SCIENTIFIC SUPPORT PLAN FOR A SUSTAINABLE DEVELOPMENT POLICY

SPSD II

INTEGRATING CLIMATE, RESOURCE AND WASTE POLICIES THROUGH A PRODUCT POLICY

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PART 1

SUSTAINABLE PRODUCTION AND CONSUMPTION PATTERNS

GENERAL ISSUES

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SCIENTIFIC SUPPORT PLAN FOR A SUSTAINABLE DEVELOPMENT POLICY
(SPSD II)

Part 1:
Sustainable production and consumption patterns

FINAL REPORT

Integrating climate, resource and waste policies through a product policy

CP/13

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1 Introduction

1.1 Context

In Kyoto (1997) and later in Marrakech (2001), the nations have asserted their will to fight climate change, which, as well as the problems of resources use and waste, is also amongst others priorities in the 6th European Environmental Action Program.

Attention is shifting more towards examining the potential of policies oriented at products and consumption patterns. This, because the sector-based, mostly 'process'-oriented environmental policies seem insufficient to reach the objectives of sustainable development. The Integrated Product Policy (IPP) at the European level[1] and the preparation of the "Federal Guiding Plan on Product Policy and Environment" (2001) in Belgium aim at taking these issues into account and were the general policy framework for the present project.

The perspective of "Integrated" in IPP is the consideration of the entire product's life cycle chain and the consideration of multiple environmental problems to avoid averse effects and shifting to other impact types. IPP is of relevance in the framework of sustainable development, also considering the social and economic pillars.

1.2 Description of the project

1.2.1 Goal of the study

The project aims at providing information on the *possibilities of reinforcing and integrating existing climate, resource and waste policy through a product policy.*

The main objective is to contribute to the *identification of the priority products* that should be targeted by product policies. According to the IPP White Paper "priority products" are those having the greatest potential for improvement. This implies 2 important conditions: first the (political, social, economical…) feasibility to apply additional measures for these products and second evidence on the generation of substantial impact reductions due to these measures.

The study has been undertaken in 3 phases:

1. Phase 1 of this project is on the *evaluation of life cycle impacts of products in Belgium*. This identification should allow policy makers to select products that qualify for an assessment of their improvement potential and, depending on the outcome, for being addressed by product policy (at Belgian federal level or at the European IPP level).[2] This project is limited to an integrated evaluation of impacts on resources use, waste and greenhouse gas (GHG) emissions, but allowing the model to be expanded for other impact categories. This work was carried out during the first year of the project (2002).

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[1] COM(2003) 302 final

[2] This study hence does not seek to identify products or product groups for which *implementation of improvement options* is relatively easy. The aim is to identify the 'hot spots' with regard to environmental pressure, rather than to identify the 'low hanging fruits'.

Secondly, the project focused on 4 case studies : household packaging, computers and related paper use, passenger cars and domestic dwelling. This focus was separated in two phases :

a. Phase 2 of this project contributes on the methodological framework for the *evaluation of theoretical impact reductions* due to product policy measures. This analysis can identify where product policy measures will contribute to simultaneously reduce GHG emissions, resource use and waste generation or controversially where particular measures might have averse effects. This work was carried out in 2003.

b. Besides these environmental analysis, phase 3 of the project aims at contributing to establish a framework for the *evaluation of proposed product policy measures by stakeholders*. To establish realistic improvement potentials of measures, their social and economical implications should be considered. Stakeholders were able to evaluate a set of proposed measures for the considered product case studies on these criteria. This work was carried out in 2004.

1.2.2 Methodology

In general, 2 types of analysis apply to this project: first, an environmental analysis of products consumed in a given economic region over a given period of time and this with a life cycle approach (point 1 and 2a described below). Secondly, a consultation of stakeholders to evaluate a set of proposed policy measures on a number of predefined criteria (point 2b described below).

For the environmental analysis of products, no strict methodology or standards were available and an approach had to be developed by the research team. The approach chosen is that of bottom-up LCA, which is based upon existing principles for product LCA (and for which ISO standards exist). In general, a product list is defined, product LCA's are executed and these are extrapolated with product consumption figures to entail the total economic activity. The arguments for selecting this approach and the development of the method are described in detail in paragraph 2.4.1.

For the stakeholder consultation, an approach is developed based on principles of the Delphi method. The development of this methodological approach is described in paragraph 3.2.

The project is composed of three complementary parts and the activities and methodological approaches are briefly described:

1. Evaluation of life cycle impacts of products in Belgium (phase 1)

This work was based on the assessment of products consumed by households in Belgium, for the reference year 2000. The selected methodological approach for this analysis was bottom-up LCA as it builds on previous work and knowledge available to the research team. The work encompasses the definition of a structured product list, the development of the evaluation model and extensive data collection on product consumption (in physical units, not EURO), product material composition, product life spans, life cycle energy requirements, life cycle greenhouse gas emissions, waste generation and waste treatment associated to this consumption. This also lead us to identifying some crucial statistics improvement that are required to make the method and the results more robust.

This work is presented in chapter 2.

2. Evaluation of theoretical impact reductions for 4 product cases (phase 2)

These analysis aim at estimating life cycle GHG emissions, resource use and waste generated by the Belgian demand on affected products as well as identifying "environmentally effective"[3] reduction options (resulting either from technological changes, material / product substitution or behavioural changes) for these impacts. This will provide the theoretical reduction potential for the four product cases, for the three studied impacts.

This work included a more detailed inventory and study of the four product cases as compared to phase 1 of the study (i.e. more detailed product definition, consumption and stock data for the period 1990-2010 etc…). Also some adaptations were made to the model taking into account stakeholder and expert comments on the work of phase 1 (i.e. the inclusion of "avoided impacts" for recycling, the 50/50% allocation for secondary materials) and basic data for the policy scenario's needed to be generated (i.e. material reductions, adapted recycling and reuse rates, etc…). ICEDD studied housing and information technologies, whereas Vito studied domestic packaging and cars.

The methodology for this part is presented in paragraph 3.1. The results are presented, along with the ones from the following phase, in paragraph 3.3.

3. Evaluation of proposed product policy measures by stakeholders for the 4 product categories (phase 3)

This evaluation aims at identifying the most appropriate sets of product-oriented measures which could be best implemented in order to achieve these theoretical reduction potentials. This evaluation was carried out on 3 criteria: "efficiency of the measure", "acceptance by users" and "acceptance by the industry". The realistic reduction potentials that could be expected from these sets of efficient and accepted measures could not be quantified at this stage because the stakeholder evaluation did not result in a consensus.

The work in this phase included the development of a framework for the evaluation of proposed measures by a broad range of involved stakeholders. Two consultation rounds were held of which the first encompassed an online questionnaire that could be freely consulted. In the second round, after the results of the project were presented in a workshop, stakeholders could again give their comments on the approach and preliminary results.

The methodology of the stakeholder consultation is presented in paragraph 3.2 and the results are presented in an integrated way in paragraph 3.3.

1.2.3 Relation with other studies

This study was drawn upon a previous study of ICEDD and Vito for the PPS Science Policy. Also, during the course of this study, other studies by ICEDD and / or VITO were carried out in parallel which were closely related to this one. A brief overview is presented here.

[3] It should be noted that in this stage of the evaluation, only the "environmental effectiveness" is considered. For these effective options, the evaluation can be later expanded to the concept of "eco-efficiency", understood as the ratio of cost per environmental benefit. Economical and social aspects are partly considered in phase 3 of this project but it should be noted that these should be more elaborated prior to any policy use.

2001 : Institut Wallon[4], Vito, IDD for Federal Science Policy (SPSD 1), "Reduction of greenhouse gas emissions and material flow"

This project was a first research effort aiming at providing an evaluation of the total life cycle greenhouse gas emissions of product consumption in Belgium. It included an evaluation of the potential of technical improvements at the level of production modes and waste management systems after the use of products. It focused on three product categories (single family housing, beverage packaging and livestock products). The current project builds on this previous project in the sense that it evaluates a broader scope of products and impact categories.

2002 : Institut Wallon, Vito, IGEAT[5] for FPS Health, Food Safety and Environment – DG Environment "Identifying Key Products for the Federal Product & Environmental Policy"

The objective of this study was similar to that of phase 1 of this study ("*evaluation of impacts of products in Belgium*"). In this study, more impact categories were included. The results of this study were presented to stakeholders at a Round Table held in December 2002.

2003 : ICEDD, Vito for Federal FPS Health, Food Safety and Environment – DG Environment "Priority Policies and Measures for the Federal Product Policy in order to mitigate Climate Change"

The objective of this study was similar to that of phase 2 of this study ("*evaluation of theoretical impact reductions"*). Also here, more product categories were analyzed (i.e. industrial packaging and electrical appliances) and also an analysis was made of the existing policy measures that are in place for these product categories. Some key stakeholders were consulted for the validation of modelling data[6].

2004 : IPTS[7]/ESTO[8] for EC, "EIPRO - Environmental Impact of Products in Europe"

This project was carried out by several international research institutions: TNO-STB (NL), CML (NL), DTU (DK) and Vito (BE). The Belgian study on the "Identification of priority products for the Federal Product & Environmental Policy" was referred to in the publication of the White Paper on IPP (2003) as a possible methodology for the evaluation of products in Europe. In this EIPRO project, all existing studies were compared and evaluated (besides the Belgian study, 7 others) to determine their usability for the European IPP development. As a result, a new model for the EU was developed.

2004 : IPTS/ESTO for EC, "EIRES - Environmental Impact of Resources"

This project was carried out by several international research institutions; Technical University of Denmark (DK); TNO-STB (NL); 2.-0 LCA consultants (DK). In 2004, the EC published its communication on Resources Strategy.

The Belgian study on the "Identification of priority products for the Federal Product & Environmental Policy" was also evaluated, besides other existing studies, in the framework of this EU policy area.

[4] Institut Wallon. Now : ICEDD (Institut de Conseil et d'Etudes en Développement Durable)

[5] IGEAT: Institut de Gestion de l'Environnement et d'Aménagement du Territoire

[6] For packaging, this was FOST PLUS and VAL-I-PAC

[7] IPTS: Institute for Prospective Technological Studies

[8] ESTO: European Science and Technology Observatory network

2 Phase 1 : evaluation of life cycle impacts of products in Belgium

2.1 Goal and scope

The objectives of this phase were translated into a specific goal and scope description at a more detailed level. The choices are presented below:

a) The study focused on identifying the product groupings on the basis of their current life cycle environmental impacts. They were identified on the basis of the environmental impacts of the whole volume of the products purchased by households in Belgium, for the reference year 2000.

b) The product system boundaries and the unit processes considered within are delimited by the availability of data; where generally data exists on material composition, energy use of products, emissions during operation, disposal scenarios (for Belgium); for other aspects these are difficult / impossible to quantify, i.e. product assembly and material processing steps (these are the processes proceeding material extraction and production i.e. thermoforming of plastics, moulding of aluminium etc…).

c) The study included capital goods and intermediate transport steps where it considers the extraction and manufacturing of materials and also the disposal phase of products. Transport steps and infrastructure are not considered for the use stage of products except for the products on transport where the effects during the use stage are of crucial importance.

d) The study paid attention to specific materials such as packaging, building materials and other intermediate products, despite the fact that they are not final commodities for consumers. This deviation to the list of "final products" should be considered when interpreting the results (i.e. packaging should be reallocated to their packed final units).

e) The study primarily focused on the final consumption in Belgium, and not on production for export.

f) This study is limited to impact categories on resources, waste and climate change. The model developed however should enable the inclusion of other common LCA impact indicators. These type of indicators are available for most impacts, but not for all i.e. one must be very prudent with ranking on the basis of toxicity indicators, since scientific knowledge about this issue is limited.

g) No impact assessment or weighting step was used to overcome the inherent discussions about impact assessment methods (weighing different types of effects, mostly on a subjective manner or on external costs). Examples of such methods are CML plus weighting, EPS[9], ExternE[10] and Eco-indicator 1999[11].The goal and scope choices make clear that the method applied was based on a system approach and elements of life cycle impact assessment (LCA).

[9] "EPS" reference: Bengt Steen (1999) A systematic approach to environmental strategies in product development (EPS), Centre for Environmental Assessment of Products and Material Systems, Chalmers University of Technology.

[10] Methods on External costs.

[11] The Eco-indicator 99 is an LCA impact assessment method developed with the need for a practical impact assessment tool in mind. Report about the methodology can be downloaded from the website www.pre.nl

2.2 Definition of environmental impacts

2.2.1 Policy context

The selection of these 3 environmental themes is due to their relevance in a political context. At the EU level, the 6th Environmental Action Plan programme identifies four environmental priority areas for urgent action. The first and last area are the focus of this project:

1. Climate Change

2. Nature and Biodiversity

3. Environment and Health and quality of life

4. Natural Resources and Waste

Sustainable use of resources is thus one of the priority topics. The Commission has prepared the Communication "Towards a Strategy on Sustainable use of Resource". This document is a first step towards the adoption of an European strategy in 2005. This strategy will not define new policies and measures besides those that are already implemented or envisaged in other strategy documents (like the Integrated Product Policy). Instead it will define quantified objectives for the EU with regards to the use of resources.

According to the Communication, natural resources cover raw materials, environmental media, resource flows and space. In the present study we consider only raw materials and energy, but it also makes the distinction between non renewable and renewable resources.

One of the main statements made is the fact that :

- As far as non-renewable resources are concerned, the major impact of resource use is linked to the environmental impacts induced by this use, while scarcity is a much less challenging issue.
- For renewable resources, on the opposite, due to the pace of exploitation which is more rapid than the regeneration capacity of such resources, scarcity has to be considered amongst priorities in the EU strategy.

Some initiatives already exist at the Belgian national and regional level, i.e. the Flemish VMM annually reports in its Mira-T reports, the TMR (Total Material Requirement) indicator to monitor the state of dematerialization in Flanders (TMR/GDP index), the TMR calculated for the Walloon Region, etc. This TMR comprises all primary materials (both energy-containing and non-energetic) required for '*the production side'* of an economy (including both direct and hidden flows). However, since the focus of this study is on the *'consumption side'* it cannot be compared.

Regarding waste, many policies already exist and it is an environmental issue of political relevance that has a longer history and has been more elaborated compared to the other relatively new environmental policies. It also concerns policies already targeting specific product groups such as cars, packaging and electrical and electronic equipment.

The current waste policy goals are closely linked with that of other areas and an efficient integration should be sought after. General objectives formulated at the EU level are:

- **reduce** the amount of waste generated (waste going ultimately to **'final disposal'** by 20% from 2000 to 2010, and by 50% by 2050);

- special emphasis on cutting ***hazardous waste*** and

- 3 principle approaches are:

    - **waste prevention** by better use of resources; reducing presence of hazardous substances in products; encouraging shift to more sustainable consumption patterns;

    - **recycling and reuse** and 'priority waste streams' identified by EC include packaging waste, end-of-life vehicles, batteries, electrical and electronic waste;

    - **improving final disposal and monitoring** a.o. the EC approved directives on the ban of certain waste streams from final disposal (e.g. tyres) and sets targets for the reduction of biodegradable waste. Another recent directive lays down limits on emission levels from incinerators (dioxins and acid gases such as NOx, SO_2, and hydrogen chlorides).

2.2.2 Environmental indicators

1. Climate Change

Emissions of greenhouse gases (CO_2, CH_4, N_2O, F-gases) can be transformed into global warming potentials expressed in CO_2-equivalents. This aggregation method which is also in accordance with the UNFCCC (2000) guidelines is based on the use of a set of conversion factors.

2. Waste

According to the Directive 75/442/EEC waste means "any substance or object in the categories set out in its Annex I which the holder discards or intends or is required to discard". In that sense, all three stages of the products life represent sources of waste :

- the <u>production phase</u> results in the generation of waste because all material processes (including raw material mining) result in some quantities of industrial waste. Depending on the process type, on the production site, and on the type of waste, the fate of this waste will vary between elimination by landfilling or incineration (with or without energy recovery), or valorisation by internal recycling or recycling outside the production site, either in an other production process, or in a final product.

- the use phase results indirectly or directly in material dissipation. On the one hand, if the product uses energy during its use phase, waste is produced indirectly because the extraction of primary energy sources and then the production of final energy produces some quantities of waste. On the other hand, any spare part and consumable will ultimately be disposed of.

- the disposal phase, per definition consists in the conversion of a final product into waste materials.

For generated waste, comparable operational cause-effect models have not been developed yet for use in LCA studies. In so far, the pressure of waste generation as such (total tons) is taken as an impact potential.

The waste indicator could not be differentiated because in LCA inventories the classification of waste types are incomplete and not consistent when using different LCA sources. This is also true for the classification of hazardous waste. Also, sometimes no distinction can be made between ultimate waste going to landfill (endpoints) and waste going to treatment (midpoints), that cause additional impacts.

The above mentioned pitfalls are identified by the research community and LCI waste inventories are now being composed according to existing classifications i.e. the European EURAL classification (a.o. used by APME for its 'ecoprofiles' on plastics since about 2000). In many cases this also solves the problem of classifying toxic waste. However, evaluating the toxicity of products knows another major pitfall: data availability on chemicals in products (and potentially toxic content) is difficult / impossible to find. The EC has prepared a White Paper on Substances in Products which deals with this issue and mainly on a better control mechanism on hazardous substances in products that are imported in the EU.

3. Resource use

Environmental impacts resulting from the use of raw materials occur at the different stages of the raw materials life cycle : mining, processing, disposal. The associated impacts resulting from the use of these materials in product life cycles are reflected in the other impact indicators on greenhouse gas emissions, energy use, raw materials use, waste, etc.

The resource indicators mentioned below reflect the demand of resources due to product consumption.

A distinction has to be made between the following:

1. Material intensity indicators (M) : covers the total amount of basic materials used for the manufacturing and use of products, often reflecting the weight of the product and the weight of the materials lost during processing (i.e. amount of steel, plastic, glass etc.)

2. Energy intensity indicators (E) : covers the total amount of primary energy used for the manufacturing and use of products. All energy carriers are traced back to calculate their primary energy equivalents.

3. Raw material use indicators (R): covers the weight of all traced back primary raw materials that have to be extracted from the ecosphere to generate and use the product.

The following material intensity indicators (M) are distinguished:

- Metals (kg M_{metal})
- Minerals (kg $M_{mineral}$)
- Synthetic organic (kg $M_{synthorg}$)
- Natural organic (kg M_{natorg})
- Total (kg M)

The following energy intensity indicators (E) are distinguished:

- Production energy (MJ E_p)
- Energy use during operation (MJ E_u)
- Life cycle energy (MJ E^{LC})

For the raw materials (R), the definitions of resources provided by the EC (COM 527, 2003) are adopted. According to the Communication, natural resources cover raw materials, environmental media, resource flows and space. In the present study we consider only raw materials and energy. A brief summary is provided and their use for indicators in this study.

- *Raw materials, which include minerals such as fossil energy carriers, metal ores and biomass. Fossil fuels and metal ores are non-renewable in the sense that they cannot be replenished within a human timeframe, whereas biomass is in principle renewable within the human timeframe.*

  Indicator(s): only total raw material use (kg R) has been used as an indicator. The inventory of raw materials includes all non renewable resources. Timber is the only considered renewable resource. Wood for housing is supposed to be harvested from sustainable managed forest where the harvesting rate is at least balanced by the growing rate of forests. Hence, we do not envisage any strategy that would lead to an overexploitation of non renewable resources.

- *Environmental media*, which include air, water and soil, which sustain life and produce biological resources.

  Indicator(s): the use of water from public supply by households (litres) is considered in this study. Water use by industry during manufacturing of products is not considered, because different LCA data sources are not consistent on this aspect (i.e. in-, exclusion of other than tap water from public supply such as sea water, surface water etc., different methods for the accounting of closed loop water systems etc.)

- *Flow resources* which include wind, geothermal, tidal and solar energy.

  Not considered in this study since they have no relevance from a depletion standpoint. However, the impacts from conversion to usable energy or electricity are accounted where applicable.

- *Space*, which includes land use for human settlements, infrastructure, industry, mineral extraction, agriculture and forestry, and is required to produce and sustain other resources.

  Not considered in this study. Many LCA databases have included data on land occupation and conversion, however, this is not the case for all datasets. Also, methodologies on land use indicators differ among studies and LCA data sources. Because consistency in data and results could not be guaranteed, this has been left out. The model should enable inclusion of this type of indicators when more consistent data becomes available.

2.3 Inventory of products in Belgium

The definition of a product provided by the Belgian law on Product Standards (1998) is: *"all physical movable goods and services that are brought on the market for private and/or public consumers".* In the same law a product category is defined as "*a group of products that are intended for the same use (thus perform an identical function)."*

Some decisions need to be made however on the scope of the project:

1. The focus of the project is on consumption by households, which excludes all types of intermediate products only purchased by industry. Intermediates can be considered as inputs required to ultimately generate these final products. For this study, the scope of products are *"final products"* and can be defined as *"products that require no additional transformation prior to their use by households".*

2. In the LCA approach one needs to define product systems, which in principle include all inputs and outputs during the life cycle of the product, including the input or output of intermediate products. The impacts of these intermediates are thus allocated to their subsequent final product systems. When also considering these intermediates as separate categories, double counting of impacts would occur.

3. Food and drinks are excluded from the study, as they are also not in the scope of the Belgian Law on Product Standards. However, packaging, that could be considered as an intermediate product contributes substantially to this omitted category. As packaging are also targeted in this law, they are also included in this study. However, all packaging can not be aggregated together to keep the product list consistently 'final product' oriented. Consequently, the resulting impacts from packaging should not be compared (ranked) unambiguously with that of other final product categories.

4. *Non-movable* goods such as domestic dwelling (housing) do not fall under this legal definition of products. On the other hand building materials for use in domestic dwelling are movable goods. As such these intermediates are included in the study and can be aggregated as one functional class "Housing".

5. Some types of intermediate products such as glues, paints… were listed separately under the category "Cross-cutting Products ". According to the definition above, they are not final products (since they are an input in the life cycle use stage of other product systems) but since several existing policies apply to these specifically, it can be argued to study these as a group. To avoid the error of double counting in the 'final product' classification, their environmental impacts were allocated to the main final product systems they are an input to.

The study arrives at product groupings by dividing the final consumption into product classes at different levels of aggregation. The study will include the following 4 levels (from high to low):

1. Functional areas of consumption (e.g. 'Building Occupancy', 'Building Structure', 'Transport', 'Personal Care', 'Recreation' etc.) Typical resolution: the total final consumption in society is divided in twelve elements.

2. Function groups: groups of product categories with related but mutually different functions (e.g. 'Passenger Transport' that groups all personal vehicles and public transport). Typical resolution: the total final consumption is divided into some 50 elements.

3. Product groups: groups of products that are intended for the same use; at this level the functional unit is defined (e.g. the subdivision of the function group 'Passenger Transport' into 'passenger car', 'motorcycles', 'public buses', etc.) Typical resolution: the total final consumption in society is divided into some 123 elements.

4. Final Products; which is the lowest aggregation level considered in the analysis for phase 1 (e.g. the average 'diesel cars'). Typical resolution: the total final consumption in society is divided into 289 elements.

Note that in phase 1 of the project the aggregation does not go down to the level of more or less homogeneous product groups (e.g. 'middle-class diesel cars') or even individual products (e.g. a 'specific diesel car'). An analysis at this detailed level would hardly be of practical value at this stage, nor would it be feasible to execute in one year. In phase 2 of the study, a more detailed study and aggregation is applied to 4 product case studies.

2.4 Methodological framework for the evaluation of the environmental impacts

2.4.1 Bottom-up LCA approach

2.4.1.1 Existing methods for the evaluation of the environmental impacts of products

During the period of this study, phase1 (2001), few other finished (or published) studies were available that examined the life cycle impacts of product consumption in an economic region. However, several studies were ongoing in some other Member States and also one study was being conducted for the European Commission. The studies known to the authors of this project are listed in the table below. At that time, these represented the 'state of the art' in methodology development.

In general two approaches are used:

1. "Top-down approaches" where impacts are determined from National Accounts Matrix extended by Environmental Accounts (NAMEA) where total impacts are allocated downward to products and services on the basis of household expenditure statistics and monetary transactions between sectors.

