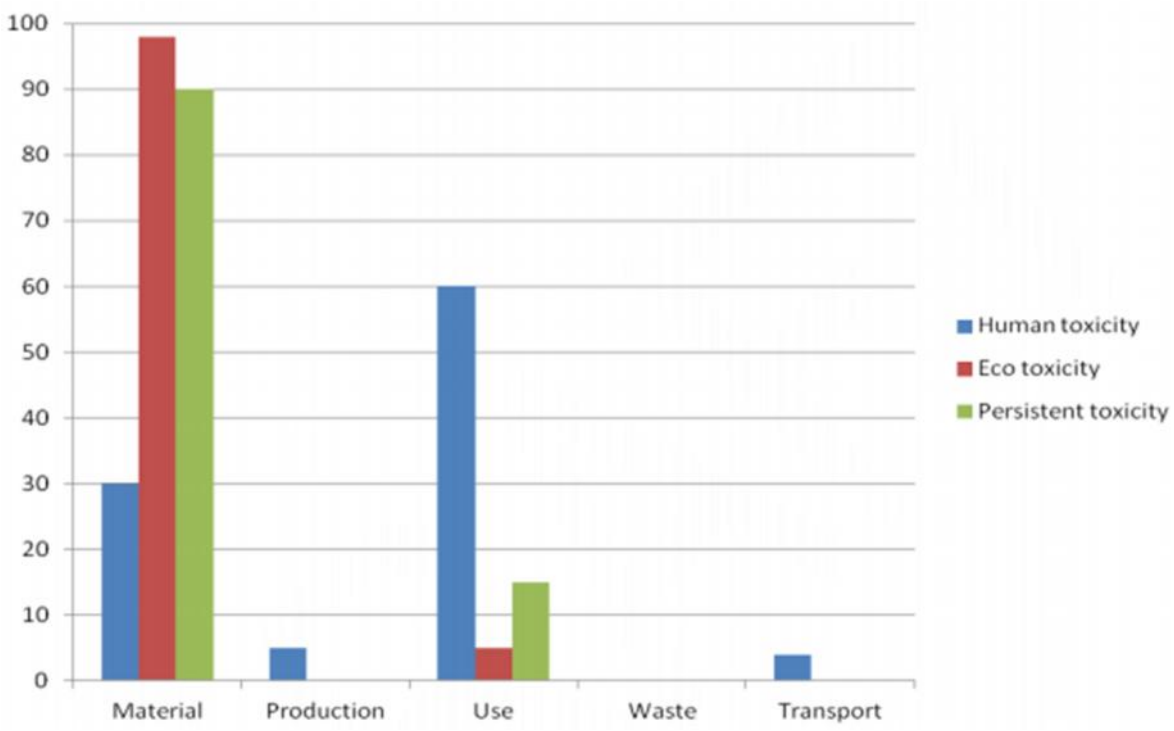


Figure 1 T-Shirt LCA results interpreted as toxicology end-points (ref. Ecolabel)

The main contribution to ecotoxicity and persistent toxicity in the material phase is the use of pesticides (herbicides, insecticides, fungicides, growth regulators and defoliation agents) in the cotton production. Regarding the human toxicity whilst 30% of the impact is related to the cotton production but here the use phase is the main contributor (60%) mainly from the detergents and the use of electricity in the drying process (ref Ecolabel).

Results for primary energy used are shown in Figure 2.