2. "Bottom-up approaches" where environmental impacts are determined from the extrapolation of product Life Cycle Assessments (LCA's) to the entire market.

Reference	**Reference**	**Approach**
1	Hansen E. et al, *Ranking of industrial products*, Danish EPA (project n° 281) – COWI, Denmark, 1995	Bottom-up
2	Cobas, E., *Life Cycle Assessment Using Input-Output Analysis. Doctoral Dissertation*, Carnegie Mellon University, Department of Civil and Environmental Engineering, Pittsburgh, PA, 1996.	Top-down
3	Labouze E. et al., *Study on external environmental effects related to the life cycle of products and services – Final Report Version 2*, European Commission, DG Environment – Sustainable Development and Policy support, BIO Intelligence Service/O2 France, Paris, 2003.	Bottom-up
4	Nijdam DS ; Wilting, *Environmental load due to private consumption; Milieudruk consumptie in beeld (RIVM rapport 7714040004)*, the Netherlands, 2003	Top-down
5	Rixt K. et al., *Household metabolism in European countries and cities Comparing and evaluating the results of the cities Fredrikstad (Norway), Groningen (The Netherlands), Guildford (UK), and Stockholm (Sweden).* Toolsust Deliverable No. 9 Center for Energy and Environmental Studies, University of Groningen, 2003	Top-down (only on energy)
6	Dall et al., *Danske husholdningers miljøbelastning. København: Miljøstyrelsen. (Arbejdsrappport 13)*, Denmark, 2002	Bottom-up
7	Weidema et al., *Prioritisation within the integrated product policy.* In preparation (available only by June 2004)	Top-down
8	*Environmental implications of resource use – insights from input-output analyses*, draft, prepared by the European Topic Centre on Waste and Material flows (ETC WMF), Germany, 21 October 2003	Top-down

2.4.1.2 Selection of the bottom-up LCA approach

Main reasons why the bottom-up approach was applied for this study:

1. Existing expertise at Vito and ICEDD in the field of LCA.

2. Builds on approach and results project SPSD I where a similar approach was taken (see paragraph 1.2.3 for more information on this project).

3. The required Economic Input-Output tables, extended with environmental data, which were needed for an input output analysis were not available for Belgium at that time.

4. Bottom-up method was used for a Danish study (ref. 1 in table) and was being applied for an European study (ref. 3 in table). Contacts were established with the researchers from the European study. Advantages and disadvantages were known to the researchers and efforts were directed at making the approach more robust. .

5. Only in the bottom-up LCA approach the impact modeling is based on physical product quantities and product parameters. This model allows for phase 2 to relatively easy calculate theoretical impact reduction potentials by altering these parameters. This is more difficult in the top-down method because all impacts are allocated on the basis of monetary flows between different sectors in an economic region, so there is no direct relationship in the model of impacts with product parameters.

6. Impacts related to the use and waste phase of products need to be specifically modeled in environmental input-output analysis and this cannot always be done at a very good level of detail.

Advantages of bottom-up LCA approach:

1. Possibility to model each product category at a very high level of detail.

2. Possibility to model and see the consequences in terms of impact reductions when changing the model parameters (final demand, product composition etc…).

Disadvantages of bottom-up LCA approach:

1. Level of detail for product category modeling depends on availability of data for that category (average weight, material composition, processing technologies, energy use, useful lifetime, emissions, treatment when disposed etc…).

2. Differences in data coverage for different product categories will result in uncertainties and may affect ranking.

3. Differences in methodology behind LCA databases from different sources. These have to be mixed because no individual database contains all materials or processes required for the study.

4. Differences in quality of LCA data; reference year, extensiveness of inventory, coverage of technology etc… In most databases however this is well documented.

5. System boundary cut off which is inherent to LCA system boundary definition. The resulting cut off impacts are not multiplied upward with market data. In extended input-output analysis total impacts are allocated downwards to product categories and in principle cover the full consumption-production system. LCA's necessarily are cut off since not all small inputs into the life cycle can be inventoried in practice.

An extensive review of all these methods and results from the different existing studies, including this Belgian study was carried out in the European project EIPRO (see paragraph 1.2.3).

2.4.2 Two-step procedure based on resource intensity

Ideally, the selection of product categories with the highest environmental impacts should be based on a detailed study of all products consumed in Belgium and for all possible environmental indicators. The initial product list consisted of 123 product categories (second lowest level of aggregation) covering in total 289 products (lowest level of aggregation).

This was, however, out of the scope of this research. In addition, it was not possible to draw a detailed overview due to the (un)availability or inconsistency of data and practical circumstances. In consequence, this project deals with a limited number of environmental indicators and also includes a procedure to limit the number of products from the originally very extensive product list. The developed model thus provides the basis for testing the research method that can be built on and broadened gradually and systematically.

It should be clearly stated that for future research developments and prior to use in the context of policy making, this two-step procedure should be eliminated and replaced with an extensive data inventory for all impact indicators and all product categories. This study contributes on the provision of information on these required data needs and currently existing gaps.

The reason why material intensity (M), energy intensity (E) and water usage (H) were preferred as criteria for this initial selection of products is their correlation with impacts such as acidification, climate change, ecotoxicity, human toxicity, nutrient enrichment (eutrophication), photochemical ozone formation (smog), etc… Independently from the material application in products, similar materials undergo similar transformation throughout their life cycles causing specific impacts.

The initial analysis of all product categories (step 1 of the procedure) resulted in a set of 9 indicators: M_{metal}, $M_{mineral}$, $M_{synthorg.}$, $M_{natorg.}$, M, E_{p}, E_{u}, E^{LC}, H. Since a wide range of sources was used to quantify these indicators, the uncertainty of these data could vary from 10% to almost 45% for some low quality data sets.

A product category having a contribution for one indicator of at least 2% of the total of that indicator for all product categories, is included in the detailed analysis (step 2 of the procedure).

2.4.3 Recycling

A traditional problem in LCA is how to deal with processes where recycled material is used as an input or where the output of a process is further used as secondary material in another product system (open-loop recycling). Allocation is needed to partition the responsibility for the environmental impacts caused by the raw material extraction, the recycling and the final disposal of a material over different product systems in some proportional shares.

Compared to a system in which recycling and/or energy recovery is not considered, recycling leads to three benefits :

- reduced emissions due to avoided emissions from primary fuel & resource extraction, purification and delivery and from primary fuel combustion, virgin material production;

- reduced use of natural resources (closing material loops) due to avoided extraction of primary fuels and resources;

- reduced waste, due to avoided landfilling of materials that have the inherent potential to be valorized.

It is important to highlight the fact that the benefit of recycling can be reaped at two stages of the life cycle of products : at the production stage if it is composed of recycled material and/or at the disposal phase if the materials are recycled.

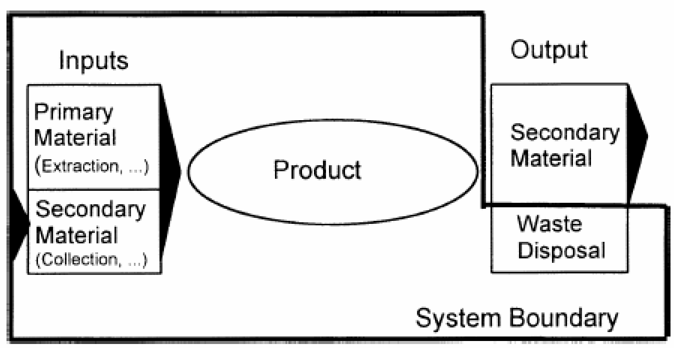
In this study, the environmental burdens of the primary and secondary materials, as well as the outputs, are allocated according to the following principles:

1. Primary material as input: the environmental burden of the raw material extraction and processing is included entirely in the system studied.

2. Recycled material as input (use of recycled material in new product): the environmental effects of collecting, processing and reintegrating the material are 100% included in the system. The avoided effects of using secondary materials instead of primary materials are not included in the system.

3. Recyclable materials as output (product recycling of disposed product): any environmental effects of collecting and recycling are excluded (as a burden or credit for the next product system), thus 0% included. This because when both the secondary material processes as input and as output are accounted the full 100 % in one system boundary, double counting of these effects will occur when calculating the total for all product categories.

4. Non-recyclable wastes: the effects of disposing non-recyclable wastes are included in the system.



Why did we use this approach? Although this study is not conform to a typical LCA study and as such no standards exist, we have tempted to apply however some main LCA approaches and ISO standards on recycling in LCA: ISO/DIN 14041:1998 and ISO/TR 14049:2000 The norm describes a procedure on how to deal with recycling. This procedure is briefly explained and also why this norm has not been followed in this phase 1:

1. ISO: "…wherever possible, allocation should be avoided by expanding the product system" which means crediting the avoided emissions due to material recycling and also for energy recovery. This is however not desirable for this study. One argument is that the results of the analysis should reflect the 'absolute' amount of life cycle impacts caused by product consumption in Belgium and not the 'difference' compared to a system where no recycling and recovery takes place for these products. This because i.e. sector data on greenhouse gas emissions, which are also 'absolute' need to be compatible with these results in order to conclude on how product policies can contribute to achieve existing climate change objectives in Belgium.

2. When system expansion cannot be applied, ISO suggests to apply allocation; if possible based on physical properties, but also allows allocation on the basis of economic value or based on the number of subsequent uses of a material in different product cycles. This would mean that impacts from i.e. the burden from extraction of raw materials, the further processing etc… can be partitioned over the original product (as primary) and its subsequent uses (as secondary). Future products using secondary materials would thus inherit impacts from the past where the original primary material was produced and used. For particular LCA type of studies this could be a valid accounting method, however for this study it is not for the same reason as mentioned above: results should reflect 'absolute' amounts actually caused during the product's life cycle timeframe.

2.5 Summary of results

2.5.1 Step 1 : Selection of resource intensive products

The selection procedure resulted in 30 product categories remaining from a total of 123 product categories originally and at the lowest aggregation level: 116 products from 272 originally. The resulting product categories are listed in the table below for the top 3 levels of aggregation.

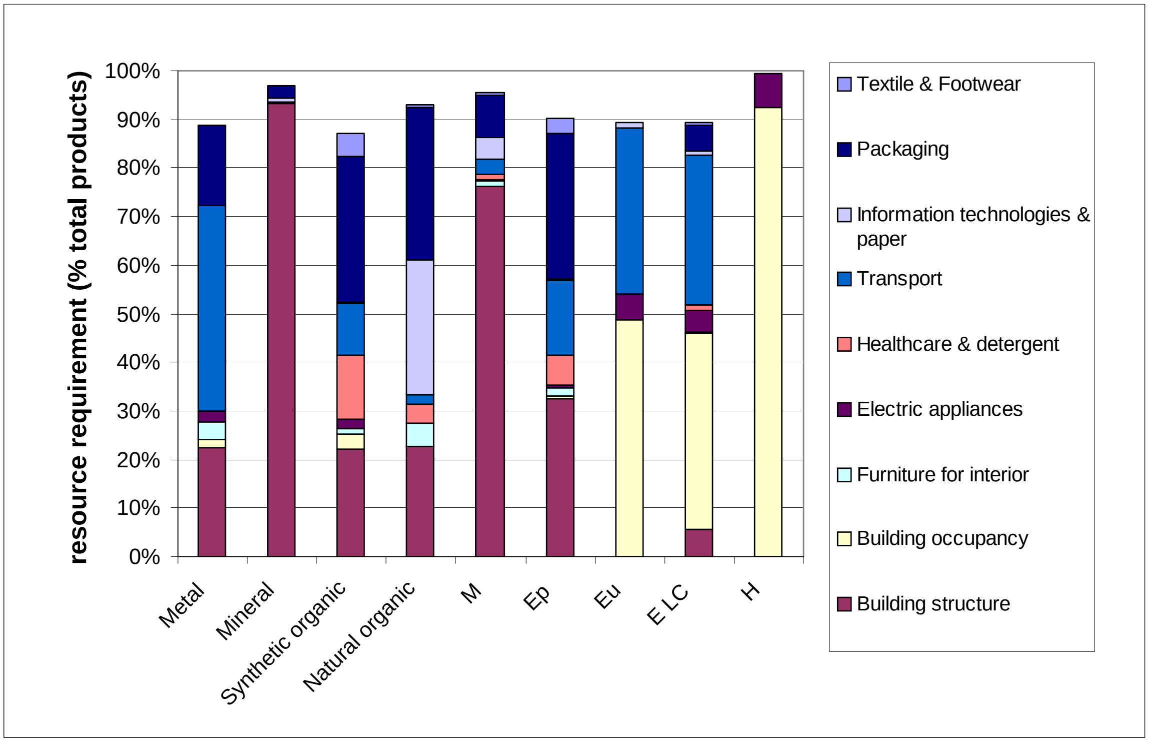
Function class	Function group	Product category
BUILDING STRUCTURE	exterior wall	Supporting wall
		Exterior ornamental gable
		Wall isolation
		Window
	floor	Supporting floor
		Ornamental floor (top layer)
	interior wall	Wall elements
		wall preparation for decoration
		Bathroom and kitchen walls decoration
		Other non plastered wall decoration
	roof	Roof covering (top layer)
	building foundation	Foundation & cellar
BUILDING OCCUPANCY	hot water	Water heaters
	interior climate	Heating system
	lighting	lighting systems
	sanitary equipment	Bathtub
		Shower head
		Toilet emptying system
FURNITURE FOR INTERIOR	furniture	Furniture
ELECTRICAL APPLIANCES	washing laundry	Washing machine
		laundry dryers
	washing tableware	Dishwasher
HEALTHCARE AND DETERGENTS	baby products	baby diapers
	healthcare and dtergents	Soap, detergents
TRANSPORT	passenger transport	Regular trips up to 150 km
	transport of goods	Transport goods (Domestic)
INFORMATION TECHNOLOGIES AND PAPER	office machine	Copier
PACKAGING	household packaging	beverage packaging
		food packaging
		Other household packaging
	industrial packaging	Industrial packaging
TEXTILE	clothing	Clothing

This initial prototype-analysis, based only on the resource indicators, shows that about 25% of all product categories cause more than 85% of the total for each indicator. This is also confirmed in other studies[12] that have also considered other impact indicators and justifies to focus product policy efforts on these hot spots. However, the precautionary principle mentioned before should be considered: for some particular impact categories, a different set of products may be top rankers, so one should only conclude relating to the specific considered impacts, never generalizing it to overall environmental relevance.

In the following graph the contribution of the resource intensive products (after selection procedure) is shown to the total caused by all products from the original product list (100% line). For example the selected resource intensive products contribute 90% to the total energy requirement for material extraction and manufacturing ("Ep" in the graph).

[12] i.e. Elaborated in detail in the EIPRO study

Note that the selection of resource intensive products is done at the lowest level of product aggregation and hence the results per function class do not cover all original product categories in that function class.



In the following table, all results for these resource intensive products are presented at the highest level of product aggregation. For example: all selected resource intensive building structure products contribute for 22% of the total metal requirement (before selection), for 93% of the total mineral requirement, for 23% of the total natural organic requirement, etc. If a function class accounts for more than 30% of the total impacts, it is put in red. The function class can be considered 'very important' for that impact. If it accounts for 15 to 30% it is put in orange. It can be considered 'important'. If it accounts for 5 to 15%, it is put in light orange. In that case it can be considered 'relevant.'

	Material					Energy			Water
Function class	*Metal*	*Mineral*	*Synthetic organic*	*Natural organic*	M	Ep	Eu	E LC	H
Building structure	22%	93%	22%	23%	76%	32%	0%	6%	0%
Building occupancy	2%	0%	3%	0%	0%	1%	49%	40%	93%
Furniture for interior	4%	0%	1%	5%	1%	2%	0%	0%	0%
Electric appliances	2%	0%	2%	0%	0%	1%	5%	4%	7%
Healthcare & detergent	0%	0%	13%	4%	1%	6%	0%	1%	0%
Transport	42%	0%	11%	2%	3%	16%	34%	31%	0%
Information technologies & paper	0%	1%	0%	28%	4%	0%	1%	1%	0%
Packaging	16%	3%	30%	31%	9%	30%	0%	5%	0%
Textile & Footwear	0%	0%	5%	1%	0%	3%	0%	1%	0%
total	***89%***	***97%***	***87%***	***93%***	**95%**	**90%**	**89%**	**89%**	**99%**

> 30 %
15 - 30 %
5 - 15 %

Table 1. Resource-intensive product categories.

We notice that the function class 'building structure' represents more than 70% of the total material requirement (and 93% of the total mineral material requirement). Building structure represents also 32% of the energy requirement due to the material manufacturing.

'Building occupancy' represents the highest energy consumption (49%) and also the highest demand for water (93%).

'Transport' is an important consumer of metals and synthetic organic materials (42% and 11%). It has an important share in the total energy demand (both for the production and the use phases). It accounts for 31% of the total E^{LC}.

'Packaging' contributes to 9% of the total material demand, with especially large consumption of metals (16%), synthetic organics (30%) and natural organics (31%). Note that packaging is an intermediate category and should actually be divided over the final products they pack i.e. food and beverages category, healthcare and detergents category etc…

Then 'Electrical appliances', represent non negligible consumers of energy and water (7% for water use and 5% of energy). Although the group as a whole has a relatively high energy requirement (about 15% of the total for all products), the energy use by all individual and diverse product categories remains below the 2% threshold. As a result many electrical appliances are not included after the selection. All resource intensive products together represent 88% of total E^{LC}. Of the 12% E^{LC} not accounted for, 7% originates from electrical appliances.

Information technologies and paper represent an important consumption of natural organic (paper for copiers and printers), with 28% of the total.

Resource intensive products among the function classes "Textiles & footwear", "interior furniture" and "healthcare & detergent" represent a smaller resource requirement.

2.5.2 Step 2 : Analysis of selected resource intensive products

The following table shows the contribution of the different function classes to the different impact indicators on resource use, waste and greenhouse gases.

	Inputs			Outputs	
				emissions to air	
Function class	Energy	Intermediate material	Raw materials	GHG	waste
BUILDING STRUCTURE	6.3%	78.8%	61.9%	10.8%	79.5%
BUILDING OCCUPANCY	38.2%	0.4%	0.9%	33.7%	0.2%
FURNITURE FOR INTERIOR	0.4%	1.0%	1.0%	0.8%	1.1%
ELECTRICAL APPLIANCES	9.8%	0.9%	2.6%	5.6%	0.7%
HEALTHCARE AND DETERGENTS	1.0%	1.3%	0.5%	0.3%	0.7%
TRANSPORT	33.7%	3.2%	15.1%	36.4%	3.2%
LEISURES	1.7%	0.2%	1.1%	1.0%	0.2%
INFORMATION TECHNOLOGIES AND PAPER	3.4%	4.9%	4.8%	3.4%	4.5%
GARDEN	0.3%	0.1%	0.4%	0.2%	0.1%
PACKAGING	4.7%	8.7%	11.5%	6.6%	9.3%
TEXTILE	0.6%	0.4%	0.3%	1.2%	0.4%

	30%
15%	*30%*
5%	*15%*

Table 2 . Impacts from the resource-intensive function classes.

2.6 Conclusions

2.6.1 Most important functions and product categories

From the previous table, we can conclude the following on the importance of the function classes:

- 'Building Structure', 'Building Occupancy' and 'Transport' are very important from an overall waste, resources and GHG point of view.

- 'Packaging' is important as an intermediate group, but it should be divided over and related to its respective final product categories.

Most other function classes do contribute significantly, or only to a limited number of impacts:

- Information technologies and paper are important with regard to material use and use of scarce resources. From the FSE study, which included the evaluation on more impacts, it could be concluded that this category is also very important for emissions to water and relevant for acidifying substances.

- Electrical appliances are relevant for energy use, certainly when taking all the original (before selection, step 1) products into account and also with regard to water use.

Figures presenting the ranking of product systems at the 4th and lowest level of product aggregation for all impact indicators applied in this study, are presented in the first intermediary report (January 2003). Conclusions on these are:

- Due to the high ranges of uncertainty on the data collected, the omission of some product categories and the effect of aggregation principles, no exact ranking of product systems could be generated and the Figures should thus be interpreted carefully.

- With regard to intermediate material consumption (M) :

    - Metal consumption is mainly due to the production phase of personal transportation systems and reinforcement steel in building construction.

    - Consumption of minerals is mainly related to building structures.

    - For synthetic organic materials; detergents and personal transportation systems contribute substantially; followed by some midrange systems such as beverage packaging and clothing. Personal transportation systems (tyres, oil…) and the cleaning of floors represent high contributions in the use phase of products.

    - For natural organic materials, copiers (mainly due to paper consumption in the use stage) and roofing represent high contributors.

- With regard to raw materials consumption (R):
    - Having the highest requirement is building foundations. Another high contributor in the same order of magnitude is personal transportation systems. The range of products following these top contributors are mainly other building elements.

- With regard to water consumption (H):
    - Highest contributor are toilet systems, accounting more than double compared to other individual sanitary product systems such as showers, bathtubs or electrical appliances such as dishwashers and washing machines. (Note that only tap water use was considered and no other water use i.e. during the production of goods).

- With regard to energy consumption (E):
    - Energy consumption is the largest for transportation and heating systems, use stage, but also the production phase is not negligible in case of transport (negligible in case of heating). These 2 products represent 70% of the total energy requirement of all considered resources intensive products.

- Greenhouse gas emissions (GHG):
    - These figures largely reflect energy use and therefore we notice again the major importance of transportation and heating systems that represent about 40% of the total emissions for all resource intensive products. Hot water accounts for about 5% of this total emissions.

- Waste
    - These are closely related to the material intensity of products (M) and the disposal route that are typical for certain material fractions (i.e. recycling for metals, glass and paper recovery or landfill for plastics and minerals). Although production waste is also accounted, the highest shares mainly result from the waste generated from disposing the final product.

2.6.2 Comparison with results from other studies

Additional results could be drawn from the FSE project (Nemry et al., 2002), in which the scope of impacts was expanded, the following additional conclusions can be mentioned:

- Healthcare and detergents are relevant for emissions to water.

- Textile is relevant for acidifying substances and photochemical substances.

- Furniture for interior contributes only for a very small part to the total of all impacts.

Results on high impact product categories could also be drawn from the ESTO project in which all results from all existing studies (among other this Belgian study) were compared and which were confirmed by the newly developed input-output model for product consumption in Europe. The following is a summary of the conclusions from the ESTO project as they are of relevance to the conclusions of this study.

Among the studies, general agreement exists on these highest contributors, however differences exist about their mutual ranking.

The following product categories always show up in the top ranking of the different studies:

- Transport: passenger cars and transport of goods (last only considered by Labouze et al. (2003)).

- Food production (not considered in this study, but considered in all other studies).

- Heating.

- Construction: housing, offices and civil work (last two only considered by Labouze et al. (2003)).

No agreement has been found on the 'midrange' categories following these top rankers and the results from the different studies are not conform. The following product categories show up as relatively high contributors in some studies, however not confirmed by other studies that also treat these categories:

- Packaging; when considered as separate intermediate product group, are relevant with regard to resources use (kg-based, not characterized) and waste. However, when the characterised indicator on resources scarcity is applied (Labouze et al. (2003), and also in the detailed study on packaging of this project in phase 2), packaging becomes irrelevant Also, when packaging are considered an integral part of final product systems, their impacts will be distributed accordingly over these final product categories (i.e. packaging for 'food and beverages').

- Household (electrical) appliances; importance strongly depends on how these products are aggregated i.e. all kept together or more subdivided according to function (cooking, lighting, leisure etc.).

- Office (electrical) appliances; is not a final product group but could be of relevance for IPP. Mainly the paper use related to these appliances seems relevant (resources and waste). Only Nemry et al. (2002) considers this product group, that is why its importance can not be confirmed by the other studies.

- Other midrange categories are : 'Furniture', 'Clothing and textiles', 'Spare time, restaurants, hotels, holidays…', 'Water supply for dwellings'

One should question if for IPP it is of importance to identify also the relevant intermediate product categories. The question is related to two aspects:

a) All studies reviewed focused on final consumption by households. *This hence does not make explicitly visible the products used in the production system (i.e. for business to business activities).* For instance, cars are used by final consumers, but also for business purposes. One could argue that IPP should focus on total car use rather than car use for final consumers.

b) Most existing studies applied a strong functional approach. This implies that 'product' categories that traditionally have been policy relevant are not made visible explicitly in the studies (e.g. some packaging becomes part of the final products 'food', 'electrical appliances', etc.)

The following intermediate product categories came up as relevant from the studies by Labouze et al. (2003) and Nemry et al. (2002), these are:

- Packaging (household and industrial),
- Office appliances (copiers, computers and peripherals etc…),
- Non-residential building occupancy (heating, lighting in office buildings etc…),
- Non-residential construction (i.e. office buildings, civil work).

2.6.3 Distribution of impacts over all products

Distribution of impacts over all products is a general rule, but varies in percentages for each individual impact category among the different studies. However, when comparing the results of the different existing studies that each tackle a somewhat different range of impacts, the same principle applies: a small range of top contributors represent a large bulk of the total impact.

When comparing the different existing studies and acknowledging that methodologies and scopes vary among the considered studies, the following cautious conclusions can also be drawn.

1. In most cases, a few top contributing product categories represents about 20% or more of the total impact.
2. In most cases, the products with lowest impact in the 60-percentile[13] still represent 5% to 10% of the total impact. This however strongly depends on the product scope and aggregation principle applied in the studies i.e. the study by Moll et al. (2004) has much more categories compared to the other studies and consequently the individual contributions are much smaller, with the top contributing product group ranging from 10% or more depending on the impact indicator considered.

[13] The 60-percentile is defined as the range of products, ranked in descending order for a particular impact indicator, that represent 60% of the total impact from all products.

3. When looking at each study and the highest impact product categories that represent 40% of all impacts considered, the number is rather limited to a few top rankers (4 to 12 categories, depending on study). When looking at the 60-percentile and 80-percentile, the number of categories representing these shares grows a factor two to three. The lowest impact contributors outside the 80-percentile still constitute a large number of products (30 to 60% of product categories, depending on the study).

2.6.4 Most important life cycle stages

Material use (M) and also raw material use (R) is mainly due to the production of products, but for some products the use of consumables during the use stage contributes significantly i.e. tyres, batteries, oil etc for transportation systems, paper use for copiers and printers, cleaning agents for floors, detergents for dishwashers and washing machines etc…

With regard to energy use: the top contributing energy consumers are mainly due to energy use in the use stage. The same is true for greenhouse gases. The share of the disposal phase is completely negligible for these impacts: this is mainly due to the methodological allocation applied in this study namely the impacts from secondary materials are allocated 100% to the use of secondary materials and 0% to the end of life recycling. This means that the recycling of materials or recovery of energy at the end of product life cycles are granted zero impacts. Also, the energy use or greenhouse gas emissions from landfilled materials are rather negligible compared to the other life cycle stages.

Although production waste is also accounted, the highest shares from waste (W) mainly result from disposing the final product.

2.7 Discussion on used methodology and results

An expert review of this project and also other existing (similar) studies revealed that differences in applied methodologies for identifying high impact product categories have more influences on the results and the ranking of products compared to differences in consumption patterns for different economic regions. As such, agreement among the studies existed on the importance of some top ranking product categories, but not about their order of ranking. No agreement at all existed on the midrange product categories following the few top rankers.

Some main aspects seem responsible for this deviation of results:

1. Aggregation principle applied for the product list: function oriented, final product oriented or industry sector oriented. Also, while some intermediate product categories such as packaging, tyres, batteries are already focussed in product oriented policies, is it not interesting to consider them both as separate categories and complementary as a life cycle aspect related to other final product categories in this type of studies? This is also the case for products purchased by industry such as computers, leased cars etc... Also, products purchased by public authorities are often not in the scope of these studies.

2. Definition of the scope and system boundary of the product list: this study encompasses consumption, while other studies also include production for export. In this case, products of the own (production) economy are granted higher rankings and become more the focus of product oriented policies.

3. Allocation methods applied for secondary materials and energy recovery: how is double counting of impacts avoided and how are impacts and credits due to secondary resources divided over their use versus the generation at the end life of products.

4. The top-down versus the bottom-up method for modelling the impacts stemming from the life cycle of products. Where in the bottom-up the main data uncertainties lie in the availability and reliability of data on consumption of products (as number of units), the availability and reliability of inventory and averaging of product data, and the impacts cut-of inherent to the defining the system boundary in the LCA approach. In top-down input-output analysis, the main uncertainties lie in the allocation procedure and reliability of statistics to divide total impacts over product categories according to monetary flows between industry sectors and expenditure by households. In general, from a data availability point of view, the top-down approach is more efficient because it is related to available national and EU statistics that are updated regularly. The LCA approach is restricted to the use of a wide and often inconsistent base of scattered data sources.

The aspect of data uncertainty in the bottom-up LCA approach is more elaborated in the project by Nemry et al. (2002). An estimate on the uncertainty level is calculated for the results of this study and ranges from about -60% to +100%. Therefore it makes no sense to literally interpret the absolute results and ranking, but rather conclude on groupings of products that lie within the same order of magnitude and substantially differ from other aggregated categories that contribute at least double or half to the impact categories. More information is presented in chapters 7.2, 8.2 and 8.4 of that report.

The project of Nemry et al. (2002) entailing phase 1 of this project and describing the methodology and results has been reviewed by several external experts. These review reports can be consulted in the annexes of this report. Also, the methodology has been reviewed in the framework of the EIPRO and the EIRES project (see chapter 1.2.3). These project reports can be consulted for more information (not yet published). Several industry federations have also reviewed this study such as the Belgian FEB-VBO[14] and ERM[15] for the Alliance for Beverage Cartons and the Environment.

The bottlenecks reported by the authors and reviewers of this study were communicated to the project team of the EIPRO study, where an European model for determining the impacts of products in Europe was developed. This European study will be followed by a study on the improvement potentials for the high impact product categories.

In the scope of this Belgian study, the improvement potentials for 4 product categories have been investigated. The selection of these 4 product cases was not related to results of phase 1 of this study, although phase 1 confirms the importance of personal cars and building structure. On the other hand, no conformity exists on the importance of packaging and computers (and related paper use).

[14] Joint platform 'European and international environmental policy', position Integrated Product Policy, comments on the methodology used in the Belgian study, 2003 September 3rd

[15] Environmental Resources Management, "Review of the Belgian Product Study", May 2004

3 Phase 2 and 3: Detailed analysis of four case studies

The second phase of the project consisted in the detailed analysis of four case studies, namely packaging, passenger cars, housing, and computers with the associated paper use. This detailed analysis comprised two different stages. First, the impacts of these four case studies were calculated, and theoretical improvement potentials were estimated; and last, policies and measures that would help reducing these impacts were listed and analysed. The aim was to evaluate if a product policy could help in significantly reducing the impacts of these four product categories, in terms of greenhouse gas emissions, resource use and waste production. More particularly, how a product policy could help Belgium to reach the GHG emission target set by the Kyoto protocol was an important element of this analysis.

3.1 Phase 2 : methodology for the calculation of theoretical improvement potentials

3.1.1 Strategies for improving the environmental impact indicators

The implementation of product policy requires an appropriate approach to take into account both the different life cycle stages of products with their own environmental impacts, and the different strategies with their ability to tackle one or several life cycle stages.

In the framework of the project, we have developed and used an analytical tool that aims at linking product life cycle stages with the emissions, emission reduction potentials and relevant policies and measures.

This analytical tool is presented in Table 3. It summarises how different improvement strategies of products can influence their greenhouse gases emissions at different life cycle stages. Vertically are listed the different improvement strategies that can be envisaged to reduce impacts. Horizontally, the product life cycle stages are distinguished. The coloured boxes represent the life cycle stages for which the impacts could be potentially affected by the strategy. The colour shows to what extent the strategy is actually envisaged in current environmental programmes (especially for Belgium). Measures envisaged in these programmes can target one or more strategies.

These strategies are more precisely defined in the following paragraphs.

	part of life cycle of which impacts could be reduced					
Improvement strategies	materials processing	product manufacturing	production waste treatment	distribution	product use	product waste treatment
Changes in final demand for the considered function	orange	orange	orange	orange	orange	orange
Substitution of products fulfilling the same function	orange	orange	orange		orange	orange
Product reuse	blue	blue	blue			blue
Optimizing the product life time	orange	orange	orange	orange	orange	orange
Rational use of the product					orange	
Changing the product composition	blue	blue	blue			blue
Increasing end-of-life products recycling	blue	blue	blue			blue
Industry process substitution	orange	orange	orange			
Improving the efficiency of energy transformation	grey	grey				
Energy substitution	grey	grey				
Improving the efficiency of materials	blue	blue	blue			blue
Energy recovery	grey	grey	grey			grey
Reducing transport distances for materials & products				blue		

(blue) *neglected in ongoing climate programmes*
(orange) *only partly considered in ongoing climate programmes*
(grey) *fully considered in ongoing climate programmes*

Table 3 : Improvement strategies and product life cycle stages.

<u>Changes in final demand for the considered function</u>

This strategy aims at changing the demand of consumers for a particular function (e.g. hot water, heating, freezers, etc). It would of course influence all life cycle stages, but is not often envisaged in environmental programmes, as it influences consumption and therefore production of goods and is often seen as damaging for the economy and the quality of life.

<u>Substitution by products fulfilling the same function</u>

The final function can be fulfilled by different products. The design of the product (shape, material composition) can influence its life cycle impacts. For those products for which the impacts from the use phase are important, the shift from lower to higher energy efficiency or from higher to lower carbon-content fuel can also contribute to reduce the life cycle impacts (for instance using electric heating, central heating by gas or by gasoil, stoves, etc).

Concerning life cycle stages, only the distribution of goods is generally not likely to be affected by this strategy, except if the products have very different weights. Product substitution is sometimes already envisaged in current environmental policies, e.g. through the substitution of old boilers by newer, more efficient ones.

Product reuse

Product reuse allows doubling (or more) the product's use phase, thus delaying the time when it will become a final waste. Therefore it does not influence the use phase of the products (annual emissions remain the same) but influences the waste phase and the production phase (because less new products are consumed). Product reuse is mostly not considered in actual climate policies, but more in waste policies.

Optimising the product life time

Increasing the product's life span, especially in the case of energy consuming products in their use phase, can have either a positive or a negative effect (if new products are more efficient). Therefore it is necessary to optimise the product's life span in order to have the lowest possible impacts. This strategy has an influence on all life cycle stages, even on the use phase, because of technological changes affecting the product's emissions during the use phase. It is only partially considered in environmental policies.

Rational use of the product

Properly using a product has a significant influence on its impacts during the use phase and can also extend the product life span. It is only partially considered in the current environmental policies, mainly through information and education measures.

Changing the product composition

Changing the product composition can allow to reduce the energy used for manufacturing the product and for material processing. It can therefore reduce impacts from these life cycle stages. It also influences the product's waste treatment. However, this is not envisaged by current environmental policies.

Increasing end-of-life products recycling

The increase of product recycling has a mostly beneficial influence on energy used/generated in the waste phase, but also on the material production and product manufacturing through the use of recycled materials or parts. In general, recycled materials need less energy for transformation. Product recycling is not envisaged as such in climate policies, but is mostly implemented through waste policies.

Industry process substitution

The industry process used for the production of material or product manufacturing of course has a great influence on the impacts from these stages, and also to the emissions due to the production waste treatment. In the case of cement, for example, changing from the wet to the dry process allows a substantial decrease of impacts. This strategy is sometimes considered in current environmental policies.

Improving the efficiency of energy transformation

Improving the efficiency of energy transformation can be envisaged at the material production phase and the product manufacturing phase. It allows a better use of energy. Since the energy efficiency improvement of products during use phase is already part of the strategy "Substitution of products fulfilling the same function", the use phase is not considered here.

Energy efficiency is one of the main strategies envisaged by current environmental policies.

Energy substitution

GHG emissions vary from one source of energy to the other. Therefore energy substitution is very often envisaged in climate policies. It influences mainly the product manufacturing and material production.

As the energy substitution during the use phase is already part of the strategy "Substitution of products fulfilling the same function", the use phase is not considered here.

Improving the efficiency of materials

Improving the material efficiency of a product allows to decrease the amount of material required to manufacture a product. The less material is used, the less energy is needed to produce it. It also influences emissions from waste treatment, both from production and from end-of-life product. This strategy is not considered in current environmental plans.

Energy recovery

Energy recovery can be envisaged during most industrial processes, either during the production or during waste treatment. Energy recovery during use phase seems marginally feasible. It is envisaged in current environmental programmes.

Reducing transport distances for materials & products

None of the strategies listed above explicitly targets the product distribution. However, CO_2 emissions from distribution can be non-negligible especially for electronic equipment that is not produced in Belgium. But it is not envisaged in current environmental programmes.

3.1.2 Evaluation of theoretical improvement potentials

3.1.2.1 Introduction

A product oriented policy would potentially aim at curbing not only impacts from products bought each year, but also impacts from products already used in the country (existing stock). For instance, one policy could aim at speeding up the replacement of old products with new ones. As a result, the impacts from old products during their use phase would be reduced.

This means that both the existing stock of products and the products put on the market must be considered in the study, especially in the development of scenarios on impacts from products, including impacts produced in Belgium but also impacts produced abroad.

Considering both stock and new products adds some data requirement as compared to the previous phase of the project where only new products put on the market were analyzed.

As the present study aims at evaluating to which extent a product policy would contribute to the simultaneous fulfillment of the three objectives to reduce GHG emissions, waste and pressure on raw materials, impacts and impact reductions have been calculated in such a way as to fit with the following environmental objectives:

- regarding greenhouse gas emissions, the emission reduction targets agreed in the Kyoto Protocol are expressed as a percentage reduction of the average annual national emission over the period 2008-2012 compared to the 1990 level.

- regarding waste, several types of objectives are defined in the regional waste policy documents, based on per capita annual emission ceiling and minimum recycling or reuse rates in a year.

As a result, for GHG emissions and for waste, annual emissions need to be estimated and especially "domestic" emissions.

Regarding material resources, there is no quantified objective. However, the European Union is developing a strategy on raw material use.

3.1.2.2 Calculation of annual impacts and scenarios of impacts from products

For all four product groups studied in the project, we have developed a common methodology for the construction of scenarios. The development of this methodology has been guided by two main concerns, which are to:

- ♦ reflect the annual environmental impacts from the existing and from the new products used in Belgium until 2010, with a clear distinction between impacts from the disposal phase of existing products, from the use phase of existing products and from the production phase of new products;

- ♦ quantify the individual impacts from each general improvement strategy as well as the impacts from the combination of all these general improvement strategies.

The methodology is based on the application of the formulae as explained in the second intermediary report (January 2004).

It starts with the building of a "business as usual" scenario (BAU) that reflects an evolution where the current policies will not be changed in the future. The BAU scenario is based on the different data sets and on several assumptions regarding future trends.

Basically, the **data** concern:

- ♦ data on ownership rates (and hence on product sales)
- ♦ data on the composition of the existing stock of products
- ♦ data on product life span, material composition, consumable and energy consumption during the use phase
- ♦ data on product disposal scenarios
- ♦ LCI data on materials, fuels and electricity as used in the products and in the consumables

Main **assumptions** made for most products for the period 2000-2010 are:

- ♦ the ownership rate (from which the product sales are derived)
- ♦ the share of each individual product in the product category
- ♦ the technical characteristics (energy consumption, life time,...)
- ♦ any relevant evolution on LCI data (especially referring to well known industry process improvements, including those resulting from the existing climate policies)

Then, having defined the BAU scenario, alternative scenarios are built in order to reflect the relevant improvement strategies. This was done by changing the parameter(s) reflecting the effect of the strategy (see the January 2004 intermediary report).

3.1.2.3 Detailed accounting rules

3.1.2.3.1 Raw materials

In this phase of the project, the indicator which was used is based on the 'abiotic resource depletion' indicator developed by CML (University of Leiden, Netherlands) which is expressed in equivalent antimony. This indicator was also used in the European study by Labouze et al. Indeed, it enables to distinguish between rare materials and other more usual materials.

3.1.2.3.2 Waste

3.1.2.3.2.1 Impacts from waste elimination

During the first phase of this study, the waste was calculated by weight units (kilograms). During the second phase, we focused on the one hand on the environmental impacts which are generated by waste treatment, and on the other hand on the amount of final waste (which goes to landfills).

Indeed, depending on the waste treatment route, different environmental impacts will occur. In all cases waste treatment represents a more or less important transformation of the physical and chemical properties of the materials contained :

- One fraction of the waste will be converted into air pollutants - hence contributing to air pollution and climate change - and water emissions.

- An other fraction will be converted into a new type of waste that will remain into the environment over a long period with possible impacts on health and environment : if the "ultimate fraction" is landfilled, it will for instance impact biodiversity or groundwater. In addition, if it is composed of toxic waste, it can damage human health and fauna or flora.

In the project we took into account these two types of impacts to some extent. We will evaluate both :

- the greenhouse gas emissions, the net energy use resulting from the waste treatment and

- the ultimate waste fraction after landfill and incineration.

Regarding the first indicators (GHG emissions), we will refer to the need to calculate actual emissions. This is particularly important to comply with that accounting rule for greenhouse gas emissions because, the verification of compliance with the commitment of the Kyoto Protocol emission reduction target will be based on such emissions.

For the second type of indicators (ultimate waste) the evaluation was limited to waste from the use and the disposal phases. Indeed LCI data on waste from the production phase are sketchy (data are not available for all materials) and also comparison from one data source to another is not easy. For instance, the fact that internal recycling is or is not taken into account is not clearly specified. For this reason, using these LCI data would lead to a very rough estimate that needs to be consider very cautiously. This would be especially true when comparing different improvement strategies.

However, for housing only, since the waste flows are easier to figure out (most of the waste is inert and goes to landfills), and also since this is a very important parameter, we will also include the waste from the production phase.

3.1.2.3.2.2 Impacts of recycling

Considering one specific product system wouldn't neglect the fact that in reality the system is one part of a much more broad system which is the Belgian economy and even "the rest of the world". More specifically, we have to keep in mind the fact that if some recycled material is used to assemble one product studied, this recycled material has been part of another product (either of the same or of another type as the product considered) before.

Also, if some material is recycled after the product considered is disposed off, this recycled material will subsequently be used in new products (either of the same type or other type).

Thus the concern is to have consistency in the accounting of impacts for several products, especially to avoid double counting of impacts.

In this phase of the project, the approach of system expansion is applied (crediting the avoided effects of recycling). A 50%/50% allocation rule has been applied for that phase, because the other two options seemed too discriminative:

- allocation 100% of the impacts to the production phase, as we did in the previous phase of the project, actually favours products which use a lot of recyclates, whatever its collection and recycling rates are,

- whereas allocating 100% of the impacts to the disposal phase favours products having high collection and recycling rates, whatever their use of recyclate.

3.1.2.3.2.3 Credit from recycling

As explained before, we choose to quantify the actual impacts of product consumed in different scenarios.

In some existing studies, and also industrial reports, a different approach is followed that introduces the concept of "credit" linked to avoided primary material. In order to enable comparison of this project with such studies, we complemented the evaluation of actual impacts with a calculation of credits. These "credits" should be seen in the context of the general economy of a country – or even world-wide. They represent impacts that would have occurred in this economy if no recycling had taken place. In this case, primary materials would have been used, but also the disposal would have consisted in incineration and landfill. Thus, the recycling of materials brings a general benefit to the economy.

Even in the BAU scenario, credits exist. A strategy which, for example, reduces the consumption of the product category, would result in a decrease of this credit, but the ratio credit / actual emissions would remain the same. Thus, it is this ratio which should be considered when evaluating the benefits of a strategy in terms of credits.

3.1.2.4 Calculation of the share of impacts occurring in Belgium

3.1.2.4.1 Introduction

While a product policy primarily aims at reducing the life cycle impact of products, countries (including Belgium) are faced with national emission reduction targets either to fulfil objectives decided internally or objectives resulting from international agreements (such as the Kyoto Protocol).

One first question that needs to be answered when designing policy measures for a particular product, is to know the **fraction of life cycle emissions** that occurs in the country itself. This information is useful for the policy maker to evaluate the potential effect of the policy on its national emissions.

Therefore, it would be also necessary to calculate the share of **emission reduction** resulting domestically from the policy in its total emission reduction.

The complexity of the problem is more or less important depending on the product phase considered :

- For the production phase, there is no direct answer because a product is composed of different materials of which one fraction has been (partly) processed abroad.

- For the use phase, if the impacts are mainly linked to energy use, it can be stated that most of the combustion process that produce CO_2 emissions occurs in Belgium (of course one fraction of the electricity used is produced outside of Belgium, however it still remains small as compared to the Belgian production). If, on the opposite, the use phase mainly consists in the use of spare parts and consumables, the problem is similar to the production phase.

- For the disposal phase, for some products like packaging, or building materials it can be expected that most of the waste flow will remain in Belgium. For others, like cars, one fraction of the end-of-life vehicles initially bought in Belgium will leave the country.

Hereafter, a method that enables to approximately estimate the share of Belgian emissions in the total impacts from the production phase is presented.

Thereafter we study the problem of evaluating the share of domestic emission reductions in the reduction of these total emissions.

3.1.2.4.2 Share of domestic emission in emissions from the production phase

3.1.2.4.2.1 Simple case

Let's consider a very simple product system corresponding to one material M. For the material, mass conservation at the national scale implies that :

$$P + I = C + E$$

P : production in Belgium, I : import, C : consumption in Belgium, E : export

If only one production process is executed in Belgium, and if this process corresponds to the extraction + manufacturing, the situation is even more simplified: the impacts from this process then correspond to the emissions occurring from "cradle to consumption" (excluding the impacts from consumption waste disposal).

Then, two cases can be considered :

- the case where no imported material is subsequently exported unless a significant transformation process occurs ("no transit" case). In this case the calculation is possible.

- the case where one fraction of the imported material is subject to no or minor transformation in Belgium and subsequently exported ("with transit" case). Indeed, statistics on foreign trade reveal much more complex situations. In this case, which is the most common one, it is impossible to determine which part of the impacts actually occur in Belgium. This is clearly illustrated with e.g. recovered paper pulp:

    - ♦ production: 1569 kt
    - ♦ import: 801 kt
    - ♦ export: 1765 kt
    - ♦ consumption: 605 kt

These figures indicate that export is larger than production. This is due to the fact that one fraction of import is subsequently exported again. Unfortunately this exact fraction is not known[16].

In this particular case we never have the guarantee, even when export is lower than production, that no imported goods are subsequently exported. And if such transit movements exist, we of course can not know their exact amount.

This means that in most cases we can only make the reasoning that:

- ♦ either production is preferably dedicated to the internal market and the surplus is exported. This means that the share of domestic emissions in the life cycle emissions of consumed products is given by P/C and is limited to 100%;

- ♦ or production is preferably dedicated to the external market (all production is exported). This means that the share of domestic emissions in the life cycle emissions of consumed products is given by (P-E)/C and exceeds 0%.

As a conclusion, the share of national emissions lies between :

$$max((P-E)/C, 0\%) \quad \text{and} \quad min(P/C, 100\%) \qquad (1)$$

An average value "p" can be calculated as the average of those two values.

Depending on the values P, E and C, the uncertainty range will be more or less important.

Moreover, for most products / materials, national production covers a much more complex process chain than in the previous example. In addition, import flows occur at different levels of the product system life cycle. Therefore, the problem can't be solved with one single equation. The complete calculation will result in an accumulation of all corresponding uncertainty levels. As a consequence: the more complex the chain, the larger the uncertainty will be.

[16] In addition, the level of statistics quality can interfere with this explanation.

3.1.2.4.2.2 Additional problem: statistical data on exported and processed materials

The relation of domestic emissions in combination with material flows in an economic boundary (in this case Belgium) can be modelled as long as statistical data is available for it relating to import/export/production (and favourably in mass or unit quantity terms).

A problem occurs when for a specific intermediate material in the process chain, no Belgium production occurs i.e. this is the case for the polymerisation of PET in Belgium. Although ethylene, BTX etc… (occurring before in the total process chain of PET bottles) are produced in Belgium, the fraction used for PET production is entirely exported abroad. This means that for PET supply in Belgium, in the model proposed, all 'aggregated' emissions are non-domestic.