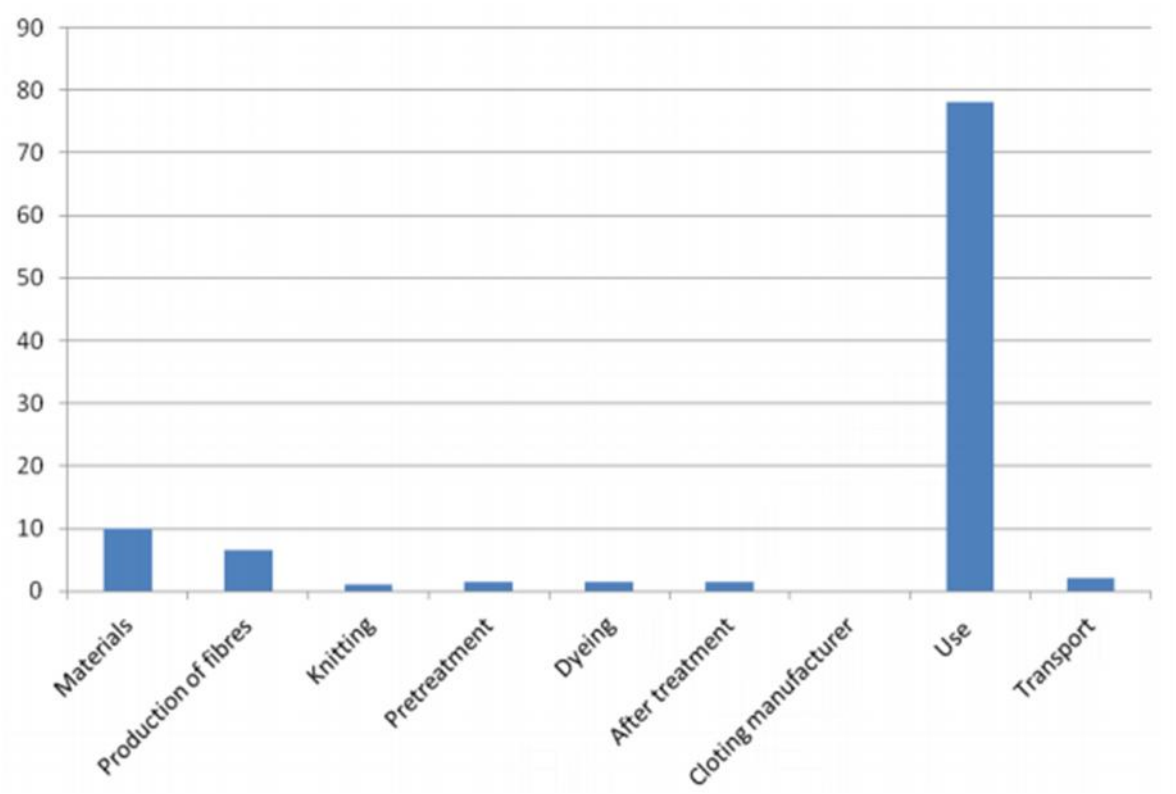


Figure 2 T-Shirt LCA results for primary energy use (ref. Ecolabel)

GHG emission is dominated by the requirement for burning fossil fuel to create electricity for heating water and air in laundering. Other major energy uses arise in providing fuel for agricultural machinery and electricity for production.

Table 6 Source identification of the most energy-intensive processes in the T-shirt's lifecycle (EDIPTEX)

	Consumption of primary energy / MJ
Materials phase	10 % of total primary energy consumption
Fibre production	Approx. 70 % of this phase's contribution originates from transport of the fibres, while production of N artificial fertilizer and pesticides comprises 13 % of this phase's energy consumption.
Production phase	12 % of total primary energy consumption
Yarn manufacturing	Approx. 55 % of the production phase's consumption of primary energy originates from electricity consumption during yarn manufacturing.
Knitting	The consumption in this process originates from the consumption of electricity (Denmark) corresponding to 10 % of this phase's total consumption.
Pre-treatment	The consumption of primary energy in this process originates primarily from burning natural gas, approx. 12 %.
Dyeing	The consumption of primary energy in this process originates primarily from burning natural gas, approx. 12 %.
Finishing	The consumption of primary energy in this process originates primarily from burning natural gas, approx. 12 %.
Making-up	Credit of energy from reuse of cut-off textiles, approx. 1 %.
Use phase	78 % of total primary energy consumption
Washing (households)	24 % of this phase's consumption originates from electricity consumption (Denmark) for heating water in the washing machine.
Tumbler drying	68 % of this phase's consumption is due to consumption of electricity (Denmark) for tumbler dryers.
Ironing	8 % of this phase's consumption originates from the consumption of electricity (Denmark).
Disposal phase	-2 % of total primary energy consumption
Incineration	Credit of the energy recovered by incineration of the T-shirt.
Transport phase	2 % of total primary energy consumption
Transport	Consumption of fossil fuels for petrol and diesel for various vehicles

The environmental impacts of transportation are very low within a life-cycle context due to large shipment quantities.

Waste volumes from the sector are high and growing with the advent of 'fast fashion'. On average, UK consumers send 30kg of clothing and textiles per capita to landfill each year. Water consumption – especially the extensive use of water in cotton crop cultivation – can also be a major environmental issue as seen dramatically in the Aral Sea region (ref UK_Textiles)

Polyester production requires non-renewable resources, such as fossil raw materials, resulting in on the average 63% higher energy consumption than the production of cotton per 1 kg fibres (ref Autex) However, used in a cotton blend polyester increases the durablility of the fabric and decreases the laundering energy requirements due to the hydrophobic nature of polyester fibres.

To evaluate the effect of not usilg chemicals the study (ref. EDIPTEX) did a comparison to using organic cotton. Consumption of primary energy does not change significantly, only by about 4 per cent over the total life of the T-shirt. This is because most of the energy consumption arises from processes in the production and use phases and these do not change in this scenario. The toxicological environmental impacts are reduced considerably using organically cultivated cotton. Persistent toxicity is reduced 58 by 85 per cent, while ecotoxicity is reduced by 95 per cent compared with the reference scenario. The energy-related environmental impacts, the greenhouse effect, nutrient loading, and photochemical ozone formation are reduced by 5-10 per cent. The reason is that there is no longer a contribution to these potentials from production of artificial fertilizer and pesticides. The same applies for the waste categories.

It should be noted that production amounts of organic cotton are still very low, only 0.03% of the total annual cotton production, and cannot yet be considered as a global alternative (ref Autex).

Most of the remaining environmental impact is in the use-phase and here it is the consumer that has the greater influence (frequency of washing, chosen temperature, choice of detergent, etc.)