This 'hidden flow' of Belgian intermediates going abroad to be further processed and afterwards partly coming back to Belgium in the form of processed materials can not be modelled because no statistical data can be connected to it.

It should be noted that this 'hidden flow' can occur for each consequent step in a process chain, increasing the uncertainty level of results on domestic/non-domestic impact contributions.

3.1.2.4.3 Share of domestic emission reduction in total life cycle emission reduction

Let's assume that an improvement strategy is targeted to one product consumed in Belgium and results in curbing the material consumption for the considered product with ΔC.

The amount and direction of changes of each flow *P, I, E* are not obvious to anticipate as they depend on different parameters (notably the economic conditions of internal and international markets).

For instance, three extreme cases could be encountered :

1. Import level decreasing by the same level as consumption change ($\Delta I=\Delta C$).

2. Production level unchanged and export increasing to compensate the decrease in domestic demand ($\Delta E=-\Delta C$).

3. Production level decreasing to adjust to the new consumption level ($\Delta P=\Delta C$), thus decreasing domestic emissions.

Assuming a certain probability of occurrence of these three types of consequences would require developing a macro-economic model reflecting the market functioning at the international level, which is of course beyond the scope of the current study.

This means that in this study, there is no way to decide on the scale of change in national emissions. Even calculating the arithmetical average between the three values would be highly speculative.

3.1.2.4.4 Conclusions

The uncertainty in the calculation of the share of the domestic impacts in the total impacts from the production phase is resulting from three difficulties :

1. the impossibility to separate out the "transit" flows of goods, i.e. to separate out the fraction of imports which is dedicated to export.

2. the modelling of 'hidden flows' of Belgian intermediates going abroad, and returning to Belgium in the form of processed materials (or processed intermediates more upwards in the total process chain). This mainly gives problems if a specific process cannot take place in Belgium (P=0).

3. the combination of uncertainties occurring at each step of the chain of the material.

The consequence of these three combined factors varies from one material to the other (and hence from product to product). The uncertainty is limited only in a few cases where "transit flows" can be considered negligible and where the considered material chain is limited to only a few processes.

This is the case for cement and other building materials (bricks, flat glass, ...).

On the opposite, the uncertainty for materials like PET, paper, etc..., can be very high.

As a conclusion, for the production phase the different materials were not further analysed, except for the most representative building materials.

The same difficulty must be expected for the use phase for spare parts and consumables.

For energy use during the use and disposal phase, the estimation was made for each specific product.

3.1.3 Definition of the system boundaries and main hypotheses

3.1.3.1 <u>Building structure</u>

3.1.3.1.1 Definition

The product category considered is the building structure of single family houses (SFH). Concentrating on single family houses is justified by the fact that about three quarters of Belgian households are living in single family houses in 2001 (which represents an increase of 10% compared to 1990).

In the definition of the product system we consider :

- the <u>production phase</u> (mining of raw materials, manufacturing of materials and assembly phase as being the construction of the whole building or the construction of annexes to existing houses).

- the <u>use phase</u> : we consider the maintenance of the structure of the building during its life (that implies to replace roofs every 50 years and windows every 35 years). The energy use for the heating of the dwelling is not considered: we suppose that houses have the same insulation level[17].

[17] It is considered that the insulation level corresponds to k=0.4 W/m.K for walls and for roofs.

- the <u>disposal phase</u> representing the demolition of building and the impacts resulting from the disposal of end of life building materials.

The transport phase has not been included in the modelling but rough estimates have been made on the CO_2 emissions linked to building material transportation (import and distribution).

This product category is subdivided in different products, each having a particular composition for each element of the building:

	brick&concrete house	**stone & concrete house**	**Expanded clay house**	**Cellular concrete house**	**wood & brick house**	**Wood house**	**recycled material-based house**	**renovated conventional house**	**renovated wood house**
foundation	strong sole foundation				light sole foundation		strong sole foundation		light sole foundation
external walls	Brick&concrete wall + reinforc.	Stone + concrete wall	Brick & expanded clay	Brick & cellular concrete	Brick & wood	Wood	Brick&concrete wall + reinforc.		Wood
interior walls	concrete wall		expanded clay wall	cellular concrete wall	wood wall		concrete wall		wood wall
roof	tile roof + mineral wool	natural slates + mineral wool	artificial slates + mineral wool		natural slates + mineral wool		tile roof + mineral wool		natural slates + recycled paper
soil	concrete floor				wood floor		concrete floor		wood floor
windows	PVC window frame	Wooden window frame	PVC window frame	Wooden window frame			PVC window frame		Wooden window frame

Table 4. Composition of housing.

3.1.3.1.2 Assumptions of BAU and alternative scenarios

- For the **BAU**, the evolution of the demand for new and renovated houses for the period 2000-2010 was based on projections made by IDD in the framework of a former Science Policy project with the model Locatelli. These estimations covered the surface per house and the number of new houses and renovations. These projections were adjusted to reflect more realistic surface evolutions (total surface per new house of 185 m^2 in 2010 instead of 200 m^2) as well as improved statistical data from NIS (National Institute of Statistics). It is also assumed that the market share of the different construction types from a material composition standpoint is not influenced by voluntary policies : it is only influenced by the action of some independent initiatives (labelling by environmental NGO's, professionals from the wood sector,...).

- Scenario strategy 1 **"Changes in final demand"** : the change in demand consists in curbing the surface of new houses. The average surface per new house is frozen to 160 m^2 (as in 2000).

- Scenario strategy 2 **"Substitution of products fulfilling the same function"** : the level of new construction is reduced up to 20000 units, which means that over the 10-year period about 29000 new constructions are avoided and compensated by the renovation of unoccupied dwellings.

- Scenario strategy 6 **"Changing the product composition"** : the share of new construction using low impact materials (CO_2 emissions, raw material and waste) is increased. A similar increase is considered also for the maintenance (roofs and windows using material with better environmental performances).

- Scenario strategy 7 **"Increasing the use of recycled building material and the end-of-life products recycling "** : the construction of recycled material houses is rapidly increasing up to 2010 to a percentage of 12%. The contribution of other constructions is adjusted accordingly.

- **Synthesis scenario** : This scenario reflects the combined effect of all changes assumed in the four alternative scenarios.

Other scenario were not modelled (e.g. increasing the life span would have had no visible results by 2010).

3.1.3.2 <u>Passenger cars</u>

3.1.3.2.1 Definition

The product category considered is passenger cars. We have been evaluating the use of raw material, the greenhouse gas emissions and the generation of ultimate waste of all 8 different types of Belgian passenger car models, both for the newly purchased cars and for the already existing car park.

We consider three phases in our analysis:

- production phase: comprises all manufacturing steps ‘from cradle to consumer’. It therefore encompasses the extraction and processing of materials, the production of car parts, the assembly of these parts. The GHG emissions from the pre-combustion phase of the fuels (extraction, refining, …) have not been considered. Also, due to the high uncertainties and a lack of data, no account is taken of the intermediary transport steps. This should, however, not pose a huge problem, as their share is expected not to be influenced heavily by policy measures taken in order to relieve the environmental impact of cars.

- use phase: is of very high importance to the product category of passenger cars. It mainly comprises the fuel use (diesel or petrol) during driving, but also the amount of tyres and car batteries used during the product’s entire life cycle.

- disposal phase: these are the wreck treatment processes ‘from consumer to grave’, such as incineration, recycling and landfill.

An important assumption is to limit our analysis to the “first use life” of a car, which means that we neglect the exportation of cars (because of lack of exact data availability) and suppose that they are disposed of at the moment of exportation. Of course, when a second-hand car is sold to another Belgian consumer, it is still accounted as a part of that car’s “first life”.

Another important simplification is that those cars which are exported after their first life are assumed to be disposed of in the same way as is usual in Belgium: with the same processing techniques, the same collection rates, … This is an underestimation of the environmental impact, because the (mostly African or East European) car importing countries tend to have a wreck processing system inferior to the Belgian.

3.1.3.2.2 Assumptions of BAU and alternative strategies

In order to construct a BAU scenario, we departed from the year 1990-2001 data (from the TEMAT model and other sources) which we extrapolated towards the 2010 time horizon. All (Flemish) TEMAT data have been extrapolated on the basis of 1999-2001 data in order to incorporate the passenger cars from the whole of Belgium.

- Scenario strategy 1 **"changes in final demand"**: the total number of vehicle-kilometers driven by all passenger cars together is supposed to remain constant at the year 2000 level. In reality, because passenger car sales remain equal to the BAU scenario (i.e. slightly increasing), this assumption implies a decreasing mileage per car.

- Scenario strategy 4 **"optimizing the product's life span"**: a yearly increase of a passenger car's life span of 1,5% is assumed. This assumption of course has implications on the sales figures, because the longer a product is used, the less products need to be bought for replacement.

- Scenario strategy 5 **"rational product use":** this scenario is based on the voluntary agreement of ACEA, which states that the average CO_2 emissions of all new passenger cars entering the European market will be reduced by 25% by the year 2008 compared with 1995 levels. CO_2 emissions need to be cut therefore by 46 to 140 g/km in 2008. Because the time horizon in this study is only till 2010, the impact of this measure would only last for 3 years (2008-2010). In this scenario, it was supposed that this measure would be finalized already by 2005. It should be noted that attaining this agreement has only a relatively small influence on the results, because the emissions are only influenced during 6 years (2005-2010).

- Scenario strategy 6 **"changing product composition":** in this scenario we assume an accelerated change of passenger car material composition. This means that the change from steel use into aluminium and plastics use is doubled with regard to the BAU scenario: -10% of steel in 2005, and -20% in 2010 in comparison to 2000. These percentages are compensated for by an equal weight increase of aluminium and plastics. Although this assumption on equal weight may be fairly unnatural, it reflects a radical stop to the tendency of ever heavier cars (mainly because of the increasing number of accessories and safety measures) and we esteem it would be too ambitious to believe this tendency could be reversed in the short term. As a result, there is supposed to be no influence of this measure on the car's fuel efficiency.

- **Synthesis scenario:** this scenario reflects the combined effect of all changes assumed in the alternative scenarios.

3.1.3.3 Household packaging

3.1.3.3.1 Definition

The product, or better packaging category considered is that of household packaging. Concentrating on beverage packaging and food packaging is justified by the fact that beverage and food packaging account for about ¾ of all household packaging! It can be expected that GHG emissions from packaging will also result mainly from the contribution of these 2 categories!

In the definition of the product system we consider:

- Production phase: mining of raw materials, manufacturing of basic materials and conversion into packaging.
- Distribution phase: from producer gate to consumer is considered for beverage packaging only. For this category, a relation can be made between the efficiency of the packaging system on a volume-restricted cargo load. The difference in the efficiency of cargo loads is allocated to the packaging (as additional truck-km required, compared to the most optimum packaging system). For refillable beverage packaging, the reverse transport and the amount of reuse cycles is also considered.
- Disposal phase representing the waste treatment routes for household packaging (mechanical or feedstock recycling, municipal waste incineration, landfill).

The packaging considered have been chosen in order to ensure the best representativeness that is possible in the framework of such a study and also taking into account the amount and the format in which data is present with regard to these categories.

Beverage packaging systems: for this packaging category, individual *"beverage packaging systems"* have been modelled. All relevant life cycle aspects related to these packaging systems have been inventoried and are allocated to the applicable beverage type categories.

Food packaging is subdivided in the following categories as *according to "material composition"*.

1. Glass jars
2. Metal cans
3. Paper & Cardboard
4. Thermoformed sheets
5. Flexible food packaging
6. Liquid carton packages

3.1.3.3.2 Assumptions of the BAU and alternative strategies

Calculations on the future demand for beverage packaging (expressed in litre of packaging service per capita) were made in the framework of a previous OSTC project. This calculation is based on the results of the Corelli model for beverage consumption in Belgium.

In the year 2000, Belgium consumed about 253 kton of food packaging. The BAU is based on the estimation about the evolution during the next 10 years (2000-2010) that the total amount of food packaging will increase with of 8%. The market shares were also estimated but these are rough estimates and should be interpreted with much care, because a substantial uncertainty exists on this data. During the course of the data inventory, no explicit sources were found on the future demand of food packaging in specific.

- Scenario strategy 1 **"Changes in final demand":** both for final beverage demand and food demand, no strategy was considered. The main aim is to reduce the effects from its packaging, not reducing the demand for the packed product itself.

- Scenario strategy 2 **"Substitution of products fulfilling the same function":** For beverage packaging substitution of small packs with large packs resulting in packaging weight reduction per unit (~litre) of beverage consumed is considered under this scenario. For food packaging, an alike scenario could not be developed, because the food packaging systems themselves could not be modelled (no adequate data available).

- Scenario strategy 3 **"Product Reuse":** Product reuse is not considered for food packaging. For beverage packaging, a strategy was calculated for a more than assumed "Business as Usual" demand of refillable bottles. Also, in this scenario refillable PET bottles replace refillable glass bottles and also replace a substantial share of one-way PET bottles.

- Scenario strategy 6 **"Changing the product composition":** For food packaging this strategy scopes the replacement of aluminium used for cans and food barrier films with steel or plastic alternatives (where applicable); the substitution of LDPE with thinner PP films and the replacement of synthetic plastics with biodegradable plastics. For beverage packaging this entails: with regard to milk and milk drinks; a slight increase of market share for beverage cartons (instead of expected decrease, a slight increase) and replacing one way PE bottles. With regard to fruit juices: an increasing market share of PET bottles, replacing one way glass bottles.

- Scenario strategy 7 **"Increased recycling":** A slight increase compared to BAU of recycling ratios is considered under this scenario both for beverage packaging and food packaging. The increase depends on the packaging category and the packaging materials. For beverage packaging, an increase of 5% is assumed for plastics (PE and PET bottles) and also for liquid cartons. The same is considered for liquid cartons in the food packaging category.

- Scenario 11 **"Increased material efficiency":** Decreasing the material content of packaging systems and an increased use of recycled materials are considered under this scenario for both food and beverage packaging. This entails a whole range of measures; reducing wall thickness, improving structural strength, etc… For food packaging, reductions are estimated for glass jars, metal cans, films, cardboard boxes and thermoformed sheets. For beverage packaging, reductions are estimated for all pack types (except liquid cartons). Both for food and beverage packaging an increase in recycled content is estimated for plastics, steel and aluminium.

- **Synthesis scenario**: This scenario reflects the combined effect of all changes assumed in the alternative scenarios.

3.1.3.4 Computers and paper

3.1.3.4.1 Definition

Computers and paper were studied over two product categories : computers in households, and computers & paper in the Federal Public Services (FPS).

For household computers, the distinction was made between laptops, desktops with CRT screens and desktops with LCD screens. We did not quantify any consumables, since data are very scarce and vary widely in the household sector.

3.1.3.4.2 Main assumptions of the BAU and alternative scenarios

In the BAU scenario, the main assumptions are that :

- The ownership rates will continue to increase.
- LCD screens will become more and more common, as well as laptops.
- The trend is towards larger screen sizes. This affects their energy consumption.
- Scenario 1 **change in final demand** for the function: In this scenario, we assume that the penetration rate of computers in households remain constant after 2000. In FPS, we envisaged a reduction of the penetration rate due to a better organisation. For paper, a decrease in the average number of copies and prints is envisaged.
- Scenario 2 **substitution of products fulfilling the same demand:** In this scenario, we assume an increased market share of LCD screens and laptops and a decrease of CRT screens.
- Scenario 3 **product reuse**: Computers can be re-used easily as long as they meet the needs of the customer and as long as they are not too damaged when they are disposed of. Indeed, most computers are replaced because they are outdated, not because they are not working. In these conditions, they can fulfil a second use. We assumed a second life span of three quarters of the first one.
- Scenario 4 **optimising the product's life span**: In this scenario, we look at the total amount of CO_2 avoided by 2010 and try to maximise it. We find that still at 10 years of life span, this avoided CO_2 is still increasing. However, a life span of more than 10 years is not realistic. Thus we chose 10 years of life span.
- Scenario 5 **rational use of the product**: In the BAU scenario, both the time of usage and the time in standby mode are increasing. For this scenario we assumed that they remain constant after 2000. For paper, an increased use of recycled paper is assumed.
- Scenario 7 **increasing end-of-life recycling**: We assume 100% selective collection rate and 100% recycling for all materials after 2003.

3.1.4 Conclusions

For this second phase of the project, the general approach was the same as for phase one. The main difference consists in taking into account the existing stock and not only new products put on the market. Also, we modelled the product categories on 20 years period, not just one year. In addition, we refined the methodologies used for the calculations of resource use and waste production.

The results from this modelling are presented in paragraph 3.3.

3.2 Phase 3 : methodology for the evaluation of policies and measures

3.2.1 Introduction

Once the impacts of the four case studies were determined, we envisaged how a product policy could help in lowering these impacts. Measures already exist targeting these product categories.

We thus reviewed other studies on these products in order to draw a first list of possible additional measures aiming at reducing the impacts in terms of GHG emissions, resource use or waste production.

The objective of this new task was to develop realistic strategies and estimate, as a result of this, realistic emission reduction potentials. 'Realistic' in this sense should be interpreted as the level to which a product policy measure, or a mix of measures, could be implemented.

The detailed analysis results of the four product categories already allowed us to evaluate the 'effectiveness' of some measures applied to certain product categories..

In this task, the final aim was to calculate realistic improvement potentials, based on stakeholders consultation. This was planned in three steps :

- Identify measures and sets of measures to reduce GHG emissions, resource use and waste production.

- Quantify variables identified during the quantification of technical improvement potentials.

- Calculate realistic improvement potentials based on these variables, using the calculation model developed for the previous phase.

In order to identify measures and quantify variables, the expertise of stakeholders was required. Indeed, ex ante and ex post evaluations of measures are scarce and are not sufficient to draw conclusions.

3.2.2 Review of existing methods for the consultation of stakeholders

We reviewed a series of methods based on the following pragmatic criteria:

- Usability for all stakeholders : As far as possible, we find it best (for sake of consistency) to use the same method to consult all stakeholders, not only one part.

- Equity between stakeholders : It is highly desirable that all stakeholders can participate, and that people talking the loudest, or stakeholders with more active lobbyists do not end up imposing their views.

- Amount of time required from stakeholders : The method should allow for a time requirement as short as possible for stakeholders.

- Possibility to express their views : Stakeholders should have the possibility to speak freely, adding ideas and having a real input in the process.

- Quantitative exploitability of the results : We planned to use the evaluation process to calculate realistic potentials in impact reduction. In order to carry out this task easily, we needed to have a method allowing for quantitative evaluation of parameters.

We also evaluated cost and total time requirement for the research team.

The following paragraphs show a summary of existing methods.

3.2.2.1 MCA – Multi Criteria Analysis

MCA is a mathematical approach to support decision making when several alternatives have a different impact on a limited number of criteria. It allows to underpin the selection of the optimal alternative. It is therefore NO stakeholder consultation method and can, as such, not be compared with the other methods described here. It is certainly an interesting approach when a lot of measures need to be evaluated on a limited, but diverse set of criteria, which is not the main goal of the project but only an interesting addition.

3.2.2.2 Delphi

Delphi is a method developed in the 60's to 'encourage true debates between experts, in the view of obtaining a consensus. The underlying assumption is that experts agreeing together are very likely to have the right answer to a given question. It is based on two main values : anonymity and feedback.

During Delphi consultations, a pool of experts is given a first written questionnaire. After collection of answers, a summary is written collecting all answers to the first questionnaire. This summary is then given with the same questionnaire to the experts who are asked to review their opinion based on the answers given in the first round. Experts holding extreme views are asked to justify them. Delphis can be carried out for more rounds, in order to reach a consensus.

However, in the 70's, a new type of Delphi emerged, in which consensus is not requested, but instead diversity is mapped : the policy Delphi. This method intends to give a review of all options, with supporting evidence, to the policy makers. It typically gathers opinions of experts on policy issues based on the following criteria using a range of scores (1 to 4):

- Desirability (Effectiveness or Benefits) : very desirable to very undesirable,
- Feasibility (Practicality) : definitely feasible to definitely unfeasible,
- Importance (Priority or Relevance) : very important to not important,
- Confidence (In Validity of Argument or Premise) : certain to unreliable.

Policy Delphi or normal Delphi, the method always consist of the same steps :

- Select stakeholders to be involved and contact them,
- Write the first questionnaire. Special attention is need because answers can be very sensitive to the way questions are formulated,
- Test the questionnaire,

- Send it to the stakeholders,
- Collect results (allow 2 to 3 weeks for obtaining answers) and summarise them anonymously,
- Send the second questionnaire with the summary, etc….

Using quantitative notation ranges allow determining mean values for each question, as well as the statistical distribution. Usually, each person is given the same weight in the answers, but it is also possible to give different weights to stakeholders according to their degree of expertise, e.g. through self-rating questions or through the resumes of these people.

Delphis have had a long time of implementation. Pitfalls and precautions to take are now well studied and it is also known that the decisive phase is the design of the questionnaires. The Delphi method, allowing structured answers and removing traditional bias occurring in conference rooms, is a good method to have stakeholders' views while obtaining quantitative inputs to the model.

3.2.2.3 Focus group

A focus group is a planned discussion among a small group (4-12 persons) of stakeholders facilitated by a skilled moderator. It is designed to obtain information about (various) people's preferences and values pertaining to a defined topic and why these are held by observing the structured discussion of an interactive group in a permissive, non-threatening environment.

Overall, it is not the most appropriated method with respect to the aim of this study, but could be of interest to further develop the work on the socio-economic matrix with should give an idea of 'expected' social and economic boundaries of certain types of measures.

3.2.2.4 Scenario analysis

Scenario analysis is a process in which different scenarios are elaborated and then presented to stakeholders in order to have their view on the implications of the different scenarios and on the means to achieve them (or avoid them if these are negative scenarios). A traditional scenario consists of the following steps :

- Identifying key driving forces for the defined issue.
- Write scenarios and look at implications of each of them.
- Present them to stakeholders : they must define which scenarios they like best, and what are the steps to take to achieve the desired scenarios.
- Implement measures.
- Review periodically the achievements.

Scenarios can be either defined in a first workshop or defined in advance by the research team. However, there must be a small number of scenarios presented in the workshops, in order to ensure easy feedback from stakeholders.

3.2.2.5 Expert panel

Group of experts that summarize a variety of inputs on a specialized topic and produce recommendations for future possibilities and needs for the topics under analysis. Each expert is expected to investigate and study a specific topic assigned and set forth their conclusions in written reports. A possibility is to organize a public session afterwards at which the conclusions and recommendations are presented. This method is only appropriate in the form of a panel of expert researchers, that have no direct or indirect political or economical interests in the issue. It is not appropriate for consensus-finding between affected stakeholders.

3.2.2.6 Results of the evaluation

The five different methods were given scores from 1 to 5 for the seven selected criteria. The results are shown in the following graph.

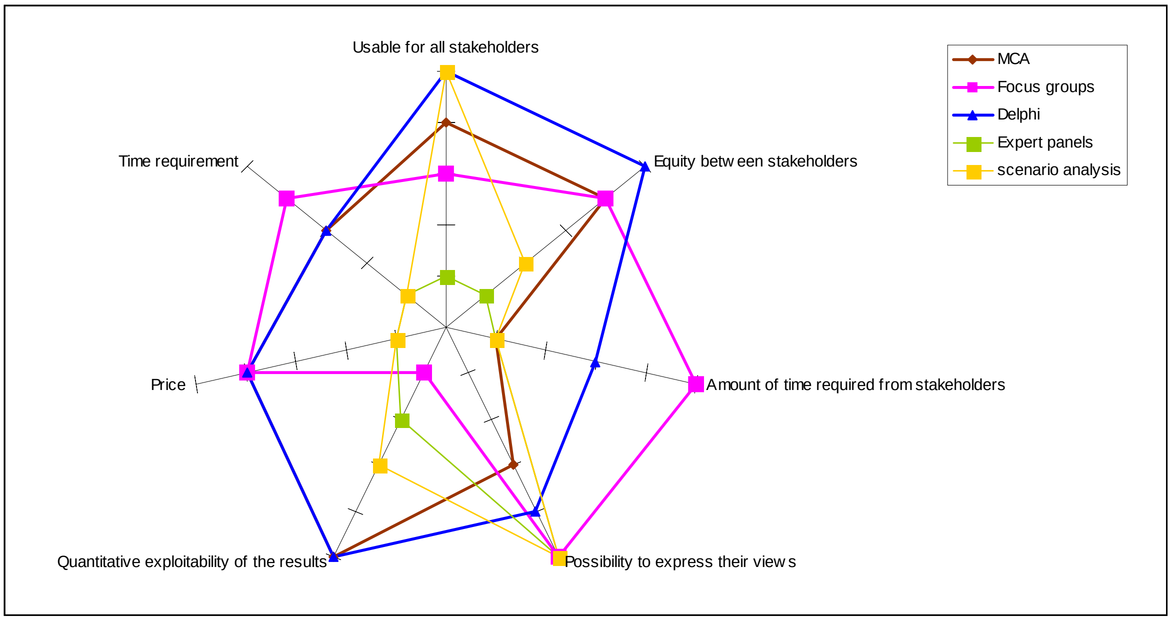


Figure 1 . Schematic representation of the scoring of envisaged evaluation methods.

From this representation, we immediately notice that scenario analysis and expert panels score poorly for most criteria, and can therefore be discarded.

Focus groups are very interesting in a preliminary phase to raise questions and possible answers. However, we have already carried out part of this phase through the establishment of a list of possible measures. Moreover, focus groups are definitely unworkable for the other types of stakeholders (i.e. other than consumers). We therefore discarded it.

However, we found good complementarities between the Delphi method and the Multi Criteria Analysis (MCA). We thus developed an approach enabling to use their respective advantages.

3.2.3 Description of the approach

Following the evaluation of existing methods, an approach has been developed combining the positive points of the two most promising methods (MCA and Delphi) in the context of this study and of its targeted objectives and outcomes.

3.2.3.1 <u>First consultation round</u>

The set of measures that was drawn needed to be evaluated for their realistic impact reduction potential. After the first round, we wanted to obtain a list of measures that are found to be feasible, efficient, accepted and least expensive.

A Delphi questionnaire was supplied to the stakeholders willing to cooperate, asking them to evaluate the measures on a series of criteria.

This questionnaire should result in a list of measures appearing as "the common denominator" between all stakeholders in terms of feasibility, efficiency and acceptance. In that sense, MCA is useful to come up with the best possible set of measures. Ideally, we would come up with at least one set of measures per strategy, for each product category.

3.2.3.1.1 Criteria of the evaluation in round one

In both rounds, we had to be very careful about the phrasing of questions and of measures. Stakeholders should have the opportunity to enter new measures, as well as to rephrase the measures. We also differentiated the criteria according to the stakeholder in order to require less time from them: it would, for instance, not make much sense for an industrial to be asked about the political feasibility of a measure.

The following criteria were evaluated in round one :

- Technical feasibility : is technology / knowledge adequately available to implement this measure?

- Political feasibility : is there political willingness (or no political impeachments at least) to set up, implement and monitor this measure?

- Effectiveness : can this measure result in a substantial reduction of at least one impact (GHG emissions, resource use, waste production)?

- Acceptance by the stakeholder : would the measure be well accepted by the stakeholder?

- Market acceptance : will the affected market positively perceive this measure?

- Cost for industry : will this measure substantially increase the costs in the industry concerned?

- Cost for policy : will this measure require the allocation of a substantial amount of money from the policy level for its implementation and monitoring?

- Cost for users : will this measure substantially increase the total cost of ownership (purchase price + run price) for the user?

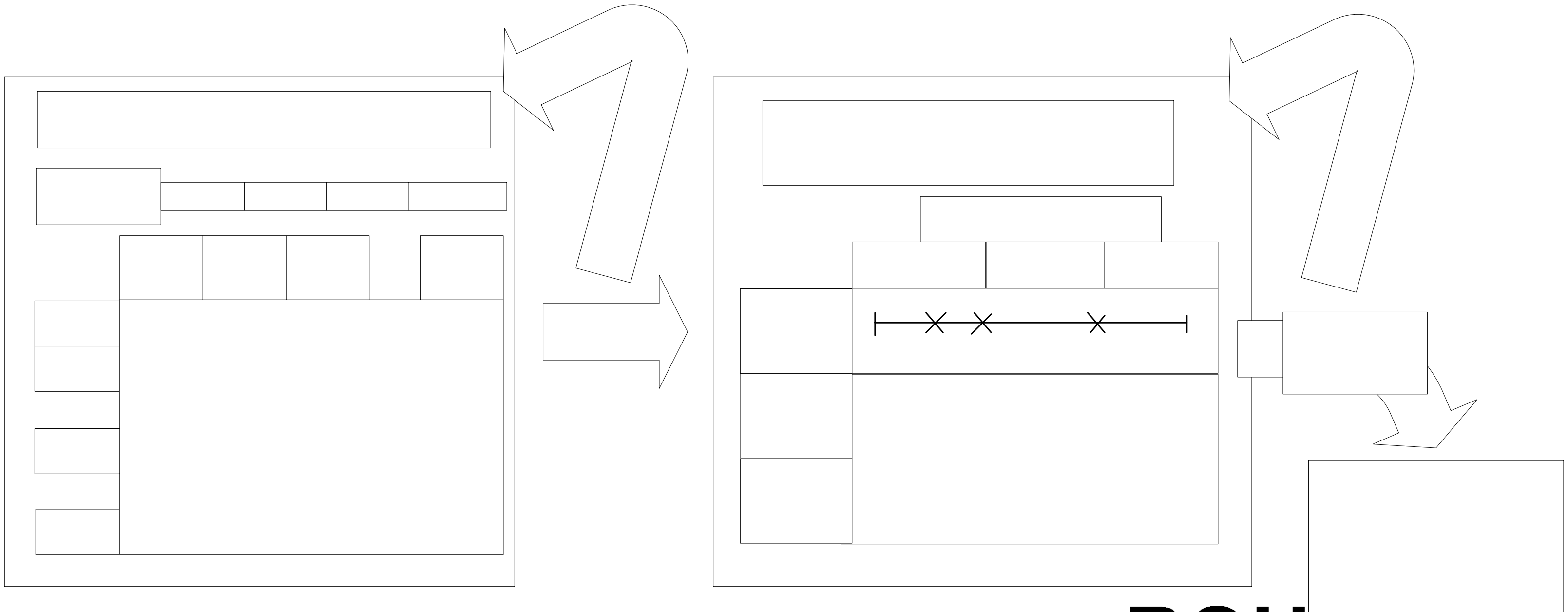


Figure 2. Overview of the methodology for the stakeholder consultation.

Preference choice of

Stakeholder consultation: industry politics res

technical feasibility
Commer cial
Market acceptar

3.2.3.1.2 Analysis of the results from first round

At the end of the first consultation round, we expect to come up with a list of possible measures evaluated following the above-mentioned criteria. From this list, we need to choose a set of preferable measures to implement. In order to do so, multicriteria analysis is a good way to systematically compare and rank measures.

3.2.3.2 Second round of consultation

In a second round, we planned to send a new questionnaire to the stakeholders, with the selection of one or more set(s) of measures, and a feedback on their evaluation in an anonymous way. Stakeholders may then change their opinion, or maintain it. They shall then be asked to quantify a series of parameters that will be necessary to calculate the realistic potentials for the four product categories. Consumers will not be asked at this stage of the consultation round, because they are supposed not to have much insight into the parameters for which we required their participation.

The parameters we planned to ask the stakeholders to answer relate strictly to the data that need to be filled in into the calculation model. We planned to give the stakeholders an idea of the values of the parameter in 1990 and 2000 and then ask them to comment on the value they think the parameter can obtain in 2010 if the listed measure(s) are taken by the government.

After all stakeholders have filled in this questionnaire, an average can be calculated for every type of stakeholder (industry, research or policy level). These three values might yield an interesting insight into the different points of view of every group of stakeholders. The average value for every parameter obtained from this questionnaire may then be used to construct new (technically more realistic) scenarios = combinations of measures.

3.2.4 Organisation of data and practical implementation of the questionnaires

The questionnaires were filled in through the Internet, on a web site. This solution enabled getting easily available data and allowed the stakeholders to have a personalised questionnaire that they can access anytime, with a login and password. In order to limit the time asked to each stakeholder for answering the questionnaire, the list of criteria was limited to his / her supposed field of competency, and the list of measures was also limited according to the life cycle stage for which the stakeholder was involved in.

The questionnaires were thus powered by a web database developed by VITO. This database gathered the answers from the 2 rounds in a convenient and manageable format.

3.2.5 Findings from round one : reorientation of round two

We had several findings from the first round on the general methodology for this consultation.

First, although we limited the number of criteria and the number of measures to limit the time requirement from stakeholders, we had several negative comments on this subject. Indeed, most stakeholders would have preferred to have all measures and all objectives, and select themselves the ones for which they feel they have enough expertise.

Secondly, the number of criteria was found to be too large to enable an easy assessment; moreover, some criteria were found either to be redundant or to have a too wide definition which would have required to split them up into other criteria.

- Political willingness : no stakeholder felt knowledgeable to answer this criteria,
- Industry distortion of competitiveness : redundant with the costs for industry,
- Feasibility : by definition, all the measure that we suggested (based on experiences abroad, literature, etc) are technically feasible.

For the second round we thus reduced the criteria to the following ones:

- acceptance by users : user perception and user costs,
- acceptance by industry : costs for industry and social costs,
- efficiency.

Last, but not least, we found that the comments given by each stakeholder were more useful than the actual figure to evaluate measures. However, the results altogether did not enable a common ground required to carry out the identification of priority measures, and the other steps which we intended to carry out (quantification of variables and calculation of realistic improvement potentials).

Based on these findings, we decided to reorient the second round. In agreement with the users committee, the second round was dedicated to deepening the comments from all stakeholders, with the aim to present the variety of opinions of the different stakeholders on the subject of product-oriented policies and measures. Indeed, given the lack of common ground which appeared from the first round, trying to quantify realistic improvement potentials would have been artificial and pointless.

Moreover, for the second round, all stakeholders were able to answer to all measures for all 5 criteria. A questionnaire was sent to them, in order to gather their general opinion on the particular challenges and threats of the product categories, as well as their view on other people's comments.

3.3 Results of the detailed analysis of the four case studies

3.3.1 Introduction

This paragraph presents the results of phase 2 (calculation of theoretical improvement potentials) and phase 3 (evaluation of policies and measures) in a aggregated manner. For each product category, an introduction is made in the first place, in order to present general comments on this product category. It also presents the number of people who were contacted to answer for this product category, and the number who actually answered.

In some cases, e.g. for environmental NGOs, we had only answers from one stakeholder. However, we notices the setting up of working groups or agreements inside some stakeholder categories. In the case of environmental NGOs, for example, we received mails from NGOs stating that they agreed with the answers of a central NGO. In the industry federations, working groups were set up. For computers regarding social economy stakeholders, A key organisation worked in close relation with its members. Thus having only one answer does not mean this answer is not representative of the sector.

After this general introduction, each strategy is detailed. A table presents the potential improvement potentials of this strategy compared to the BAU in terms of GHG emissions, resource use and waste production. The shares of the production, use and waste phases are also presented for each impact. Then, an overview of the main comments received regarding this strategy is given, per stakeholder type.

When interpreting the results, it should be noted that the answers given by the respondents could be considered a mixture of best guess opinions and expert answers based on objective research and insights. In any case further and more in-depth research and stakeholder participation would be required to scientifically determine the real (cost-) effectiveness, acceptance by industry and users, social repercussions etc… of particular proposed measures. The approach used in this project by means of the questionnaire is meant to explore if a general broad stakeholder and public support exists for particular IPP strategies and is in no case useful as a sound scientific basis for immediate policy actions and/or decisions.

Finally, a conclusion is made per product category, trying to sum up the different comments and the common positions which appear as a result of this consultation.

3.3.2 Housing

3.3.2.1 Introduction

The industry consider that the model should have taken into account the other buildings (flats, offices..). But as previously mentioned, those buildings could not be modelled. Moreover, they consider that the whole life cycle should have been studied. However, modelling the use phase of housings would have required a study on its own.

Stakeholders	NbUsers	NbAnswers
policy	26	7
private	34	4
research	13	2
consumer organisation	16	2
environmental NGOs	10	3
trade unions	4	1
Total	103	19

Table 5 : Overview of respondents of questionnaire on housing.

3.3.2.2 Results per strategy

3.3.2.2.1 Scenario 1 : Reduction of the final demand

	CO2 emissions (kt eq CO2/yr)			raw materials (kt eq Sb/yr)			waste (kt/yr)		
	2000	2010	trend	2000	2010	trend	2000	2010	trend
BAU	1,993	2,135	7%	12	15	18%	1,188	1,085	-9%
Scenario 1	1,993	1,905	-4%	12	13	4%	1,188	976	-18%
production phase in 2010	1,628			12			773		
use phase in 2010	255			1			107		
waste phase in 2010	23			0			97		

The objectives for this strategy of reducing the final demand, were the information of professionals, the public sensitization, and the surface of built dwellings. Here below are summarized main comments on this strategy.

Main comments from industry

For industry, the whole life cycle of the building must be considered, not only the construction phase, thus also taking into account the life span of the building, the insulation level…

Main comments from policy

Policy makers insist on providing an education and an easy and straight forward tool in order to help the choices of consumers and professionals, in this meaning public authorities or real estate promoters. Consumers education on the impacts of buildings could be supported by a compulsory labelling on building materials.

Main comments from environmental NGOs

Environmental NGOs emphasises that an education can be achieved via publications, or training, or a "housing counter", about even a global education on housing and sustainable development . Low-income households should also be taken into consideration.

Environmental NGOs would promote joint ownership, grouped housing… To make people come back to town centres, measures should be taken to increase the quality of life (noise, safety, green area...).

They propose to establish specifications for the building and renovation of low or passive energy buildings (materials, insulation or sealing techniques, solar protections, warming) also targeting to distributors, technicians…

Main comments from researchers

Researchers in applied science think that labelling of buildings and environmental audit are good instruments, probably not to decrease the needs of houses but to decrease the impact of building and the use. A "tool" to assess the impacts for different stakeholders, could contribute to this goal with several levels or details (preliminary draft, implementation phase, use phase…). A compulsory labelling should be applied to building materials, but not to building sector. Caution should be taken during the comparison between product classes and their technical application.

They think that the demographic situation already shows an evolution to smaller housings for smaller households, given the fact that the amount of basic commodities for a smaller household are the same as for a bigger one. Flexible housings, where kangaroo-living is possible should be encouraged.

Main comments from consumers

Consumer organisations doubt that information on environmental effects could reduce the final demand in housing, compared to a campaign on individual benefits for more eco-friendly house. They add that labelling is not very efficient for consumers (based on the experience of CO2-labelling of cars), but may be more for intermediaries. They also add that it is not really a problem of surface, but of surface per inhabitant.

Main comments from trade unions

Trade unions say that the size of housing is not the only source of impacts, the number of sides of the house (2, 3, 4) is important as well. A life cycle perspective taxation should also take this into account.

Agreements on this strategy

There is a general agreement on the need of a tool to assess impacts, addressed to all stakeholders.

Labelling on building materials is a good tool for policy makers and researchers in applied science, but from the consumer organisation point of view, labelling is not really efficient for consumers but may be more for intermediaries.

It seems that the surface unit could be more specified. Trade unions propose to add the number of sides, and users propose the surface per inhabitant.

3.3.2.2.2 Scenario 2 : Substitution by another product

	CO2 emissions (kt eq CO2/yr)			raw materials (kt eq Sb/yr)			waste (kt/yr)		
	2000	2010	trend	2000	2010	trend	2000	2010	trend
BAU	1,993	2,135	7%	12	15	18%	1,188	1,085	-9%
Scenario 2	1,993	1,849	-7%	12	13	1%	1,188	949	-20%
production phase in 2010	1,572			12			746		
use phase in 2010	255			1			107		
waste phase in 2010	23			0			97		

The objective behind this strategy, is the renovation. Here below are summarized main comments on this strategy.

<u>Main comments from industry</u>

The industry thinks that a new building can also be better for the environment. A deeper analysis is needed in order to guarantee a better solution with respect to the environment.

<u>Main comments from policy</u>

Policy makers consider that a study on environmental impacts of some renovations can be useful. To compare the impact of the renovation with the building of an ecological house, and above all its life span. This comparison would help to encourage or not any renovation.

<u>Main comments from environmental NGOs</u>

Environmental NGOs emphasize that existing buildings should be made more sustainable. This could be achieved by establishing a schedule of condition, sustainable renovation… This solution should be approached by type of buildings.

<u>Main comments from consumers</u>

The consumer organisation notices that the motivation of building new housing should be known in order to evaluate if this objective is good. So far, the propositions are related to the environment. But the access to housing is an important problem in Belgium. Proposals should not worsen this problem, in terms of access to housing. Measures should be taken in order that housing available for underprivileged consumers would have the same quality in terms of security and environment, compared to other housings. Moreover, consumer organisations consider that many renovations are carried out without architects (too expensive). An "architect check" could then be encouraged.

<u>Agreements on this strategy</u>

A deeper analysis comparing renovation and new buildings is asked by the industry and policy makers. For consumer organisations, the motivation behind those new buildings is of high importance.

Policy makers and environmental NGOs insist on the environmental impact assessment and on how to make existing buildings more sustainable.

3.3.2.2.3 Scenario 6 : Changing the product composition

	CO2 emissions (kt eq CO2/yr)			raw materials (kt eq Sb/yr)			waste (kt/yr)		
	2000	2010	trend	2000	2010	trend	2000	2010	trend
BAU	1,993	2,135	7%	12	15	18%	1,188	1,085	-9%
Scenario 6	1,993	1,902	-5%	12	13	6%	1,188	965	-19%
production phase in 2010	1,712			13			788		
use phase in 2010	168			1			80		
waste phase in 2010	23			0			97		

The objective behind this strategy is low embodied GHG dwellings. Here below are summarized main comments on this strategy.

<u>Main comments from industry</u>

The industry insists on the fact that it is mostly the use of the building, the habits of the people who work or live in, influence CO2 emissions. The whole life cycle has to be considered ; materials are integrated in a building. They insist on the importance of the use of the building in GHG, compared to the materials. They agree on the need of energy efficient production processes for GHG reduction.

<u>Main comments from policy</u>

Policy makers notice that CO2 emissions of materials are lower than emissions linked to the building occupation, warming and cooling. It would also be better to educate architects and trade associations as well. For them, fiscal incentives for non-energy-intensive materials would be a very good measure, expensive though in the short term, but certainly efficient in the long term. Also integrating environmental criteria in urban guidelines would be a very good measure.

<u>Main comments from consumers</u>

Consumer organisations wonder if there is a normalisation. The important question is the respect and the control of those normalisations. Concerning labelling, they emphasise that eco-labels are not the best solution, because they are voluntary and do not enable the comparison between materials. Compulsory labelling based on energy would be more efficient. They also have some doubts on the efficiency of promoting sustainable wood, which is difficult to obtain; ecological wood is easier to buy.

<u>Main comments from researchers</u>

Researchers in applied science point out that material use in a housing represents only 15% of the environmental impacts. Environmental Product Declaration (EPD) of building materials should be done. The starting basis is sustainable building in order to avoid that one environmental impact would be disproportionate.

<u>Main comments from trade unions</u>

Trade unions also underlines that other impacts than GHG, resources and waste should be taken into account in the measures.

<u>Agreements on this strategy</u>

Researchers in applied science point out that material use in a housing represents only 15% of the environmental impacts. The industry and policy makers agree also on the fact that the use of the building itself, and not only materials, generates more GHG emissions/environmental impacts.

Trade unions, researchers in applied science and policy makers are talking about environmental impacts, generally speaking, not only GHG.

A regulation on environmental impacts of materials is proposed by researchers in applied science and consumer organisation.

3.3.2.2.4 Scenario 7 : More efficient product use

	CO2 emissions (kt eq CO2/yr)			raw materials (kt eq Sb/yr)			waste (kt/yr)		
	2000	2010	trend	2000	2010	trend	2000	2010	trend
BAU	1,993	2,135	7%	12	15	18%	1,188	1,085	-9%
Scenario 7	1,993	2,020	1%	12	14	14%	1,188	990	-17%
production phase in 2010	1,773			14			799		
use phase in 2010	224			1			94		
waste phase in 2010	23			0			97		

The objective behind this strategy is healthy dwellings. Here below are summarized main comments on this strategy.

<u>Main comments from industry</u>

The industry consider that healthy housing is interpreted as daily housing, protecting from the environment, with a healthy indoor.

<u>Main comments from policy</u>

According to policy makers, the demand of certificates should be linked with building materials, in order to guarantee the quality. Beyond this, lies the idea that good quality lasts longer. Same for good practice for professionals. For healthy housings, the impact of the choice of products for building, renovation, and maintenance is important. The term health is maybe misleading in the frame of the discussion of healthy indoor climate.

Main comments from environmental NGOs

Environmental NGOs opinion is that eco-consumption, consumption respecting the environment and health, and eco-management should be promoted.

Main comments from researchers

Researchers in applied science are wondering about the meaning of healthy housings (only indoor air, accessibility, security of the housing). They think that accessible and adaptable dwellings are also important for a healthy dwelling with a long life span.

Moreover, those researchers in applied science point out that LCC (Life Cycle Costs) could give an insight. The IFD building (Industrial, Flexible and Dismantable) can be applied to housings, which is easier and cheaper to make among others with a flexible or adaptable concept or by using building elements.

Main comments from consumers

Consumer organisations propose to couple this measure with the other objective on longer life span.

Agreements on this strategy

The industry, researchers in applied science and policy stakeholders consider that the term healthy housings is misleading, and is often taken in the frame of healthy indoor.

Moreover, researchers in applied science and consumer organisation think that this scenario should be coupled with a longer life span scenario.

3.3.2.2.5 Scenario 4 : longer life span

This scenario could not be modelled because the effects of such objective and measures would not be visible by the year 2010. Nevertheless, comments on this scenario will be presented here below. The objective behind this strategy is long life dwellings.

Main comments from policy

For policy makers, we should look at healthy housings in the long term. The difference between both objectives is not clear. They propose to extend the housings building, with materials respecting the environment and the health, which are built in such a way as to minimise the energy, water and resources during the building life length. A recognition must be as global as possible and integrate the impacts of the construction choice on the consumption during the life span.

Main comments from environmental NGOs

The environmental NGOs from a general point of view insist on the fact that public authorities have to drive the industrial policy in function of determined social objectives. They notice that more and more, companies are guiding the political action, in function of their own objectives. They remind that economical tools would be more useful to guide production and consumption pattern, even if those tools are denied by the corporate world voice. Nevertheless, the sensitization measures having limited impacts are more supported. The choice of those measures should be based on an independent socio-economical assessment. The experience shows that the estimation of the cost of environmental measures are often overestimated before being put in place.

They also insist on establishing norms and labels to guarantee the technical quality of those materials and their innocuity for the health and the environment.

Main comments from researchers

Researchers in applied science think that the life span and healthy buildings have to be examined together. The life cycle costs can also bring here some insight. Moreover, build IFD (Industrial, flexible, demountable) could be applied to houses, and is easier and cheaper to realize. Finally, accessible and adaptable housings are also important for a healthy housing with a long life span.

Main comments from consumers

Consumer organisations emphasise that this has to be achieved by respecting quality and safety and eco-efficiency norms. Safety is an important concern, and the technical quality must be guaranteed for industry (recycled materials can lose some of their mechanical strength).

Main comments from trade unions

Another suggestion from trade unions is to couple the quality criteria to other criteria such as safety, indoor pollution.

Agreements on this strategy

Policy makers, trade unions and researchers in applied science would couple the longer life span objective with the healthy indoor objective.

Consumer organisation, trade union would add as well the safety criteria. The quality criteria is as well mentioned by environmental NGOs, users, trade unions.

A life cycle analysis and cost is needed for researchers in applied science, policy makers, and environmental NGOs.

3.3.2.2.6 Scenario 3 : reuse

This scenario could not be modelled because the effects of such objective and measures would not be effective or visible by the year 2010. Nevertheless, comments on this scenario will be presented here below. The objective behind this strategy is to reuse building materials.

Main comments from industry

The industry notices that in the building sector, a lot of building materials are already reused.

Main comments from policy

According to policy makers, it is important to reuse but not at any energetic price for instance. Reuse channels should be targeted to optimise this.