Manufacturer options for improvement include extending the life-time of the t-shirt through, for example, better colour durability or use of better fibres or weaving. Halving the lifetime of a t-shirt results in a 30% increase in the consumption of primary energy. Similarly, the toxicological environmental impact potentials are increased by 40 per cent, the determining factor being the increased production of cotton.

7 Policy Analysis

7.1 Ecodesign policy options

The highest environmental impact (particularly primary energy consumption) was identified in the use-phase due to the electricity consumption during washing and drying of the t-shirt. Both equipments are already covered by Energy Labelling and Ecodesign Regulations.

Information requirements on the proper care of the product, which could include preferred washing and drying temperatures, could also be implemented, however, the impact of such measures would probably be limited.

Regarding the production phase, minimum levels of organic materials or recycled content could be set. However, due to the global nature of the supply chain, this requiremens would be difficult to enforce and would be better based on a global certification scheme.

7.2 Labelling policy options

7.2.1 Labelling of the Product Carbon Footprint

(For further information on Carbon Footprint labelling see case-study for fresh-bread – section 7.2.1)

In the case of t-shirts, the CO_2 emissions are mainly in the use-phase (~70%) where differences are set by the consumer behaviour rather than the products characteristics. Although reductions in other life-cycle stages are possible the achievable differences would probably not be significant in the overall picture. Furthermore, it is not clear that the consumer will understand the label, particularly because this is a non-energy related product, or if it will influence its buying choices. Therefore, the impact of labelling the Carbon Footprint seems limited for t-shirts.

7.2.2 Labelling of the Product Environmental Footprint

In its conclusion on the "Sustainable materials management and sustainable production and consumption" (December 2010), the European Council invited the Commission to "develop a common methodology on the quantitative assessment of environmental impacts of products, throughout their life-cycle, in order to support the assessment and labelling of products".[1]

On this basis, DG Environment together with the European Commission's Joint Research Centre (JRC IES) and other Commission services developed the environmental footprint methodology which is recommended to be used by Member States, companies, private organisations and the financial community.

[1] Source: http://www.pef-world-forum.org/eu-environmental-footprinting/

According to DG Environment[2], a three-year testing period (EF European pilot phase) was launched with the following objectives:

- to set up and validate the process of the development of product group-specific rules in case of products (Product Environmental Footprint Category Rules – PEFCRs), including the development of performance benchmarks
- to test different compliance and verification systems, in order to set up and validate proportionate, effective and efficient compliance and verification systems
- to test different business-to-business and business-to-consumer communication vehicles for Product Environmental Footprint information in collaboration with stakeholders (individual companies, industrial associations or any other private, non-governmental or public organisation both from the EU and outside of the EU).

The PEFCRs resulting from the EF pilot phase will become the product rules valid under the PEF, to be used by all stakeholders in the sector in the EU or internationally who decide to measure the performance of their products based on PEF.

A pilot study, under this programme, has recently started for t-shirts. Reasonably, the outcomes of these pilot studies should be awaited before drafting further specific policy measures.

[2] Source: http://ec.europa.eu/environment/eussd/smgp/product_footprint.htm

8 Conclusions

T-shirts have a long life-cycle processes chain, with very different practices which lead to large uncertainties in the evaluation of its environmental impacts.

The cotton clothing supply chain is complex and globally dispersed making it difficult to track the source materials and environmental impacts, and probably to enforce some of the policy options.

The environmental impact is mainly focused on two life-cycle stages: (1) toxicity in cotton farming mainly driven by the use of pesticides and (2) GWP in the use-phase mainly caused by washing and drying.

The environmental impacts of cotton farming could be reduced by imposing minimum levels of organic cotton, which is pesticide free, on t-shirts. However, the share of cotton produced by organic methods is still very small to allow for such a requirement.

In the use-phase, impacts are already tackled by MEPS and Energy Labelling of both washing machines and dryers. One issue identified is that the MEErP methodology is mainly technological focused and for this product group behavioural factors have a mojor contribution to the environmental impact.

Impacts in both stages can potentially be reduced by targeting consumers since its choices may influence the two most relevant life-cycle stages. Small behavioural changes such as reducing washing temperature, washing at full load, avoiding tumble-drying whenever possible, purchasing eco-friendly fibres, and clothes being not used anymore can be achieved by improving user awareness to this issues.

An Environmental Footprint Label could improve the connection between consumer purchase and use of clothing and their environmental consequences. Because the consequences of an individual purchasing decision are rather small and distant, consumers sometimes lack the motivation for making a positive decision based on environmental (or social) concerns. Labels containing environmental information are an important step towards ensuring that fact based information on the environmental impact of a product are made clearly available but the consumer needs to understand the consequences of this information.

Promotion of ecolabels, and examples of best practice cases, should continue to be used as tools for the overall improvement of environmental performance.

ECOFYS

sustainable energy for everyone

ECOFYS Netherlands B.V.

Kanaalweg 15G
3526 KL Utrecht

T: +31 (0) 30 662-3300
F: +31 (0) 30 662-3301

E: info@ecofys.com
I: www.ecofys.com