Main comments from environmental NGOs

Environmental NGOs insist on establishing norms and labels to guarantee the technical quality of those materials and their inocuity for the health and the environment.

Main comments from researchers

Researchers in applied science are stating that reuse is defined as reuse of building materials in a similar application as previously (e.g. beams on roof that are again used as beam). They remind that reuse is a measure already applied in the building sector. This will probably remain the case in the future, like for old doors, hitting, sanitary elements, bricks,... They add that in their comments, reuse and recycling have been considered (recycling of rubble in a house, road..).

Main comments from consumers

Consumer organisations emphasise that this has to be achieved by respecting quality and safety and eco-efficiency norms. Safety is an important concern also for trade unions, and also the technical quality must be guaranteed, as well for the industry and researchers in applied science (recycled materials can lose some of their mechanical strength).

Agreements on this strategy

The industry and the researchers in applied science state that material reuse is already applied in the building sector.

The safety criteria is important for users, and trade unions. Technical quality is as well important for users, researchers in applied science, environmental NGOs and the industry.

3.3.2.2.7 Synthesis Scenario

This last scenario reflects the combined effect of all changes assumed in the alternative scenarios.

	CO2 emissions (kt eq CO2/yr)			raw materials (kt eq Sb/yr)			waste (kt/yr)		
	2000	2010	trend	2000	2010	trend	2000	2010	trend
BAU	1,993	2,135	7%	12	15	18%	1,188	1,085	-9%
Synthesis	1,998	1,431	-28%	13	10	-21%	1,189	734	-38%
production phase in 2010	1,273			10			573		
use phase in 2010	137			0			65		
waste phase in 2010	23			0			140		

3.3.2.3 Conclusions on the product category

3.3.2.3.1 Technical potentials and synergies between impacts

According to those results, although CO_2 emissions from the demand for SFH represent less than 10% of heating, these emissions are still significant (more than 2200 kt).

According to the calculation, the four individual strategies to reduce all three impacts in the near future seem to represent non negligible improvement potentials. Shifting from new construction to renovation would lead to the highest emission reduction. On the opposite, the use of recycled material results in a smaller emission reduction. However the percentage reduction is of course influenced by the underlying assumptions in each scenario. All together, the four modelled strategies could lead to an emission reduction ranging from 33% to 37% as compared to the BAU scenario in 2010.

3.3.2.3.2 Conclusions from stakeholder consultation

Industry agree on the general conclusions, on the importance of the use phase for housing, and the involvement of architects and stakeholders.

For the housing product category, the need to involve the professionals appears clearly. They should be the main target for labels and calculation tools regarding environmental impacts of the building. It has to be noted that labels should be applied to materials, rather than to the building sector.

A general comment is the need to take into account the whole life cycle of dwellings as the use phase which has not been modelled during this study, is prevalent concerning environmental impacts. Moreover, environmental impacts should be extended.

Stakeholders in general ask for more detailed research on the impacts of renovation versus new buildings. Sociological studies would also be necessary, concerning the motivation of consumers and a focus on low income households.

Targeting the demand appears challenging for all stakeholders.

One particular point for this product category is the need to take into account technical specifications of materials, their quality and also their possible consequences on the health.

One proposal from the researchers (IFD buildings) appears as a possible contribution to decreasing environmental impacts of dwellings. This proposal would require further evaluation.

3.3.3 Packaging

3.3.3.1 Introduction

In first round, a questionnaire was sent out to 186 packaging-related stakeholders (146 stakeholders were invited by Vito to participate, about 40 member companies were invited by the federation FEVIA). 35 responses have been registered for packaging and some respondents have informed us that they answer conjointly with others. Overall, the response rate is about 20%.

Answers from stakeholders are grouped according to the type of organization they represent. In the next table, per category, the amount of respondents are shown.

In general, the private stakeholders are well represented in the evaluation (all relevant federations i.e. VBO-FEB, FOST PLUS, DETIC, FEVIA, FEDIS etc. and also some individual companies). A good representativeness is also true for the trade unions and consumer organizations. Less respondents/answers were reported for the categories environmental NGO's and Research. Several respondents were reported for the federal administration, less response came from the cabinets and regional authorities. Important organizations that were not able to participate in first round were prospected again for the second round of the consultation. These are mainly stakeholders from the federal and regional authorities and some environmental NGO's.

Most of the respondents have answered representing their organization, so most answers are not individual. Also, industry federations composed working groups for each product category and formulated some common answers, which were distributed among their members and which explains why many similar comments and results were reported in the private category.

Stakeholder type	N° respondents	N° organizations
Policy Federal	5	5
Policy Regional	5	2
Environmental organizations	1	2
Trade Unions	2	2
Industry federations	10	10
Companies	5	5
Consumer organizations	3	2
Research	4	3
Total	35	31

Table 6 : Overview of respondents of questionnaire on packaging.

In round 2 of the consultation, particularly for packaging, one additional private stakeholder answered the questionnaire. The answers from round 1 of the questionnaire were not adapted by the other stakeholders.

3.3.3.2 Results per strategy

These paragraphs summarize all comments from the different stakeholders. Particular comments on proposed objectives or even on the detailed level of proposed measures are reported in the Annexes.

3.3.3.2.1 Scenario 1 : Reduction of the final demand

For this strategy, no theoretical potential was modelled because it only encompassed the objective on the reduction of bottled water and it would generate marginal results <1% for the total beverage packaging category. However, this measure was proposed in the questionnaire for stakeholders to review.

Main comments from industry

An integrated product policy must focus not so much on reducing consumption, but on modifying consumption.

The industry finds the objective of substituting bottled water with tap water not justified: mineral water is a completely different product compared to tap water and the choice should be left to the consumer. They stress that hygiene and food safety problems can occur with carbon filters (can be a source of bacteria). Also, industry doubts the potential environmental improvement i.e. while currently packaging for water are already >80% recycled.

Main comments from researchers

Find it a possible potential for improvement, but stress numerous obstacles. Also note on the possible hygiene problems with filters. Contradictory to industry, some researchers agree that the use of tap water can to some extent substitute the use of bottled water because consumers don't trust the quality of tap water, while there is nothing wrong with tap water for drinking.

Main comments from consumers

Note that general information campaigns are insufficient because the confidence in the quality of tap water is so low that more intensive information instruments and more assuring communication channels need to be used (i.e. family doctors, consumer organizations, pharmacies…). Also note to be careful with saying that carbon filters can improve the quality of tap water because when wrongly used they can be unhygienic. To promote tap water, comparison of cost per L is also an effective argument.

Policy / Environmental NGOs

No comments were received.

Agreements on this strategy

Many stakeholders found this proposed measure ambiguous: OR tap water is good and you should promote this, OR tap water is not good and you promote the use of carbon filter to solve this.

The measure is generally found ambitious with many obstacles and also not really effective in the sense that it would generate substantial environmental benefits.

It cannot be agreed to substitute bottled (mostly mineral) water with tap water and public sensitization on the quality of tap water should be seen independently from bottled water and the use of filters.

3.3.3.2.2 Scenario 2 : Substitution by another product

The substitution of small beverage packaging with larger packaging was modelled and also the substitution of reuse glass bottles with reuse PET bottles. For food packaging, no scenario was modelled. Measures on these objectives were proposed in the questionnaire for stakeholder evaluation. Also under this strategy, measures were proposed on making information available on the "best available packaging options".

FOOD & BEVERAGE PACK	**CO_2 emissions (kt eq CO_2/yr)**			**Raw materials (kt eq Sb/yr)**			**Waste (kt/yr)**		
	2000	***2010***	***trend***	***2000***	***2010***	***trend***	***2000***	***2010***	***trend***
BAU	**1155**	**1130**	**-2%**	**5**	**4,9**	**-2%**	**68**	**25**	**-63%**
Scenario 2 (only bev. pack)		**1124,3**	**-3%**		**4,86**	**-3%**		**24,9**	**-63%**
Prod. phase (2010)	**75-80%**			**100%**			**0%**		
Use phase (2010)	**0%[18]**			**0%**			**0%**		
Waste phase (2010)	**20-25%**			**0%**			**100%**		

Main comments from industry

This measure cannot be implemented across the board. After all, every material/product has its own specific characteristics and function. Where reducing the quantity of materials is concerned, the aim must be to "do more with less".

About larger packaging sizes: industry stresses the averse effect it can have on the packed product itself e.g. that the environmental consequences of product spillage are larger than the packaging effects. A distributor markets a balanced assortment and smaller packaging reflect the changing consumer lifestyle and socio-demographic tendencies (more elderly, more singles and smaller households, time-spending, "home" vs. "on the road" consumption etc…).

Refillable PET have already been introduced, without success and are generally considered unfeasible and not accepted by the market. They also find this discrimination between two packaging systems unacceptable, and this without any scientific proof. It can cause distortion of competition with bottlers of foreign waters.

[18] The distribution of refillable bottles is included in the production phase.

Determining the "Best Available Packaging Options" is considered impossible and pointless. The best available option depends on a whole range of factors, criteria, circumstances, consumer situation and is different for each specific case and moment. It shouldn't focus alone on environment and also in this sense LCA studies are not found an appropriate method.

Policy / environmental NGOs / researchers

No comments received.

Main comments from consumers

Using large pack sizes is contradictory to objectives of avoiding over-consumption of products and avoiding product spillage. Information and sensitization alone will not be sufficient to change consumer behavior. Consumers need to be encouraged financially by e.g. increasing the price of uni-dose packaging and mini-portions. Packaging systems with closures that can be opened and re-closed permit households to choose for larger packaging; and (perishable) products can be conserved longer.

Education about refillable PET bottles will be difficult because consumers perceive plastics as disposable and less durable and environmentally friendly compared to other materials such as glass. Questions if refillable PET has a more favorable environmental profile.

About best available packaging option: a tool to use could be LCA studies. LCA's are indispensable for experts, researchers, producers and policy in order to take appropriate measures on an objective basis. But is not an LCA that can change consumer patterns. It could only help organizations to better inform the consumers.

Agreements on this strategy

The increased use of smaller packaging are due to demographic changes and curbing this tendency will be difficult. Larger packs can have averse effects on the environment and can lead to over-consumption (contradictory to health objectives). Eco-developments that can lead to improved packaging i.e. to avoid product spillage and prolong the lifetime of products are generally conceived useful.

General agreement seems to exist on the fact that refillable PET bottles are unfeasible and will not be expected by the market, so this measure is pointless.

Different opinions exist about the provision of information on the best available packaging options: difficult or even impossible to determine since many aspects and market situations (not only environment) need to be taken into account. Some mention that consumers don't want all this additional information but only want policy and industry to make the right decisions based on the right information. Some find LCA a useful tool to provide objective information while others find it too temporary, generic, too focussed on environment alone and thus inappropriate.

3.3.3.2.3 Scenario 3 : reuse packaging

The potential of an increased use of refillable bottles has been calculated. For the questionnaire, measures were proposed on providing more information about reuse bottles, information about the spending of ecotaxes, reuse shopping bags and the possibilities to reuse also other packaging types.

FOOD & BEVERAGE PACK	**CO_2 emissions (kt eq CO_2/yr)**			**Raw materials (kt eq Sb/yr)**			**Waste (kt/yr)**		
	2000	***2010***	***trend***	***2000***	***2010***	***trend***	***2000***	***2010***	***trend***
BAU	**1155**	**1130**	**-2%**	**5**	**4,9**	**-2%**	**68**	**25**	**-63%**
Scenario 3 (only bev.pack)		**1053,5**	**-9%**		**4,8**	**-4%**		**23,9**	**-65%**
Prod. phase (2010)	**75-80%**			**100%**			**0%**		
Use phase (2010)	**0%**[19]			**0%**			**0%**		
Waste phase (2010)	**20-25%**			**0%**			**100%**		

<u>Main comments from industry</u>

Reuse can be an attractive option if scientific evidence suggests that it is an effective and environmentally friendly solution, and provided that it can be implemented at a reasonable cost, without detracting from the technical characteristics required for the intended application. The limitations with respect to reuse make it very important to continue encouraging research and development (R&D).

No scientific evidence exists to discriminate between reuse vs. recyclable packaging. The current ecotax on beverage packaging exists for other reasons than environment. The societal and economic consequences of favoring reuse packaging are not known and not considered, but should be in an 'integrated' policy. The refillable bottle is a much more expensive system. These extra costs do not weigh up against the environmental benefits. It's the people putting the products on the market who should find the best compromise, based on sustainable development indicators developed by public authorities. If authorities impose at the same time objectives and methods, they could only blame it on themselves if the objective is not reached.

With regard to shopping bags, although the potential is estimated marginal, measures are already in place to encourage the use of reusable bags (voluntary agreements) so there is no need for additional ones. For other applications and where useful, this already happens (i.e. industrial packaging). The industry sees little potential in this objective for other household packaging types.

In general, the industry is opposed to eco-shopping systems where consumers bring their own reusable packaging containers. Main argument are hygiene and food safety issues, impractical to organize, high costs, practical barriers (i.e. product spilling and loss when filling container at store). Only limited projects seem feasible on voluntary basis.

[19] The distribution of refillable bottles is included in the production phase.

Main comments from policy

The Federal Agency Food Safety (FAVV) stresses that extra attention should go to possible migration to food, besides other possible contaminations. Several practical implications are to be tackled: how to inform the consumer on qualified materials, packaging to put in contact with the different foodstuffs? What about other information provided on the packaging? When something is wrong with the product: how to trace the problem, the responsible for the problem?

Environmental NGOs

No comments received.

Main comments from researchers

The problem with the reuse glass bottle is its consumer-unfriendliness and the fact that other more consumer-friendly packaging have become available over time that take into account, and offer more flexibility towards lifestyle and demographic changes. It seems important to stimulate industry to search for and develop alternative reuse systems that overcome this consumer-unfriendliness and high cost of implementation. It is not only a better reuse packaging, but also a well-thought and economic valid reuse system that should be searched for.

Recycling in Belgium has proven to be very effective and efficient also in cost-terms, but this shouldn't mean that complementary strategies on reuse packaging couldn't be considered in the framework of IPP, and couldn't also be effective.

With regard to other than beverage applications: for how many products applicable? Probably little, so not much improvement potential can be realized.

Doubt if disposable bags constitute a substantial share of packaging materials brought on the market, so environmental benefit is estimated low. Some are the opinion that it would probably be more effective to consequently forbid or apply an ecotax for disposable shopping bags.

Main comments from consumers

From the consumer point of view : buying drinks in reusable packaging (with or without deposit) renders necessary to come back to the same deposit to bring the used bottles back. This is a constraint which could be alleviated if all deposit packaging could be brought back in one single point. Public authorities should give the example and buy their drinks in reusable packaging. Ecotax or Ecoboni? In any case, one should first establish and implement an efficient system with a sufficient price difference in order to be perceived by the consumer. The consumer orgs don't think the consumer needs or wants to know what the revenues are used for.

About shopping bags, very skeptical about acceptance by consumers (current initiatives on reuse shopping bags could be an indication on the feasibility of changing consumer behavior).

About bringing reusable containers to store, it is considered very unpractical and not valid for impulse purchases (unplanned purchases, products decided to buy in the store itself) because the consumer needs to anticipate its purchases in order to bring the suitable packaging or containers. Has also an effects on transport to store (e.g. after work, he/she needs to go home first to get the containers prior to going to shop).

Agreements on this strategy

With regard to beverage packaging, opinions generally differ and little agreement exists; while industry is in favour of the recycling system and sees no reason to discriminate with one-way beverage packaging; industry, policy and researchers can see some benefit in using reuse systems. Consumers stress the unpractical disadvantages of reuse systems and the need to bring back the empty bottles.

All agree that other reuse systems as proposed seem unfeasible or bring to high additional costs.

3.3.3.2.4 Scenario 6 : substitution of materials

Under this strategy, the potential of replacing conventional plastics with biopolymers has been calculated, mainly for food packaging.

FOOD & BEVERAGE PACK	CO_2 emissions (kt eq CO_2/yr)			Raw materials (kt eq Sb/yr)			Waste (kt/yr)		
	2000	*2010*	*trend*	*2000*	*2010*	*trend*	*2000*	*2010*	*trend*
BAU	**1155**	**1130**	**-2%**	**5**	**4,9**	**-2%**	**68**	**25**	**-63%**
Scenario 6 (mat subst)		**1087,5**	**-6%**		**4,3**	**-14%**		**23,8**	**-65%**
Prod. phase (2010)	**75-80%**			**100%**			**0%**		
Use phase (2010)	**0%**[20]			**0%**			**0%**		
Waste phase (2010)	**20-25%**			**0%**			**100%**		

Main comments from industry

This measure cannot be implemented across the board. After all, every material has its own specific characteristics and function.

So far there is also no reason for positive discrimination. Advantages and consequences of packaging from biomaterials are not yet known e.g. quality, environmental profile bioplastics compared to conventional plastics, consequences on existing collection and recovery/recycling system, etc.

Main comments from policy

Policy stakeholders agree if bio-food packaging complies with consumer safety requirements.

The bio-guarantee label should be promoted.

[20] The distribution of refillable bottles is included in the production phase.

Applying a EU label ("flower") for bio-based packaging would not be a success.

Environmental NGOs

No comments received.

Main comments from researchers

Questions if environmental impacts from bio-packaging are in all cases lower compared to conventional packaging? Bio-packaging do not always degrade in conditions provided by organic waste landfills so one can question the advantages compared to existing recycling and recovery systems (i.e. inadequate exposition to light, air…).

Main comments from consumers

Consumer organisation doesn't favour a separate label for packaging, since the consumers buy products, not packaging. Some respondents agree with applying an ecotax system if it can be proven for which applications biopackaging are really favourable, but note that the tax (or boni) should be adequate to make a real difference and shift consumption patterns.

Agreements on this strategy

General agreement that there is no scientific evidence so far to favour biodegradable plastics over non biodegradable alternatives. This should be established first prior to any further discussion and proposals of measures.

3.3.3.2.5 Scenario 7 : material recycling

The potential of some increase of recycling targets compared to existing and achieved recycling in Belgium was calculated. Since this yielded marginal additional benefit, no new measures were proposed in the questionnaire. However, some comments from stakeholders are reported.

FOOD & BEVERAGE PACK	**CO_2 emissions (kt eq CO_2/yr)**			**Raw materials (kt eq Sb/yr)**			**Waste (kt/yr)**		
	2000	***2010***	***trend***	***2000***	***2010***	***trend***	***2000***	***2010***	***trend***
BAU	**1155**	**1130**	**-2%**	**5**	**4,9**	**-2%**	**68**	**25**	**-63%**
Scenario 7		**1123**	**-3%**					**24,2**	**-64%**
Prod. phase (2010)	**75-80%**			**100%**			**0%**		
Use phase (2010)	**0%[21]**			**0%**			**0%**		
Waste phase (2010)	**20-25%**			**0%**			**100%**		

During the workshop with the stakeholders, a representative of G.R.L. Glasrecycling NV suggested that initiatives could be taken to prevent unrecyclable glass of entering the collection and recycling fractions i.e. glass from household products such as heat resistant glass, safety glass, etc…

[21] The distribution of refillable bottles is included in the production phase.

3.3.3.2.6 Scenario 11 : efficient use of materials

For several objectives under this strategy the potentials were calculated: reducing the weight of packaging and increasing the use of recycled content in packaging materials.

FOOD & BEVERAGE PACK	**CO_2 emissions (kt eq CO_2/yr)**			**Raw materials (kt eq Sb/yr)**			**Waste (kt/yr)**		
	2000	***2010***	***trend***	***2000***	***2010***	***trend***	***2000***	***2010***	***trend***
BAU	**1155**	**1130**	**-2%**	**5**	**4,9**	**-2%**	**68**	**25**	**-63%**
Scenario 11		**993,5**	**-14%**		**4,2**	**-15%**		**22,4**	**-67%**
Prod. phase (2010)	**75-80%**			**100%**			**0%**		
Use phase (2010)	**0%**[22]			**0%**			**0%**		
Waste phase (2010)	**20-25%**			**0%**			**100%**		

Main comments from industry

On the use of recycled materials, the industry is of the opinion that 1) no measures can be imposed which make the use of recycled material obligatory and 2) market forces themselves must determine where the raw materials yielded via recycling can be most effectively deployed.

About the efficient use of materials, the opinion is that the sustainable use of raw materials must be encouraged. To this end, information and education are important tools targeting the consumer. Developing a new label does not appear feasible.

Since measures should be controllable, measures related to recycled content are impossible.

Also, recycled content is not always desirable and possible and it is important to find an optimum ratio for new applications (many other limiting constraints exist besides health and public safety such as product quality).

When local market of secondary materials is not sufficient to achieve these content ratios, this can have averse ecological consequences due to additional transports.

Material reduction is already pursued by industry to the extent where possible (also to achieve cost savings) and some are the opinion that the potential of additional weight reductions is limited (most substantial weight reductions are already achieved in the past). Existing studies, e.g. by Fost Plus, already demonstrate a decoupling of packaging quantities on the market and the GDP. Besides that, weight is not the only determinant for the environmental effect of packaging (e.g. heavier packaging but with more recycled content). A packaging that is too light can have more negative effects on the environment compared to a packaging that is slightly over-dimensioned. Also, lighter materials are often not more environmental friendly compared to their heaver alternatives. The entire packaging system and the product content always need to be considered together.

[22] The distribution of refillable bottles is included in the production phase.

Main comments from policy

Measures on recycled content are preferred, but difficult to control. For this reason left out of ecotax law.

Main comments from environmental NGOs

In general, environmental NGO insist on the fact that public authorities must orientate industrial policy depending on determined social objectives. But we now observe more and more the contrary : companies guide political action depending on their own objectives. It should be remembered that economic instruments would be very useful to send the necessary signals to reorient production and consumption patterns. These instruments are more and more refused by industry delegates. On the contrary, sensitization measures which have minor impact, are supported. Public authorities should overcome these wishes and target public interest. Is the intuitive understanding of the different suggested measures really significant? The choice should certainly depend on an independent socio-economic study. Experience shows that the estimation of the costs of environmental measures have often been overestimated.

Main comments from researchers

About recycled content, it is a possible way to increase the demand for the increasing amount of secondary materials. It is a curative and not a preventive measure. Measures should evolve to material reductions and the promotion of really renewable packaging. Most potential lies in co-extrusion materials where food only remains in contact with the layer of new material.

About reducing weight, this is a slowly but continuously progressing issue thanks to the IVC/Fost Plus system, existing voluntary sectoral agreements and prevention plans. The usefulness of additional policies or standards is doubtful and difficult, probably impossible to control. Weight is an essential aspect for the environmental impacts from packaging, but not the only one. The selection of materials with specific properties and quantities required depend mainly on their application in the entire product + packaging system. A theoretical minimum amount could be determined (as little as possible, but as much as necessary) when the technical requirements are considered and these depend mainly on the production and distribution system and the application of the product (+ packaging). More difficult is to determine the additional quantity that can be afforded to ensure and increase the sales of the product (design appeal, product visibility, packaging label space, differentiation compared to competitors, etc…). The "less is more" principle is not always perceived as value-added by consumers. Therefore, a focus on changing consumer patterns is a useful and necessary complementary road for achieving this objective.

Main comments from consumers

Potential for increasing recycled content exists in secondary and tertiary packaging.

With regard to weight reductions, the entire packaging system needs to be considered (primary, secondary and tertiary).

Agreements on this strategy

Agreement seems to exist on the fact that measures on recycled content are difficult to implement and that it is more effective to encourage the recycling of packaging rather than the use of recycled content in packaging. Market forces adequately determine where these secondary resources are best applied. Enforcing recycled content can also have averse effects on the environment.

All agree to encourage an efficient use of products and materials in the idea of doing "more with less". However, developing measures (besides the voluntary agreements) seem difficult and impractical (i.e. standards). While policy is in favour of implementing such type of measures, industry doubt its effectiveness and fears high costs for implementation. On the other hand, NGO's see more use in the implementation of economic instruments. Some are the opinion (respondents from industry and research) that most weight reductions are already achieved in the past due to existing policies and initiatives to cut costs, so remaining potential is estimated little.

3.3.3.2.7 Synthesis scenario

This last scenario reflects the combined effect of all changes assumed in the alternative scenarios.

FOOD & BEVERAGE PACK	**CO_2 emissions (kt eq CO_2/yr)**			**Raw materials (kt eq Sb/yr)**			**Waste (kt/yr)**		
	2000	***2010***	***trend***	***2000***	***2010***	***trend***	***2000***	***2010***	***trend***
BAU	**1155**	**1130**	**-2%**	**5**	**4,9**	**-2%**	**68**	**25**	**-63%**
Scenario synth (6&11 food; 3&11 bev. pack)		**891,5**	**-23%**		**3,9**	**-22%**		**20,2**	**-70%**
Prod. phase (2010)	**75-80%**			**100%**			**0%**		
Use phase (2010)	**0%[23]**			**0%**			**0%**		
Waste phase (2010)	**20-25%**			**0%**			**100%**		

3.3.3.3 Conclusions on packaging

3.3.3.3.1 Technical potentials and possible synergies

From phase 1 of this study, it could be concluded that packaging seemed relevant from a resources point of view. However this conclusion could not be supported by other alike studies in Europe. Also, this initial research made no characterization of the used materials, so all were weighted equal relevance. In phase 2 of the project, a characterization on resources depletion was carried out. Comparing to the other product categories, packaging is of marginal relevance (conclusion supported by 1 other EU project). From a waste perspective, many policies focussed at recycling and prevention already exist and the calculated avoided impacts substantial. Also, for food and beverage packaging, a decoupling of impacts vs. consumption trend could be concluded. In conclusion, this study cannot confirm that packaging is a priority product group.

[23] The distribution of refillable bottles is included in the production phase.

Five individual strategies to reduce resource depletion, greenhouse gas emissions and ultimate waste resulting from household packaging (food and beverage packaging, representing ¾ of all household packaging brought on the market) have been evaluated as well as a combination of these strategies. The magnitude of these scenario's are cautious to some very ambitious, so do not reflect what is possible in the real world (therefore referred to as "theoretical" potentials).

When combining all strategies, the calculations indicate impact reduction potentials of about 20% for all impacts studied (but should be seen as a theoretical ceiling). Whether they are considered significant, it depends on the absolute reference impacts: food and beverage represent about 1130 kton GHG-emissions in 2010, 25 kton ultimate waste to landfill and 5 kton Sb-equivalents. Compared to the other studies product categories, this is marginal.

It can be indicated that synergies exist between climate, energy, waste and resource measures and generally have no averse effects towards other impact categories. An exception are the use of bio-based plastics for which the analysis indicates averse effects towards energy use and greenhouse gas emissions.

The study on food and beverage packaging also demonstrates that for specific packaging categories, the focus on particular measures can be different: with regard to beverage packaging, mainly reuse and reduce strategies are of relevance; with regard to food packaging, a focus could be on reduce strategies and the use of bio-based and degradable plastics.

3.3.3.3.2 Results from stakeholder consultation on policies and measures

The industry is general of opinion that in Belgium, more than 80% of single-use packaging is recycled or reused in a practical way. This category accounts for less than 6% of total waste produced, so packaging has become a non-issue. Also, each item of packaging is the product of a complex balancing act entailing the consideration and weighing up of environmental, economic, social and health-related factors. Any sort of discrimination based in inadequate or non-existent scientific evidence is rejected and focus should be on changing consumption patterns and doing more with less by means of information and education incentives and voluntary agreements between policy and industry.

Environmental NGO's and policy encourage the implementation of controllable instruments, standards and economic instruments, but many practical obstacles exist i.e. on recycled content, weight reduction (existing Belgian product law and CEN developments). While ecotax on refillable beverage bottles has already been implemented, its effectiveness cannot be confirmed so far.

3.3.4 Passenger cars

3.3.4.1 Introduction : general comments on this product category

Considering the second phase of the report, the following number of people have sent their opinion on the policies and measures list:

Stakeholder category	answers	contacted	participation
Policy (federal)	2	13	15%
Policy (regional)	5	26	19%
Industry (company)	3	7	43%
Industry (federation)	6	23	26%
Env NGO	3	9	33%
Trade union	1	4	25%
Research	6	24	25%
Cons. organisations	6	22	27%
Total	**32**	**128**	**25%**

Table 7 : Overview of respondents of questionnaire on cars.

Comments on participation:

For every stakeholder category at least one representative has answered. The most responsive stakeholder category were the industrial companies (almost 43%), whereas the least responsive category consists of the federal policy stakeholders (about 15,5%). For the category of trade unions ,only one representative answered (but only four organisations were contacted for answering the questionnaire).

Mostly the most important stakeholders have answered. Nevertheless, a confidential list is available with additional important stakeholder which did not respond to the questions.

3.3.4.2 Results per strategy

3.3.4.2.1 Scenario 1 : changes in final demand

In this scenario, the total number of vehicle-kilometres driven by all passenger cars together is supposed to remain constant at the year 2000 level. In reality, because passenger car sales remain equal to the BAU scenario (i.e. slightly increasing), this assumption implies a decreasing mileage per car.

	CO_2 emissions (kt eq CO_2/yr)			**Raw materials (kt eq Sb/yr)**			**Waste (kt/yr)**		
	2000	**2010**	**trend**	**2000**	**2010**	**trend**	**2000**	**2010**	**trend**
BAU	**18463**	**19505**	**+5,6%**	**174**	**243**	**+40%**	**8,3**	**13,0**	**+57%**
Scenario 1	**18463**	**17450**	**-5,5%**	**174**	**231**	**+33%**	**8,3**	**12,8**	**+54%**
Prod. phase (avg. 2000-2010)	**12,1%**			**22,6%**			**0,0%**		
Use phase (avg. 2000-2010)	**87,3%**			**77,4%**			**24,0%**		
Waste phase (avg. 2000-2010)	**0,6%**			**0,0%**			**76,0%**		

During the stakeholder consultation phase, the following objectives have been identified as to pursue the scenario goal: Reduce overall mobility demand, Consumer sensitization / education on the environmental impacts of cars, Consumer information on the environmental impacts of cars, Promote city life and Implementation of road pricing schemes.

Main comments from industry

One stakeholder claimed that the objective of reducing the overall mobility demand is wrong, by stating that it should not be reduced but managed in a better way.

One stakeholder wonders why the revaluation of city life would be so beneficial and calls this objective not necessarily sustainable.

Both industrial stakeholders stress that this objective in itself will not result in an environmental improvement unless the collected taxes are positively used to invest in mobility projects.

Main comments from policy

One policy stakeholder wonders whether the consumer information objective is effective: many people do not use the information they have.

Main comments from environmental NGOs

The consumer sensitization and education objective received the remark that it might only have effect on the long term, because of the strong position the car holds in one's life.

The same argument holds true for the consumer information objective.

Both NGO respondents call the implementation of road pricing schemes a valuable objective, certainly if a differentiation is introduced according to the time and place and type of car. They also call for political courage and ample preparation as this is a known unpopular measure.

Main comments from consumers

The consumer sensitization and education objective needs to be accompanied by more actively incentive measures in order to pursue a substantial change.

The revaluation of city life is called an absolute social must, that also offers a lot of answers to the mobility question.

Main comments from trade unions

A stakeholder found the objective of reducing the mobility demand impossible to achieve, certainly if no measures are taken to promote and develop the public transport (Note, however, that these measures would rather aim at shifting the mobility demand than at reducing it).

The consumer sensitization and education objective is believed not to be realistic as the driving attitude can not easily be changed by political measures due to the car's strong social status.

Agreements on this strategy

The numerical appreciation of the stakeholders shows that the objective of promoting city life is rated as the most popular one; there is also a lot of agreement on that objective. The other objectives score averagely, whereas the objective of road pricing provokes a lively debate, receiving very positive marks from policy and environmental NGO's, and very negative reactions from industry and research.

3.3.4.2.2 Scenario 4 : optimizing the product's life span

This scenario assumes a yearly increase of a passenger car's life span of 1,5%. This assumption has important implications on the sales figures, because the longer a product is used, the less products need to be bought for replacement.

	CO_2 emissions (kt eq CO_2/yr)			Raw materials (kt eq Sb/yr)			Waste (kt/yr)		
	2000	**2010**	**trend**	**2000**	**2010**	**trend**	**2000**	**2010**	**trend**
BAU	**18463**	**19505**	**+5,6%**	**174**	**243**	**+40%**	**8,3**	**13,0**	**+57%**
Scenario 4	**18463**	**19156**	**+3,8%**	**174**	**225**	**+29%**	**8,3**	**12,8**	**+54%**
Production (avg. 2000-2010)	**10,7%**			**21,5%**			**0,0%**		
Use phase (avg. 2000-2010)	**88,7%**			**78,5%**			**24,2%**		
Disposal (avg. 2000-2010)	**0,6%**			**0,0%**			**75,8%**		

During the stakeholder consultation phase, two objectives have been identified as to pursue the scenario goal: Promote prolonged use of cars and Increase car maintenance.

Main comments from industry

Two industrial stakeholders doubt about the efficiency of the prolonged car use objective. One of them for instance proposes to combine it with the compulsory use of a catalytic converter.

Main comments from policy

One stakeholder doubts whether a prolonged car use can be beneficial for the environment.

The increased car maintenance is welcomed as a good objective, that however does not contribute (much) to the overall goal of environmental improvement.

Main comments from environmental NGOs

If on a scientific basis it is proved that a prolonged car use is better for the environment, then this stakeholder agrees on this objective. However, in order to achieve the objective, it would be best to use a financial incitation measure rather than information and sensitization measures.

The increased car maintenance objective is received positively, although the respondent stresses that its environmental influence is low (merely on local pollutants), while the positive effects on e.g. road safety are much higher.

Main comments from consumers

Two consumer organizations replied moderately positive to the first objective, and both suggested to include one constraint, namely to actively control the cars on their environmental performance (e.g. during yearly technical inspection) or to restrict the promotion of second-hand cars to those that are younger than 10 years.

Agreements on this strategy

Many respondents doubt the positive influence of a longer use time for passenger cars. In this project, we calculated the influence as positive. It needs, however, to be stressed that there is a lot of uncertainty with respect to the calculation. The doubts therefore seem to be rather intuitive and are contradicted by this quick calculation example.

The numerical appreciation by the stakeholders shows that both objectives score about average, with no extreme marks.

3.3.4.2.3 Scenario 5 : rational product use

This scenario is based on the voluntary agreement of ACEA, which states that the average CO_2 emissions of all new passenger cars entering the European market will be reduced by 25% by the year 2008 compared with 1995 levels. CO_2 emissions need to be cut therefore by 46 to 140 g/km in 2008. Because the time horizon in this study is only till 2010, the impact of this measure would only last for 3 years (2008-2010). In order to compensate for this small period of influence, in this scenario it was supposed that this measure would be finalized already in 2005. It should be noted that attaining this agreement has only a comparatively smaller influence on the results, because the emissions are only influenced during 6 years instead of 10 (2001-2010).

	CO_2 emissions (kt eq CO_2/yr)			**Raw materials (kt eq Sb/yr)**			**Waste (kt/yr)**		
	2000	**2010**	**trend**	**2000**	**2010**	**trend**	**2000**	**2010**	**trend**
BAU	**18463**	**19505**	**+5,6%**	**174**	**243**	**+40%**	**8,3**	**13,0**	**+57%**
Scenario 5	**18463**	**18856**	**+2,1%**	**174**	**243**	**+40%**	**8,3**	**13,0**	**+57%**
Production (avg. 2000-2010)	**11,8%**			**22,4%**			**0,0%**		
Use phase (avg. 2000-2010)	**87,6%**			**77,6%**			**24,8%**		
Disposal (avg. 2000-2010)	**0,6%**			**0,0%**			**75,2%**		

During the stakeholder consultation phase the following objectives have been identified as to pursue the scenario goal: Increase occupancy rates, Consumer sensitization / education on more efficient product use, Reduce emissions and increase fuel efficiency and Reduce emissions due to idle engines and congestion.

Main comments from policy

One political stakeholder believes the objective of consumer sensitization / education to be a crucial one, however, rather to be pursued through fiscal incentives in order to have an effect.

Main comments from environmental NGOs

One stakeholder feared that the objective of increased occupancy rates can not have large effects on the short and medium term.

Main comments from consumers

One stakeholder suggested to establish a better link with the public transport network in order to establish higher occupancy rates. In order to achieve that same objective, another respondent suggested to organize a carpool on school level and to draft up mobility plans for schools.

For the objective of consumer sensitization / education, a stakeholder again stresses the need to accompany the information measures with other, more incentive measures, e.g. to include an item of environmentally respectful driving into the driving education, and to improve the construction of the road network in order to stimulate environmentally respectful driving.

Main comments from trade unions

One stakeholder especially favoured the promotion of collective employee transport in order to increase the occupancy rates, which was one of the suggestions included into a measures of that objective.

Agreements on this strategy

Many respondents stress the need to install (fiscally) incentive measures in order to accompany the information and education measures, because they otherwise risk to have no effect.

The numerical appreciation of the stakeholders shows that the objective of the increasing occupancy rates receives high marks unanimously by all stakeholder groups. On the other hand, the information objective scores rather badly, probably due to the fact that it has been combined with other measures in order to ensure an effective change in consumer behaviour.

3.3.4.2.4 Scenario 6 : changing product composition

In this scenario we assume an accelerated change of passenger car material composition. This means that the change from steel use into aluminium and plastics use is doubled with regard to the BAU scenario: -10% of steel in 2005, and -20% in 2010 in comparison to 2000. These percentages are compensated for by an equal weight increase of aluminium and plastics. Although this assumption on equal weight may be fairly unnatural, it reflects a radical stop to the tendency of ever heavier cars (mainly because of the increasing number of accessories and safety measures) and we esteem it would be too ambitious to believe this tendency could be reversed in the short term. As a result, it is supposed to be no influence of this measure on the car's fuel efficiency.

	CO_2 emissions (kt eq CO_2/yr)			**Raw materials (kt eq Sb/yr)**			**Waste (kt/yr)**		
	2000	**2010**	**trend**	**2000**	**2010**	**trend**	**2000**	**2010**	**trend**
BAU	**18463**	**19505**	**+5,6%**	**174**	**243**	**+40%**	**8,3**	**13,0**	**+57%**
Scenario 6	**18463**	**19257**	**+4,3%**	**174**	**241**	**+38%**	**8,3**	**13,0**	**+57%**
Production (avg. 2000-2010)	**11,0%**			**21,6%**			**0,0%**		
Use phase (avg. 2000-2010)	**88,4%**			**78,4%**			**24,8%**		
Disposal (avg. 2000-2010)	**0,6%**			**0,0%**			**75,2%**		

During the stakeholder consultation phase, the following objectives have been identified as to pursue the scenario goal: Reduce car weight and Promote the use of different materials.

Main comments from environmental NGOs

This objective of reducing car weight is agreed to be a good idea.

Main comments from consumers

On the objective of reducing car weight, one stakeholder stresses the importance to stay in line with the current car safety norms. He also criticizes the trend for accessories to be increasingly included as a standard feature, that you can not avoid to buy even if you don't want it. Another stakeholder believes that the measures to attain the reduced car weight are judged very negatively by car hobbyists.

Main comments from trade unions

One stakeholder believes that reducing the car weight could conflict with road safety measures, and therefore calls the objective unrealistic.

Agreements on this strategy

From the written comments above as well as from the numerical appreciation by the stakeholders, we understand that the objective of reduced car weight is still strongly under debate (with policy favouring the objective and industry and trade unions rejecting it).

The objective of use of other materials receives quite high marks by all stakeholder groups and seems to form a relative consensus, although no answers were received by trade unions or consumer organisations.

3.3.4.2.5 Synthesis scenario

This last scenario reflects the combined effect of all changes assumed in the alternative scenarios (1, 4, 5 and 6).

	CO_2 emissions (kt eq CO_2/yr)			Raw materials (kt eq Sb/yr)			Waste (kt/yr)		
	2000	**2010**	**trend**	**2000**	**2010**	**trend**	**2000**	**2010**	**trend**
BAU	**18463**	**19505**	**+5,6%**	**174**	**243**	**+40%**	**8,3**	**13,0**	**+57%**
Synthesis scenario	**18463**	**16854**	**-8,7%**	**174**	**218**	**+25%**	**8,3**	**12,7**	**+53%**
Production (avg. 2000-2010)	**10,6%**			**21,1%**			**0,0%**		
Use phase (avg. 2000-2010)	**88,8%**			**78,9%**			**23,6%**		
Disposal (avg. 2000-2010)	**0,6%**			**0,0%**			**76,4%**		

3.3.4.2.6 Other scenarios

During the third research phase, some additional strategies have been submitted to the respondents, the environmental impact of which had not been computed during the second phase because it was expected to be of lower importance.

The concerned objectives are listed below.

PRODUCT SUBSTITUTION:

Encourage consumption of environmentally friendly cars,

Inform and sensitize consumers on (environmental impacts of) alternative car types,

Encourage consumers to use alternative transport modes,

Reward car manufacturers that produce eco-friendly cars and that invest in eco-R&D,

Discourage use of company cars.

MATERIAL RECYCLING:

Promote the use of more recyclates,

Increase efficiency of waste recycling processes,

radical change in the dismantling process.

REUSE:

Promote the fluent resell of second hand cars.

3.3.4.3 Conclusions on the product category

3.3.4.3.1 Technical potentials and synergies between impacts

An important trend exists for more vehicle kilometres to be driven. In the BAU scenario this trend is expected to hold on until much further than 2010. This trend is due to the increasing number of passenger cars in Belgium on the one hand, and to the increasing mileage per passenger car on the other. If this trend continues, the greenhouse gas emissions (in kton CO_2eq.) would become 30% higher in 2010 compared to 1990. The vast majority (more than 85%) of these life cycle emissions occurs during the use phase of the car; whereas the disposal phase accounts for a mere 0,5%. In the meantime, the raw material use would increase by 25% (mainly fuel use during the use phase; only ¼ during production phase), and waste production by about 10%.

Applying all above mentioned strategies could lead to a substantial reduction of these impacts (almost 9% reduction for greenhouse gas emissions compared to BAU in 2010). Yet, in comparison to the 1990 emission levels (which are the basis for the Kyoto protocol), the greenhouse gas exhaust would increase by more than 12% (still on the condition that all strategies mentioned above would be adopted and yield the effect as is foreseen).

Another trend in recent years concerned the 'dieselification' of the passenger car park. This trend has a mitigating effect on the GHG emission trend, but not (necessarily) on the overall environmental effect. In the same time, cars grow bigger and heavier, thus partly compensating for the improvements in the field of fuel efficiency that have been reached recently.

As can be seen from the following synthesizing graph which describes the effects of the different strategies, the impact of the different scenarios in terms of percentage of the BAU in 2010 is rather disappointing. However, as pointed out earlier, this relatively small percentage represents a very important absolute amount of impact reduction, due to the high importance of this passenger car product category, especially in the worldwide GHG emissions.

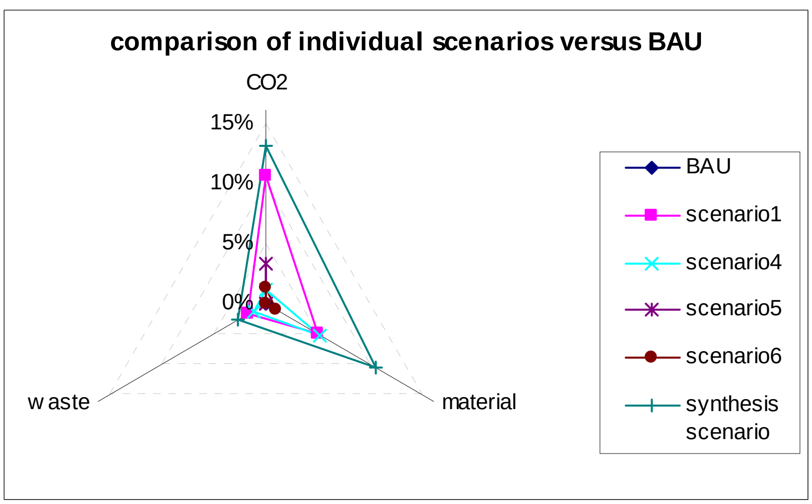


Figure 3 . Synergies between impacts for passenger cars.

Several strategies have an opposite influence on the impact categories studied here. That probably explains why stakeholder that have only few expertise in the field of the environmental impact of passenger cars can get confused easily and sometimes cause a severe inconsistency even within one stakeholder category. This also appeals for a standardised computation method for defining the environmental friendliness of a passenger car. Such an attempt is currently being undertaken by U.L.B., V.U.B. and Vito jointly in the project of Ecoscore, after several different approaches have been proposed during the last years. These results could mean an important enrichment of the calculations carried out in this project.

3.3.4.3.2 Conclusions from stakeholder consultation

The reduction of the environmental impact of passenger cars will be one of the fiercest challenges for reaching a sustainable traffic system and complying with the agreed norms of the Kyoto protocol. Targeting the demand becomes a very difficult task, that only results in clear improvements on a longer term (after which a change of attitude can be reached). Another comment often made, is about the way to achieve such a mentality shift: information alone will not greatly influence a driver's behaviour; more inciting (financially) measures need to be taken in order to produce an effect. However, if the necessary measures are taken, this strategy could certainly make the highest contribution the environmental impact reduction and should therefore not be neglected.

The above remarks on information, fiscal measures and the comparatively small effects on the short term largely apply for the objective on rational product use as well. This is the second most important strategy on the basis of its effectiveness; it can also yield an important environmental impact reduction (impact computed for only 6 years: 2005-2010).

The strategy on optimising a product's life span was received with a lot of ambiguity by many respondents concerning the environmental benefit this strategy produces. The changing product composition strategy, which is also subject to two opposite environmental tendencies (namely higher weight and higher plastic production), as well received quite different answers, mostly from people who are not familiar with the subject and only used their common sense to assess proposed measures.

3.3.5 Computers and paper

3.3.5.1 Introduction : general comments

The global aim of this case study is to compare the impacts from computers to the ones due to paper consumption related to computer use. This leads to 2 different challenges. For computers, our calculations underlined the importance of impacts in the production phase. Thus, computers should be considered not only as products needing energy in the use phase (electricity), but also products resulting from very energy-intensive processes, which are thus worthy of careful treatment as a "waste", and where reuse is a policy option which could lead to substantial environmental benefits. Concerning paper, most paper used in Europe results from sustainable management of trees, in Scandinavia, Portugal and North America. The main challenge is thus not deforestation, but rather the challenge due to the recycling of paper. Indeed, recycled paper has smaller environmental impacts but there is an increased shortage of used paper which is now going on the international market. Increasing the collection rate of used paper is thus necessary in order to prevent further shortage.

Several comments were made about the classification of this product category, which seemed artificial. Some stakeholders underlined that a better classification would have been to separate the equipment for which a substantial investment is needed (hardware and software), and the consumable (paper, ink, etc), since the possible policies and measures are quite different for these two subgroups.

The table below presents the number of stakeholders we contacted, and the numbers of each category that actually answered.

Stakeholder type	NbUsers	NbAnswers
environmental NGO	9	1
trade unions	4	0
policy	27	5
industry	26	8
research	10	2
consumer organisation	16	2
users tertiary	4	2

Table 8 : Overview of respondents of questionnaire on computer and paper.

3.3.5.2 Results per strategy

3.3.5.2.1 Scenario 1 : reduction of the final demand

	computers households									computers and paper FSE								
	CO2 emissions (kt eq CO2 /yr)			raw materials (kt eq Sb / yr)			waste (kt / yr)			CO2 emissions (kt eq CO2 /yr)			raw materials (kt eq Sb / yr)			waste (kt / yr)		
	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend
BAU	245	359	47%	2.38	2.99	26%	1.08	1.84	70%	22	19	-16%	0.37	0.31	-14%	2.35	2.30	-2%
scenario1	235	276	17%	2.38	2.31	-3%	1.08	1.46	36%	22	15	-33%	0.37	0.25	-33%	2.35	1.80	-24%
production phase in 2010	59%			18%			0%			34%			5%			0%		
use phase in 2010	36%			82%			0%			63%			95%			98%		
waste phase in 2010	4%			0%			100%			3%			0%			2%		

Objectives covering this strategy are Public sensitization; Services and Organization.

Main comments from industry

Industry emphasised the need for a product policy to change consumption patterns, but not consumption levels. The development of services vs computers (e.g. through the increase of computer centres) was not seen as a good idea due to possible side-impacts on traffic. However, in order to decrease the "digital gap", the industry is favourable to the presence of free PC access in town halls. Last, concerning the decrease of the demand in the federal public services, this does not appear as feasible by the industry.

For the actors from the social economy (selling second-hand computers), it is important to inform the consumers about the impacts from computers when they buy one. Especially, information on the cost of upgrading vs. the cost of a new computer.

Main comments from environmental NGOs

For environmental NGOs, decreasing the demand would be possible through the subvention of specialised SMEs which could bring to households the use of software.

Main comments from consumers and users

For consumer organisations, the symbolism of computers is now so important that targeting the final demand would be extremely difficult.

Position and comments from researchers

Researchers in sociology also think that the symbolism of computers is now so important that targeting the final demand would be extremely difficult.

Agreements on this strategy

There seems to be an agreement with the difficulty of the task of controlling the demand for computers, both in households and in offices. Increasing services seems the only possible solution, but a further analysis of the impacts associated with them, as well as the means to promote them, would be necessary.

3.3.5.2.2 Scenario 2: product substitution

	computers households									computers and paper FSE								
	CO2 emissions (kt eq CO2 /yr)			raw materials (kt eq Sb / yr)			waste (kt / yr)			CO2 emissions (kt eq CO2 /yr)			raw materials (kt eq Sb / yr)			waste (kt / yr)		
	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend
BAU	245	359	47%	2.38	2.99	26%	1.08	1.84	70%	22	19	-16%	0.37	0.31	-14%	2.35	2.30	-2%
scenario 2	245	346	41%	2.38	2.86	20%	1.08	1.66	54%	22	14	-34%	0.37	0.27	-26%	2.35	2.23	-5%
production phase in 2010	60%			18%			0%			29%			4%			0%		
use phase in 2010	36%			82%			0%			68%			96%			99%		
waste phase in 2010	4%			0%			100%			3%			0%			1%		

Objectives covering this strategy are Energy Efficient Equipment and Power Supply Efficiency.

Main comments from policy

Stakeholders from the administration commented that public eco-procurement is already being undertaken.

Main comments from industry

Concerning this strategy, the industry underlines the fact that such a substitution must be carried out carefully, taking into account the whole life cycle impacts of the different products as well as a cost / benefit analysis of the change. Attention must also be paid to side-effects of such changes, e.g. concerning the security of the product.

Concerning possible measures, ecolabels are not seen as a good measure since it is not a compulsory label, thus disadvantaging other environment friendly products.

They also comment that international discussions have already started to develop the Energy Star label.

Main comments from consumers and users

For consumer organisations, the promotion of energy efficient computers should preferably take place through compulsory labels rather than ecolabels, because consumers are not receptive to labels. For the same reason, developing existing labels should be preferred to creating new ones.

Main comments from researchers

For researchers, rather than developing new labels, field agreements should be preferred.

Agreements on this strategy

There is a general disagreement on the promotion of ecolabels for computers (they are considered to be ineffective labels). Stakeholders agree that a better solution to promote the use of energy-efficient equipment would be the development of existing compulsory labels, or by field agreements.

3.3.5.2.3 Scenario 3: product reuse

	computers households									computers and paper FSE								
	CO2 emissions (kt eq CO2 /yr)			raw materials (kt eq Sb / yr)			waste (kt / yr)			CO2 emissions (kt eq CO2 /yr)			raw materials (kt eq Sb / yr)			waste (kt / yr)		
	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend
BAU	245	359	47%	2.38	2.99	26%	1.08	1.84	70%	22	19	-16%	0.37	0.31	-14%	2.35	2.30	-2%
scenario 3	245	185	-24%	2.38	2.71	14%	1.08	0.37	-66%	22	13	-40%	0.37	0.31	-17%	2.35	2.26	-4%
production phase in 2010	27%			5%			0%			10%			1%			0%		
use phase in 2010	71%			95%			0%			89%			99%			99%		
waste phase in 2010	2%			0%			100%			1%			0%			1%		

Objectives covering this strategy are Software; Upgradeability; Reuse PCs; Reuse market and Leasing.

Main comments from industry

For industry, reuse can be an attractive option if scientific evidence suggests that it is an effective and environmentally friendly solution, and provided that it can be implemented at a reasonable cost, without detracting from the technical characteristics required for the intended application. The limitations with respect to reuse make it very important to continue encouraging research and development (R&D). The promotion of second-hand computers is not always the best solution, since the energy efficiency of new PCs are better than for older ones.

For the actors from the social economy, computers "cost" a lot during their production in terms of environment. Increase their life span is therefore logical. They are also in favour of open-source software, which enables the consumers to have a flexible system which can evaluate as they wish.

They also underline that reused computers do not directly compete with new ones on the market; on the contrary, they fulfil different needs (e.g. basic needs in terms of speed and power) in a responsible manner. Finally, they agree with the need to increase the upgradeability of computers, which should be carried out in the assembly phase.

<u>Main comments from consumers and users</u>

Consumer organisations warn about a possible rebound effect, where people who cannot afford a new computer could possibly buy a used one, thus increasing the penetration rate of computers in households.

Also, the network of second-hand equipment sales should be associated with the new equipment network, so that sales persons can orientate the consumer towards the best choice for him depending on needs and constraints. But in this case, second-hand equipment should be interesting to sell for the new equipment distribution network. They also suggest to develop a tool to know the characteristics of the computer fulfilling the consumer's needs. This tool could be supplied through the internet and why not on sales points.

<u>Main comments from environmental NGOs</u>

For environmental NGOs, in order to lengthen the life span of computers, their design is very important (for maintenance in particular).

<u>Agreements on this strategy</u>

In this strategy there is a clear opposition between the industry and the social economy actors. However, this strategy is particularly important for computers, as about half of their CO_2 emissions occur in the production phase. Further research and market studies would be necessary to determine if second-hand computers compete with new ones on the market place, and if developing them would lead to a rebound effect. It should be emphasised that developing the market for second-hand computers could possibly lead to the creation of new jobs in Belgium.

3.3.5.2.4 Scenario 5 : improvement of product use

	computers households									computers and paper FSE								
	CO2 emissions (kt eq CO2 /yr)			raw materials (kt eq Sb / yr)			waste (kt / yr)			CO2 emissions (kt eq CO2 /yr)			raw materials (kt eq Sb / yr)			waste (kt / yr)		
	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend
BAU	245	359	47%	2.38	2.99	26%	1.08	1.84	70%	22	19	-16%	0.37	0.31	-14%	2.35	2.30	-2%
scenario 5	245	344	40%	2.38	2.68	13%	1.08	1.84	70%	22	16	-27%	0.37	0.24	-36%	2.35	1.92	-18%
production phase in 2010	62%			20%			0%			41%			7%			0%		
use phase in 2010	33%			80%			0%			56%			93%			98%		
waste phase in 2010	5%			0%			100%			3%			0%			2%		

Objectives covering this strategy are Computer use; paper use; Environment friendly paper and paper recycling.

<u>Main comments from public actors</u>

Public actors (federal) think that the paper recycling rate is already high and that increasing the efficiency would be difficult.

Main comments from industry

The industry is of the opinion that the sustainable use of raw materials must be encouraged. To this end, information and education are important tools targeting the consumer.

The increase of recycled paper use was extensively discussed by the industry. They commented that old paper is now becoming a rare commodity, due to its increased usage by the Asian economies (mainly China) to manufacture packaging cardboard. Thus, promoting the use of recycled paper would only strengthen this scarcity problem. Moreover, paper can only be downcycled, i.e. recycled for a lower quality usage. Graphic paper is at the top of this "recycling pyramid", it requires high-quality paper, thus it always needs the use of virgin fibres, and it also requires the use of high-quality recycled paper. For industry, the increase of paper recycling raises the issue of the supply of "raw material", i.e. old paper. The sector thus pleads for an optimisation of collection and not for the increase of recycled paper use.

Main comments from consumers and users

Concerning alternative labels besides the ecolabels for paper, both the industry and consumer organisations suggest to develop environmental product declarations, which may be restricted to a few selected criteria. This is under development for tissue paper. Meanwhile, the ISO14001 or EMAS certification of a company could be used as a basis for the selection of environment-friendly paper.

Position and comments from researchers

Many comments underlined the necessity for the computer itself to help the consumer to use it more efficiently. For example, for sociologists, stand-by enabling should be set up automatically and less easily changed by users. Also, the benefits for consumers (households and workers in the tertiary sector) should be clearly stated and given to them, in order to increase the efficiency of information. For paper, they think that the recycling rate is already high and that consumers tend to stop their efforts at that point.

Agreements on this strategy

There is agreement on the possible development of environmental product declaration schemes for graphic paper, while ecolabels are not seen as a good possible measures. Concerning the recycling of paper, the industry emphasises its importance, but other actors seem to think it would be difficult to increase it.

3.3.5.2.5 Scenario 7 : material recycling

	computers households									computers and paper FSE								
	CO2 emissions (kt eq CO2 /yr)			raw materials (kt eq Sb / yr)			waste (kt / yr)			CO2 emissions (kt eq CO2 /yr)			raw materials (kt eq Sb / yr)			waste (kt / yr)		
	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend
BAU	245	359	47%	2.38	2.99	26%	1.08	1.84	70%	22	19	-16%	0.37	0.31	-14%	2.35	2.30	-2%
scenario 7	245	355	45%	2.38	2.99	26%	1.08	0.00	-100%	22	18	-16%	0.37	0.31	-15%	2.35	2.25	-4%
production phase in 2010	60%			18%			0%			35%			5%			0%		
use phase in 2010	36%			82%			0%			63%			95%			100%		
waste phase in 2010	3%			0%			0%			2%			0%			0%		

Objectives covering this strategy are Take back and Computer recycling.

Main comments from industry

The industry is of the opinion that 1) no measures can be imposed which make the use of recycled material obligatory and 2) market forces themselves must determine where the raw materials yielded via recycling can be most effectively deployed.

For the social economy actors, this strategy is an "end-of-pipe" measure that is only efficient if accompanied by priority measures linked to prevention and reuse. Experience with RECUPEL for white goods shows that monetarisation of flows inhibits reuse and limits the freedom of stakeholders in terms of private initiatives. Moreover, the IT sector works in a business to business view, thus old equipment often find solutions in the framework of leasing contracts or sales with / without take-back of old equipment.

Position and comments from environmental NGOs

In general, environmental NGOs insist on the fact that public authorities must orientate industrial policy depending on determined social objectives. But we now observe more and more the contrary: companies guide political action depending on their own objectives. It should be remembered that economic instruments would be very useful to send the necessary signals to reorient production and consumption patterns. These instruments are more and more refused by industry delegates. On the contrary, sensitization measures which have minor impact, are supported. Public authorities should overcome these wishes and target public interest. Is the intuitive understanding of the different suggested measures really significant? The choice should certainly depend on an independent socio-economic study. Experience shows that the estimation of the costs of environmental measures have often been overestimated.

Agreements on this strategy

For this strategy, it is difficult to make conclusions. The industry is against regulations in the field of recycling, and the social economy thinks this should not be a preferred strategy (rather reuse).

3.3.5.2.6 Synthesis scenario

	computers households									computers and paper FSE								
	CO2 emissions (kt eq CO2 /yr)			raw materials (kt eq Sb / yr)			waste (kt / yr)			CO2 emissions (kt eq CO2 /yr)			raw materials (kt eq Sb / yr)			waste (kt / yr)		
	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend	2000	2010	trend
BAU	245	359	47%	2.38	2.99	26%	1.08	1.84	70%	22	19	-16%	0.37	0.31	-14%	2.35	2.30	-2%
scenario synthesis	235	139	-41%	2.38	2.12	-11%	1.08	0.00	-100%	22	11	-51%	0.37	0.21	-43%	2.35	1.42	-39%
production phase in 2010	23%			4%			0%			12%			1%			0%		
use phase in 2010	76%			96%			0%			86%			99%			100%		
waste phase in 2010	1%			0%			0%			1%			0%			0%		

This last scenario reflects the combined effect of all changes assumed in the alternative scenarios.

3.3.5.3 Conclusions on computers and paper

3.3.5.3.1 Technical potentials and possible synergies

The trend for computers in households is towards increasing impacts up to 2010. This is due to the increasing penetration rates of computers in households. If this trend continues, CO_2 emissions should be 47% higher in 2010 than in 2000. It should be noticed that the production phase accounts for about half of these emissions. Raw material use should increase by 26% (mainly due to electricity use in use phase) and waste production by 70%. Applying all above-mentioned strategies could lead to a substantial reduction of these impacts (61% reduction for CO_2 emissions compared to BAU in 2010) and to the "zero waste" target by collection and recycling.

For computers and paper in the Federal Public Services, the trend is towards decreasing impacts, due to the shift to laptops and LCD screens, and to the improvement of the efficiency of the paper manufacturing process. But the technical potentials are smaller, there is actually less margin of action than in households. In 2010, the identified technical potential is a reduction of 43% of CO_2 emissions (compared to BAU).

There are clear synergies between impacts, i.e. a measure targeting one particular impact is very likely to also positively influence other impacts.

We however would like to emphasise, for this product category, that due to rapid technology changes in the field new products could appear in the near future that could change this picture in a significant manner.

3.3.5.3.2 Results from stakeholder consultation on policies and measures

For computers, targeting the demand would be a very difficult challenge; this may be possible through the increase of services offering the use of computers, but further research would be needed in this area. The other important issue is the reuse of computers. Indeed, computers are now replaced due to technological evolutions, not to actual breakdown of the equipment. However, for most uses, these computers may still be sufficient. The social economy collect and reuse some of them, however this is not very positively perceived by the industry. There could be room for communication between stakeholders on this area, since the development of reused computers could be very useful in order to decrease their impacts. Concerning energy use in the use phase, the further development of existing labels seem the preferred option for all stakeholders.

For paper, the industry identified the problem of the shortage of used paper on the international market. Promoting the use of recycled paper would thus be difficult to envisage if besides there is no increase of the collection rate of used paper. However, since this collection rate is already high, motivating users would not be an easy task. On the issue of environment-friendly paper, there is an agreement to develop a label based on the EMAS and ISO 14001 certification, while starting negotiations on the international level for EPD-based labels. Ecolabels do not seem an efficient way to sensitise consumers.

3.4 Uncertainties and precautions for interpretation

The results presented above should be interpreted keeping in mind several parameters.

3.4.1 Uncertainties in the theoretical potentials

First, the life cycle approach of the four case studies imply methodological choices which were explained in details in the previous intermediate report.

As any modeling of scenarios, the results obtained are subject to some uncertainty that depends mainly on the level of ambition of the hypothesis that were made. In addition to this ambition level assumed to calculate alternative scenarios, the sources of uncertainties inherent to the analysis must also be taken into account.

The uncertainty results from the boundaries of the product system considered, the inaccuracy of data used, and also from the assumptions made at different levels of the modeling. It was not possible to quantify the uncertainty of results. However we have qualified it in relation to the different data types (existing or estimated).

- Some of the uncertainties are influencing more the global level of impacts in the BAU, than the relative gap between the BAU and the alternative scenarios.

- On the other hand, other uncertainty sources are affecting both.

In general, the uncertainty is the lowest for computers and paper, for which the uncertainties mainly affect the absolute level of impacts, but not the percentages of reduction. It is the highest for beverage and food packaging, for which the uncertainties on LCI data are important. For building, the uncertainty related to composition affects more particularly scenario 6 (changing the composition).

3.4.2 Precautions for the policies and measures

The list of possible policies and measures was identified with the aim of decreasing environmental impacts from the four product categories chosen as case studies. The consultation was a first insight in the evaluation of the proposed policies and measures. When interpreting the results of the consultation, the following points should be kept in mind:

- The number of stakeholders who participated was limited, and their representativeness is thus not asserted. However, we think that most of the main stakeholders answered or were represented.

- The criteria which were evaluated give a first picture of the main issues, but is not sufficient for a complete evaluation. We concentrated on the environmental side of the issue, though giving a first view of the social and economic consequences, but a complete evaluation would require further work.

- It is not our aim to draw conclusions on controversial issues. Although some measures led to an agreement among the different stakeholders, this was far from being the general case.

Thus, we recommend to interpret the results from the consultation as a first opinion mapping of the different stakeholder categories in Belgium on possible product-oriented measures. Further work would be required in order to evaluate precisely possible measures on their socio-economic consequences (including costs/benefits analysis) and the opinion of a larger number of stakeholders should be sought.

4 Evaluation of the methodology used for stakeholder consultation (Delphi method)

The Delphi method is used since several decades for consultation. We decided to use it because it seemed that it best fitted with the aims of our consultation of stakeholders, and also because its advantages and drawbacks are now well studied. Putting this method in practice thus highlighted the precautions to take for its good implementation.

First, we found that indeed the drawing up of the questionnaire was a crucial phase, where expertise is needed in order to phrase the questions clearly. In our case, the wording of measures seemed to be rather well understood, but the explanation of the criteria, as well as the way to give figures for each of them, was not well understood.

Also, we noticed that most stakeholders either did not read the reports of the previous phase, or did not keep them in mind while answering. Obviously, the reports were long and technical, and providing more background in the questionnaire, and not in the form of reports, could have helped stakeholders.

On the other hand, we think that the Delphi method is indeed a very good way to obtain stakeholders' opinions without the drawbacks of a conference – i.e. some people not being able to give their comments because of other people talking too much. Each person could give as many comments as desired, on subjects ranging from a general opinion on the study to practical details for the implementation of measures. However, when we summarised their comments afterwards, due to the fact that some stakeholders answered more widely than others, we still felt that there was a bias in the results. Having the answers from a larger number of stakeholders in some category would have globally given them more impact.

5 Conclusions

This study enabled us to undertake one of the first bottom-up analysis of an economy in Europe (here, the Belgian economy, based on its consumption). This global life cycle evaluation of the impacts of the Belgian consumption in terms of GHG emissions, resource use and waste production was thus limited by data availability problems, as well as necessary methodological choices. However, it allowed us to have an insight on the levels of impacts resulting from the different product groups. This is summarized in the following table.

	Inputs			Outputs	
Function class	Energy	Intermediate material	Raw materials	emissions to air GHG	waste
BUILDING STRUCTURE	6.3%	78.8%	61.9%	10.8%	79.5%
BUILDING OCCUPANCY	38.2%	0.4%	0.9%	33.7%	0.2%
FURNITURE FOR INTERIOR	0.4%	1.0%	1.0%	0.8%	1.1%
ELECTRICAL APPLIANCES	9.8%	0.9%	2.6%	5.6%	0.7%
HEALTHCARE AND DETERGENTS	1.0%	1.3%	0.5%	0.3%	0.7%
TRANSPORT	33.7%	3.2%	15.1%	36.4%	3.2%
LEISURES	1.7%	0.2%	1.1%	1.0%	0.2%
INFORMATION TECHNOLOGIES AND PAPER	3.4%	4.9%	4.8%	3.4%	4.5%
GARDEN	0.3%	0.1%	0.4%	0.2%	0.1%
PACKAGING	4.7%	8.7%	11.5%	6.6%	9.3%
TEXTILE	0.6%	0.4%	0.3%	1.2%	0.4%

	30%
15%	*30%*
5%	*15%*

Table 9. Results of the calculation of impacts from the Belgian consumption

We then analyzed four case studies : computers and paper, housing, cars and household packaging. Though these cases were chosen at the beginning of the project, we see that two of them (namely housing and passenger cars) appear as having important impacts. For all four case studies, we identified opportunities for improvement in terms of environmental impacts. The table below summarizes these impacts and the theoretical potentials that we calculated. Moreover, our research showed clear synergies between GHG emissions, resource use and waste production, therefore showing the opportunities that can derive from measures targeting any of these three impacts.

		computers and paper		building structure	household packaging		Passenger cars
		office equipment	computers in households		beverage	food	
definition of function		copiers and computers in the Federal Ministries	computers in belgian households	Building structure of single family housing	primary packaging and secondary group packaging		entire car park of Belgium
level of CO_2 emissions in 1990/2000		18.7 ktons in 1990	133 ktons in 1990	2200 kton in 1990	610 kton in 2000	550 kton in 2000	15 000 kton in 1990
GHG emissions in 2010 as compared to 1990 levels (%)	BAU	0%	+170%	0%	-10%	+6%	+30%
	synthesis	-43%	+5%	-38%	-28%	-18%	+13%
national share of CO_2 emissions		15%	25%	>65%	<20%	<20%	+/- 90%
level of raw material use in 1990/2000 (equivalent Sb)		0.34 ktons in 1990	1.2 ktons in 1990	13.7 ktons in 1990	1.47 ktons in 2000	3.55 ktons in 2000	195 ktons in 1990
raw material use in 2010 as compared to 1990 levels (%)	BAU	-9%	+150%	-9%	-21%	+6%	+25%
	synthesis	-38%	+78%	-30%	-33%	-6%	+12%
level of waste production in 1990/2000 (ktons ultimate waste)		2.1 ktons in 1990	0.59 ktons in 1990	1350 ktons in 1990 (includes production waste)	31 ktons in 2000	37 ktons in 2000	12 ktons in 1990
waste production in 2010 as compared to 1990 levels (%)	BAU	+10%	+211%	-19%	-74%	-54%	+10%
	synthesis	-32%	-100%	-49%	-80%	-65%	+7%

Table 10. Overview of theoretical improvement potentials for the four case studies.

We then envisaged a series of measures which could help to reduce the environmental impacts of these four case studies. These measures were submitted to a series of stakeholders in order to evaluate their perceived efficiency and feasibility, as well as acceptance. Though the original aim was to derive from this the calculation of realistic improvement potentials, we perceived the results obtained as not sufficient to establish a solid basis for this calculation. We thus limited our work to a first mapping of the different opinions of the main stakeholders on these measures. This enabled us to find agreements on possible measures, or on the contrary to underline disagreements between stakeholders on some issues. Though the consultation was limited in time and in scope, and though further work would be necessary before drawing clear conclusions, this enabled a first overview of the possibilities for a product policy to contribute to the reduction of the environmental impacts from these four product categories.

6 Dissemination of results

- 2002 – 2004 : Participation to the working group on sustainable construction of the Belgian Building Research Institute. Presentation of the results of phase 1 in 2003, and presentation of the theoretical improvement potentials for housing in 2004.

- Round Table and Workshops, December 9th, 2002, Brussels, Belgium on phase 1 of this study. The methodology and results were presented to invited stakeholders (mainly representatives Belgian policy, industry, researchers and environmental NGOs). A workshop was held for each product category that was to be the subject of phase 2 and 3 of this project. A detailed report (Dutch or French) with conclusions from this round table and product workshops can be consulted if required (please contact authors for this).

- European IPP network meeting, June, 30th 2003, Bern, Germany. Presentation by ICEDD of the database developed for the first phase of the project, as well as the results of the first phase of this project.

- International Workshop on Quality of LCI Data, 20 to 21/10/2003, Karlsruhe, Germany, organized by UNEP/SETAC, Forschungszentrum Karslruhe. Presentation of paper "Identifying key products for the environmental federal product policy", B. Jansen, Vito. This paper describes the work done in phase 1 of this project and discusses the aspects of data quality.

- Workshop in framework of EIRES project (see chapter 1.2.3), 29/10/2003, Brussels, Belgium, organized by the EIRES project coordinator for the project team and representatives of ESTO, IPTS, EC DG ENV and DG TREN. At this workshop, a presentation was given by authors of existing studies, a.o. this Belgian study (results and methodology of phase 1, presented by Vito).

- Information day, October, 27th 2004, organized by ICEDD and VITO. Information day with presentation on the preliminary results from this study in general, phase 1 and 2 and in more detail on the consultation of stakeholders on policies and measures. All stakeholders who were contacted for the consultation were invited.

- December 2004 - onwards : participation to the exposition at the PASS (Parc d'aventures scientifiques, Mons) on sustainable development. This project was one of the projects financed by the PPS Science Policy that was presented to a large public. This required some vulgarisation efforts.

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The annexes of the report are available at the website of the Belgian Science Policy :

http://www.belspo.be/FEDRA, research actions CP, CP-13